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Monique Lamers
Peter de Swart *Editors*

Case, Word Order and Prominence

Interacting Cues in Language Production and Comprehension

Springer

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Preface

This volume grew out of a series of workshops held at the Radboud University Nijmegen in the period 2005–2007, and culminating in the meeting entitled "Case, Word Order, and Prominence" in November 2007. These workshops were part of the project Incremental interpretation of case and prominence (2005–2008), a research project financed by the NWO-DFG bilateral cooperation programme as a collaboration between Helen de Hoop and Monique Lamers (Radboud University Nijmegen) in the Netherlands and Matthias Schlesewsky (Phillips University of Marburg, now at the Johannes Gutenberg University Mainz) and Ina Bornkessel-Schlesewsky (MPI for Cognitive Neuroscience Leipzig, now at the Phillips University of Marburg) in Germany.

We would like to thank all participants of these workshops for making them a success. The contributors to this volume are thanked for their enthusiastic cooperation, their patience and all their efforts in helping to bring this volume about. Thanks as well to the editors of the series for giving us the opportunity to make this book, and to the reviewers of the book manuscript for their helpful suggestions. A huge thank you goes to Helen van der Stelt and Jolanda Voogd at Springer who provided invaluable help during the entire process. We also thank Marije Zegwaard (VU University Amsterdam) for her help in preparing the final manuscript for publication. Special thanks go to our (by now former) colleagues of the research group Optimal Communication at the Radboud University Nijmegen, in particular Helen de Hoop, without whom we would have never started this book.

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Abbreviations

1	1st person
2	2nd person
3	3rd person
A	Actor
ABL	Ablative
ACC	Accusative
AMB	Ambiguous, ambiguity
an	Animate
AOR	Aorist
APPL	Applicative
AUX	Auxiliary
BIUQ	Biuniqueness Principle
BP	Bare plural-before-proper name word order
CAUS	Causative
CBRI	Conflicting bindings retrieval interference
CL	Clitic
CLF	Classifier
CN	Connector
CP	Complementizer phrase
CT	Comprehension task
CVB	Converb
DAT	Dative
DClD	Dative clitic doubling
DEF	Definite (article)
dep	Dependent
DET	Determiner
DO	Double object
DOM	Differential object marking
DP	Determiner phrase
ERG	Ergative
ERP	Event related (brain) potentials

F0	Fundamental frequency
F, FEM	Feminine
FPRT	First-pass reading time
FUT	Future
FV	Final vowel
GEN	Genitive
GL	Goal
HAB	Habitual
HSPM	Human Sentence Processing Mechanism
ICE-GB	International Corpus of English
IPF	Incremental Parallel Formulator
in	Inanimate
indep	Independent
INF	Infinitive
INS	Instrumental
INV.O	Inversive object
INV.S	Inversive subject
IO	Indirect object
IPG	Incremental Procedural Grammar
LMT	Lexical Mapping Theory
M, MASC	Masculine
NOM	Nominative
NP	Noun phrase
NPAG	Noun phrase agent
NPREC	Noun phrase recipient
NPST	Non-past
NPTH	Noun phrase theme
O	Primary object
O2	Secondary object
OBJ	Direct object
obj1	First object
OBL	Oblique
OM	Object marker
Ag	Agent(ive verb)
Caus	Causative (verb)
Unacc	Unaccusative (psych verb)
OS	Object-before-subject word order
OT	Optimality Theory
PART	Participle
PASS	Passive
PFV	Perfective
PL	Plural
PN	Proper name-before-bare plural word order
PO	Prepositional object structure
PP	Prepositional phrase

PR	Preverb
PRF	Perfect
PRS	Present tense
PRT	Particle
PST	Past tense
PV	Preradical vowel
REL	Relative
RP	Regression probability
RPD	Regression path duration
RRP	Regressive re-reading probability
RRT	Regressive reading time
S, SUBJ	Subject
Sbj.-Exp.	Subject-experiencer
SG	Singular
s_H	Structural case, higher in the argument hierarchy
s_L	Structural case, lower in the argument hierarchy
SM	Subject marker
SO	Subject-before-object word order
SpecCP	Specifier position of CP
TAG	Tree-adjoining grammar
TFT	Total fixation time
TH	Theme
THM	Thematic suffix
U	Undergoer
V	Verb
V2	Verb second
VP	Verb phrase
WO	Word order
x_l	Lexical case
x_θ	Inherent case

The Interaction of Case, Word Order and Prominence: Language Production and Comprehension in a Cross-linguistic Perspective

Monique J.A. Lamers and Peter de Swart

Language offers language users a wide choice of syntactic forms to express a certain eventuality. Speakers have to choose lexical items, find the right form (e.g., case morphology) and place them in a particular order, taking into account the rules and constraints of their language system in such a way that the hearer will be able to analyze the expression to derive the meaning intended by the speaker. This fast and highly dynamic process of encoding and decoding the communicative content is one of the major puzzles of the human language faculty.

It is not surprising that the process of encoding and decoding is not always successful. This was, for instance, witnessed by a slogan used by the Dutch postal service (TNT Post) in an email campaign. Consider the following sentence:[1]

(1) *Een echte vriend stuurt u een echte kaart.*
a real friend send.PRS.2/3SG you.NOM/OBJ a real card

[1] A note on case morphology in Dutch. Morphological case distinctions are absent on Dutch nouns (beside certain fixed expressions). In the pronominal system one generally finds a distinction between a subject form (nominative) and a non-subject form (sometimes called the objective and glossed here as such). The latter form is a syncretism of the accusative and dative case and covers the functions of both the direct object and indirect object. For some pronouns such as *u* (2SG polite) a further syncretism is found between the nominative and objective case form resulting in a fully ambiguous morphological form.

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(i) 'You send a real friend a real card.'
(ii) 'A real friend sends you a real card.'

In the absence of unambiguous verbal inflection or case morphology on the arguments (more on this below), this sentence presents a classical case of a 'who-did-what-to-whom'-ambiguity. In this sentence both the noun phrase *een echte vriend* and the pronoun *u* can function as both the subject and the indirect object, resulting in two potential interpretations of the sentence. On the one hand, it can be seen as an invitation to start sending real, instead of electronic, cards to people the addressee considers real friends. This interpretation would correspond to the translation (i) 'you send a real friend a real card' (*een echte vriend* as the indirect object and *u* as the subject). This, however, is not the only possible interpretation of (1). In fact, a perhaps more natural interpretation is to read (1) as an invitation to the addressee to start sifting through his list of friends and consider only those that have sent him a real card as a real friend ('only friends that send you real cards are real friends', translation (ii) with *u* as the subject and *een echte vriend* as the indirect object). Clearly, this was not the interpretation intended by TNT Post as the body of the email message presented an offer to send one's New Year wishes by regular mail. Why, then, is the alternative interpretation so prominent?

In order to answer this question we have to consider a number of different factors that contribute to the realization and interpretation of arguments. The contributions collected in the present volume focus on three such factors: case, word order and prominence (i.e., an element's ranking on a hierarchy of semantic features, see below). Correspondingly, the aim of this volume is to shed some new light on argument realization and interpretation by bringing together recent research that addresses the role of case, word order and prominence as essential cues interacting with argument structure. Whereas previous research provides ample evidence for each of these cues independently the contributions in this volume specifically focus on possible interactions of these cues from both a theoretical and an empirical psycholinguistic perspective. Together they represent state of the art research demonstrating a variety of different methodologies and addressing different types of structures in a diverse sample of languages spoken in the world, including Mongolian, Chinese, Basque and Georgian, in addition to Western European languages such as English, Dutch and German that traditionally have been more at the center of psycholinguistic investigations.

From the different chapters it becomes clear that in each of these languages case, word order and prominence are essential cues for the speaker and hearer. These cues may all point in the same direction or they might provide conflicting information that has to be resolved by the speaker or hearer. Their precise interaction is dependent on language-specific characteristics such as the basic word order of a language, word order freedom and case-marking and agreement patterns. In order to develop a parsimonious model of the interdependence of these factors in language (use), we have to investigate the widest variety of structures and languages possible. The contributions to this volume bring us one step closer to this goal.

For now, let us return to our example in (1) and start looking at the verb. There are good reasons to do so as the verb takes up a central position in the realization and identification of arguments. Accordingly, verbs play a prominent role in many linguistic theories (for a comprehensive overview of theories of argument structure see Levin and Rappaport Hovav 2005). Verbs come with their own argument structure, which not only defines the number of arguments that should (or maximally can) accompany the verb but also specifies the relation between the arguments and between the arguments and the verb. Moreover, argument structure may make available certain case frames and put restrictions on what kind of referents can fulfill the roles associated with the verb. For instance, the Dutch ditransitive verb *sturen* 'to send' makes available the roles of Agent, Recipient and Theme that are all open to animate participants, whereas inanimate participates are generally only eligible for the Theme role. Hence, in our example in (1) only two possible linkings between referents and roles are possible, as demonstrated in (2). In other words, due to the argument structure specifications of the verb this specific combination of verb and arguments can result in two different meanings.

(2) (a) the invitation to send cards-reading

Agent	**Recipient**	**Theme**
|	|	|
you	a real friend	a real card

(b) the invitation to select friends-reading

Agent	**Recipient**	**Theme**
|	|	|
a real friend	you	a real card

Even though argument structure constrains the possible linking between referents and the roles in the eventuality or state expressed by the verb, it does not uniquely define how arguments are realized in language usage (i.e., the mapping from roles to syntactic functions), nor does it explain how language users are able to understand the wide variety of structures a speaker may produce. As to production, a speaker often has several options to link the arguments of a verb to grammatical functions through the choice of one of several available constructions (e.g., active or passive). In the case of a ditransitive verb like *send*, he can opt for a so-called prepositional dative construction (NP_{AG} V NP_{TH} to NP_{REC}) in which the recipient is realized as an oblique argument or for a double object construction (NP_{AG} V NP_{REC} NP_{TH}) in which it functions as an object. Psycholinguistic research has made it clear that argument realization as an incremental process not only depends on semantic and syntactic rules and constraints of the language system such as the (type of) verb involved, features of the argument and contextual factors (see the contributions to this volume by Aranovich and Huxley et al., for the English dative alternation see e.g., Bresnan et al. 2007; Gries 2005, a.m.o.) but also on factors such as accessibility and working memory (Bock and Warren 1985; Prat-Sala and Branigan 2000).

Apart from selecting the right grammatical functions, in many cases a speaker also has to decide on the position of the arguments in the surface string. Inspired by the typological work of Greenberg (1966) it has been established that most languages exhibit a basic word order (see e.g., Dryer 1992), be it in terms of grammatical functions (e.g., SVO in English, SOV in Dutch and German, or VSO in Welsh) or pragmatic notions (cf. topic-prominent languages such as Chinese, Hungarian and Tagalog). The existence of such a basic order may lead to a pattern of regularities that in turn may help the hearer to understand these utterances with relative ease, as it helps him to build up certain expectations for the incoming information. Analyzing a less preferred (non-canonical) structure will lead to enhanced processing costs, as might be reflected in longer reading times or differences in brain activity depending on the nature of the processes involved (see Erdocia et al., this volume). An interpretation preference that surfaces in many languages from different language families is the tendency to interpret the first constituent of an utterance as the subject. This subject first preference corresponds with the observation that in the basic order of many languages (84%) the subject tends to precede the object (Hawkins 1983). As shown in several contributions to this volume, this word order preference figures prominently in Dutch, German and Chinese providing a strong cue for argument structure comprehension (see for instance Lamers, Kretzschmar et al., Wang et al. in this volume for discussion). In fact, it is this preference that is (partially) responsible for the non-intended reading in (1) above. As shown in (3b), this reading satisfies the subject first preference, whereas the intended reading in (3a) results in an object-initial order, hence violating the subject first preference.

(3) (a) the invitation to send cards-reading (object-initial)

Object	**Subject**	**Object2**
(Recipient)	(Agent)	(Theme)
|	|	|
a real friend	you	a real card

(b) the invitation to sort friends-reading (subject-initial)

Subject	**Object**	**Object2**
(Agent)	(Recipient)	(Theme)
|	|	|
a real friend	you	a real card

The ambiguity in (1) then arises in part because Dutch, despite its canonical SO order, allows for word order permutations in which the object and the subject change places. The language is similar to German in this respect but different from English where (leaving questions out of consideration) we find a strict SV order with the subject preceding the verb and the object either following it (SVO) or preceding the subject (OSV). Due to this rather fixed word order the English word-by-word translation of (1) 'a real friend sends you a real card' is open to only one interpretation.

We thus see that the existence of a relatively free word order may result in indeterminacies in comprehension. This can be counteracted through the employment of coding mechanisms, in particular overt case marking (see de Swart 2007 for an overview of other mechanisms related to ambiguity avoidance). Case morphology can provide important information about the syntactic function of arguments and hence function as a cue in the comprehension of sentences and the resolution of (temporal) ambiguities (see Skopeteas et al., Häussler and Bader, Logačev and Vasishth in this volume for discussion, see also Bader and Lamers 2009 for an overview). Moreover, given that certain cases are representative of certain constructions or certain lexical items, e.g., the dative is often a characteristic of ditransitive and experiencer verbs, case morphology may be used to build up expectations about the argument structure of the main predicate of a sentence (see Pappert and Pechmann, this volume). In our example in (1), however, case marking does not help to neutralize the subject first preference as both the NP *een echte vriend* and the polite second person pronoun *u* are morphologically ambiguous between the nominative and objective case making them compatible with both a subject and an object interpretation. Verbal agreement is not helpful either as it is compatible with both arguments. In order to construct an unambiguous object-initial sentence with the intended reading, one would either have to mark the recipient with a preposition (*aan* 'to') as in (4a), in which case *u* can only be interpreted as the nominative subject, or use an unambiguous pronoun form *jij*, which also results in unambiguous subject agreement on the verb, cf. (4b). In the latter case the case ambiguous weak pronoun *je* would be preferred, resulting in the same unambiguous verbal agreement.

(4) a. *Aan een echte vriend stuurt u een echte kaart*
to a real friend send.PRS.2/3SG you.NOM a real card
'You send a real friend a real card.'

b. *Een echte vriend stuur jij een echte kaart*
a real friend send.PRS.2SG you.NOM a real card
'You send a real friend a real card.'

The correlations between case marking and syntactic function make case a reliable cue in comprehension. Therefore, it is not surprising to find languages that exploit case marking in a very economical fashion by restricting it to those ambiguous contexts where it is needed most (see Klein et al., this volume for a striking example, see de Swart (2011) for a more general discussion). These are often contexts in which information from word order cannot be used nor can language users rely on the prominence information of the arguments involved. Prominence is concerned with semantic/pragmatic features of arguments such as their animacy, definiteness, person and semantic role. These prominence features are often conceptualized in terms of hierarchies that in the mentioned cases rank animates over inanimates, definites over indefinites, first and second person over third and agents over patients. The higher an element's rank on the hierarchy, the more prominent it is considered to be. Thus, animate arguments are taken to be higher in prominence (i.e., more prominent) than inanimate ones. Prominence hierarchies have been established on the basis of cross-linguistic recurrent patterns as well as psycholinguistic findings (cf. Tomlin 1986; Siewierska 1988, 2004; Zúñiga 2006; Bornkessel-Schlesewsky and Schlesewsky 2009). Ultimately, linguistic prominence hierarchies should be grounded in more general cognitive or cultural mechanisms (for the latter see e.g., Yamamoto 1999). The precise way in which such a reduction is to be established is still a matter of debate (see e.g., Oshima 2007; Dahl 2008 for recent proposals).[2]

[2] Another pressing issue is the interaction and relative importance of different prominence dimensions. Given that animates are more prominent than inanimates and that definites are more prominent than indefinites, how should indefinite animates be ranked with respect to definite inanimates? The interaction of prominence dimensions is taken up in the present volume in the chapters by Klein et al., Primus, Wang et al., Lamers and Kretzschmar et al. and is bound to remain a topic in future research.

Grammatical functions, like prominence information, can also be ranked on a hierarchy with subjects outranking objects.[3] Prominence hierarchies seem to map onto (or align with) grammatical functions in such a way that high-ranked prominence features correlate with subjects and low-ranked ones with objects (a case of so-called harmonic alignment, cf. Aissen 2003). This alignment establishes a connection between semantics and syntax. Prominence information can thus be used as a cue in on-line comprehension, together with information from case marking and word order, to assess the grammatical function of arguments (although the time course and the exact underlying mechanisms are still subjects of debate (e.g., Bornkessel-Schlesewsky and Schlesewsky 2009; Osterhout et al. in press)). At the same time, the prominence of arguments influences language production as it can favor one construction or word order over the other, cf. the frequently attested preference to put animates before inanimates (see Branigan et al. 2008 for an overview).

Let us consider our example (1) a final time. Perhaps, the marketers that came up with this slogan put (too) much faith in the prominence information of the referents involved, assuming it would uniquely ensure the intended interpretation, in this case ambiguous environment by assigning the second person pronoun the subject role. If so, they overlooked the strong impact of the subject first preference in Dutch. What motivated their move to put the recipient object at the beginning of their sentence remains unclear but their message provides a clear example of the interaction between case, word order and prominence in establishing argument interpretation. As such, this example sets the stage for the contributions collected in this volume, which all highlight the influence of one or more of the factors discussed above on the realization and interpretation of arguments. Together they cover a wide range of languages, from the more familiar German, Dutch and English to the lesser studied Spanish, Basque, Chinese, Georgian and Mongolian. They do so using a diverse array of research methodologies including corpus counts, rating studies, self-paced reading, speeded grammaticality judgments, tracking of eye-movements and the recording of event-related brain potentials. Contributors accommodate their results in different frameworks, both theoretical linguistic ones such as Lexical Functional Grammar and psycholinguistic ones such as the Argument Dependency Model. Yet other contributors discuss their data in relation to general cognitive functions such as working memory capacity. Crucially, in all of these studies, case, word order and prominence turn out to play a crucial role in the comprehension and/or construction of sentences. The volume provides an overview how the impact and the interplay of these factors may vary depending on language-specific characteristics, sentence type or yet other factors as, for example, prosody.

The volume opens with the chapter **A Lexical-Functional Account of Spanish Dative Usage**, in which **Raúl Aranovich** discusses the doubling of the goal NP

[3] Although not a type of prominence information, sometimes the subject function is (confusingly) said to be more prominent than the object function.

by a dative clitic in (Argentinean) Spanish ditransitive constructions with the verb *dar* 'to give'. Based on a corpus from the Argentine daily *La Nación*, the author demonstrates that Dative Clitic Doubling (DClD) is more variable than suggested in previous studies. From a log-linear analysis of the data Aranovich concludes that DClD is not entirely unconstrained but interacts with the relative word order of theme and goal as well as the definiteness of the goal. DClD is favored in those constructions in which the goal precedes the theme or when the goal is definite. When these two factors coincide, the frequency of clitic doubled goals relative to the non-doubled ones is highest. To account for this pattern the author proposes a Lexical-Functional analysis that treats the Spanish ditransitive verb *dar* 'to give' as a cloaked causative with two alternative argument structures, one in which the goal is an object and one in which it is an oblique. He hypothesizes that a goal is only doubled by a dative clitic in the former situation. The word order effect (goal > theme) on DClD follows from the fact that objects are more likely to occur next to the verb and hence, to precede the theme, than are obliques; the definiteness effect arises from the need to satisfy a set of 'soft' constraints favoring definite objects over definite obliques. Aranovich demonstrates that his analysis can explain some similarities and differences between Spanish and English ditransitive constructions. In particular, the differences between English and Spanish in the realization of the goal are argued to follow from the more general typological contrast between accusative languages and primary object languages.

A second example of how various factors can influence the expression of a morphological category is presented in the chapter **Case in Conflict: Embedded Subjects in Mongolian** by **Udo Klein, Dolgor Guntsetseg and Klaus von Heusinger**. These authors investigate what determines the seemingly optional use of accusative case on subjects in Mongolian embedded complement clauses. The conditions governing the accusative-nominative case alternation on these subjects are shown to be different from those underlying the phenomenon of differential object marking in this language. Where the latter is conditioned solely by the definiteness of the object, the results of two questionnaires indicate that omission of accusative case marking on the subject of an embedded object clause is influenced by adjacency and relative prominence. More specifically, the accusative case may be omitted when the matrix and embedded subjects are not adjacent or when, in those cases in which they are adjacent, the matrix subject is higher than the embedded subject on the definiteness or animacy scale. According to the authors their findings can be understood through the interaction of three principles: the Prominence principle, which states that the most prominent argument (the argument highest on the definiteness or animacy scale) in a sequence of adjacent arguments bears the grammatical function of the matrix subject, the Accusative principle, prohibiting an accusative marked NP to be the matrix subject and the First argument principle, requiring the first NP in a sequence of NPs to be interpreted as the matrix subject. As a result, accusative case can be used to override the default inference associated with the prominence of arguments and hence to ensure the distinguishability of NPs across clause boundaries. Thus, the use of the accusative case on

Mongolian embedded subjects brings to light a new function of case in addition to the more traditional functions associated with case, i.e., that of distinguishing subject and object and of indicating the prominence of arguments.

Beatrice Primus also examines the interaction between prominence of arguments and case morphology but this time in the domain of verbal co-arguments. In her chapter **Animacy, Generalized Semantic Roles, and Differential Object Marking** she explores the connection between animacy and semantic roles in patterns of differential object marking (DOM) where the animacy of the noun phrase referent is assumed to trigger overt case morphology. Primus argues that the influence of animacy on such DOM patterns turns out to be less reliable than usually assumed. For instance, in Spanish, animacy is neither a necessary condition, as DOM occurs with certain inanimates, nor a sufficient condition, as there is no DOM with animate patients of ditransitive verbs. Primus therefore proposes a different view on DOM in terms of proto-roles, i.e., the decomposition of a few generalized semantic roles into more basic notions allowing for overlapping roles. The author shows that the interaction between animacy and semantic roles turns out to be closer than usually assumed. Many proto-agent properties – volition (or control), sentience, alienable possession and certain patterns of motion – imply the involvement of a higher animate participant; an observation supported by patterns of neural activity and brain areas found in various neurolinguistic experiments. By contrast, there is no link between animacy and proto-patients as no patient-like concept implies animacy on the part of the respective participant. Through the pragmatic process of abductive reasoning, animacy is argued to become a cue to agentivity. In animacy-based DOM, then, the animacy of the object leads to a situation in which this argument is interpreted as a potential proto-agent. As a consequence, this argument is marked with the same case that is used for a similar role pattern in other constructions as well (preferably the dative in many languages). In other words, it is not animacy *per se* that counts but rather the potential agentive properties of the object. Primus formulates her proto-role account in a Co-Argument Dependency Model, which is also used in the contributions of Lamers, Wang et al. and Kretzschmar et al. in this volume. Case-selection in DOM is accounted for in a model of Bidirectional Optimality Theory (Blutner 2000) through the interaction of two independently motivated case constraints requiring faithful expression of meaning (hearer optimality) and formal economy (speaker optimality).

Animacy and argument dependency are also central concepts in the following two chapters. **Luming Wang, Matthias Schlesewsky, Markus Philipp and Ina Bornkessel-Schlesewsky** focus on the role of animacy and argument dependency in their contribution **The Role of Animacy in Online Argument Interpretation in Mandarin Chinese**. The authors examine the applicability of the subject first preference to Mandarin Chinese, a language in which grammatical functions such as subject seem to play a minor role. Nevertheless, previous findings suggest that the subject preference (in simple locally ambiguous sentences) also applies in Mandarin Chinese. Following the extended Argument Dependency Model (e.g., Bornkessel-Schlesewsky and Schlesewsky 2009) the authors hypothesize that the subject preference may be attributable to a cross-linguistic preference for constructing the simplest meaning, in principle the meaning that involves an independent (subject) argument. In the present chapter, using event related brain potentials (ERPs), Wang et al. examine the possible influence of such simplicity-based structural considerations on word order preferences in Chinese and how these interact with the (animacy-based) semantic prominence of the argument. They auditorily presented speakers of Chinese with ambiguous verb-final NP-NP-V sentences in which the two arguments differed in animacy and that were disambiguated by the final verb. The overall data pattern suggests that the language comprehension system of Chinese native speakers has a strong preference for an Undergoer-before-Actor analysis of such sentences, according to the authors the simplest meaning for NP-NP-V sentences. This strong preference is found only when this analysis is also supported by animacy. According to the authors the overall pattern of the results is not easily reconciled with purely structure-based processing accounts or with accounts that are primarily semantically-based. Instead, they require a model that allows for the interaction of different types of factors. Crucially, such a model should allow for the influence of animacy to vary from one language to the other, given the authors' conclusion on the basis of cross-linguistic processing data that the influence of animacy on processing depends on the language being processed and on the other information types available to the processing system.

In the chapter **Argument Linearization in Dutch: A Multi-factorial Approach**, **Monique Lamers** shows that animacy information does not only provide an essential cue for local structural ambiguity resolution, she also relates the influence of animacy to other types of (prominence) information such as thematic dependency as well as to grammatical functions. Her analysis results in a multifactorial model of interpretation in which different types of information interact with one another. Her empirical focus lies on the comprehension of Dutch embedded clauses with an animate and an inanimate argument with special attention to the different types of verbs that may occur in sentence final position. More specifically, she compares the influence of three groups of verbs on comprehension: agentive verbs/experiencer subject verbs, causative psych verbs and unaccusative psych verbs. First she explains how multiple factors may affect the linearization of arguments. These factors include different sorts of information that might help to identify the subject and the object (number agreement, case marking, selectional restrictions), as well as factors that may affect word order preferences (syntactic function ordering, animacy dominance and thematic dependency). As in the model of incremental optimization of interpretation (De Hoop and Lamers 2006), Lamers formulates violable constraints based on the factors defining word order. Next, she examines whether the constraint violation patterns can be mapped onto the results of a rating study that investigated the influence and possible interplay of animacy and verb specific characteristics on the ease of comprehensibility of different word orders. The results show that both verb type and word order influence the ease of comprehensibility, with an overall preference for SO over OS order. These results only partially correspond to the constraint violation patterns of the constraints in the multi-factorial approach. As the constraints assign identical constraint violations to the two types of psych verbs, which differ in their comprehensibility, Lamers proposes to enrich the model with a constraint on thematic dependency that encodes a preference for the dependent argument to follow the argument it thematically depends on. Together with the other constraints, thematic dependency can account for the observed differences in the relative rating of the word order patterns of the different groups of verbs.

The strength of case marking as a cue in comprehension is investigated by **Stavros Skopeteas, Gisbert Fanselow and Rusudan Asatiani** in their chapter **Case Inversion in Georgian: Syntactic Properties and Sentence Processing**. In interaction with aspectual/modal categories, Georgian verb classes can occur with three different case-marking patterns. In line with recent accounts of Georgian case marking, the authors assume that case is licensed in two distinct layers (a lexical and a structural one) and they show that there is no evidence that case marking results in syntactic argument asymmetries. The authors' main focus is on the alternation between two case patterns: in the direct pattern the nominative marked constituent bears the role of actor and the dative constituent that of undergoer; in the inverse pattern, (with the same verb) the actor constituent bears the dative case, while the nominative argument is the undergoer. In view of syntactic processing, the absence of unidirectional associations between case and roles implies that morphological case is only a probabilistic cue for argument structure in Georgian before the verbal head has been processed. Moreover, the authors argue that word order can also only be regarded a probabilistic cue for grammatical functions. Actors precede undergoers in the canonical word order but deviations are possible and may be licensed through information structure and argument scrambling. Using a model of incremental optimization similar to that of De Hoop and Lamers (2006) the authors demonstrate that interpretation preferences can be modeled through the interaction of three constraints representing different types of information. In order to assess the role of explicit case information in the processing of Georgian, the authors carried out two reaction time experiments. The results of these experiments provide evidence that, as predicted by the model, in the absence of a verbal head, case marking is a more reliable cue than word order in processing thematically ambiguous expressions in Georgian.

The predictive power of case is also central to the contribution of **Sandra Pappert and Thomas Pechmann**. In their chapter **The Impact of Case and Prosody on the Availability of Argument Structures,** they consider whether case as an argument-specific cue and prosody as a structure-specific cue are used by German speakers as predictors of argument structure in single and double object constructions. To test the influence of these two factors, the authors conducted a cross-modal sentence completion experiment and a cross-modal naming experiment in which sentence fragments that include a case-marked constituent (either accusative or dative case) are presented for completion with reaction-time latencies serving as an indicator of incremental processing. Moreover, sentence fragments are presented acoustically such that a prosodic manipulation can be included. These completions are assumed to serve as an indicator of argument structure availability. The authors hypothesize that case influences argument structure availability such that accusative case on the first object favors single object structures and dative favors double object structures. Prosodic information is expected to modulate differences in argument structure availability due to case. Indeed, both experiments identify case as an important factor for argument structure availability in line with the authors' predictions. The prosodic cues, by contrast, did not turn out to be helpful in the completion tasks. Pappert and Pechmann conclude that their findings add to the limited body of evidence showing that prediction of arguments before the subcategorizing verb is feasible in verb-final structures. The authors propose that the sentence processor relies on case (and animacy) information to project a typical thematic relation and to predict, where required, missing arguments. This view is considered compatible with both a strict syntax-first view as well as with a lexicalist view of sentence processing.

The fact that case information can both enhance and disturb on-line processing is discussed by **Pavel Logačev and Shravan Vasishth** in their chapter **Case Matching and Conflicting Bindings Interference**. They focus on situations of so-called case matching or case attraction. Earlier research has found that disambiguation at the verb of a case ambiguous argument is facilitated when a coreferent NP with the same case intervenes but when the intervening NP bears a distinct case additional processing costs arise. The authors propose to view case matching effects as an instance of *conflicting bindings retrieval interference* (CBRI). This is a more general pattern of similarity-based interference in information retrieval from working memory (independently attested both within and outside the linguistic domain) due to a match of objects along some dimension. Logačev and Vasishth account for these types of interferences by assuming that linguistic objects consist of features linked to each other by pairwise bindings and that every object is represented by the totality of its bindings, i.e., links between its features. Interference in retrieval, and hence processing difficulty, arises when two objects match on one feature dimension but mismatch on some other feature dimension, the result being a conflicting binding. The case-matching effects then are argued to arise because the two NPs, being coreferent, match in every feature except for case. However, if CBRI is really the mechanism underlying case matching, coreference should not be a necessary condition, unlike in other accounts of the phenomenon. That is, as long as there is enough similarity between the NPs, case-matching effects are expected. In order to test these predictions, the authors conducted an eye-tracking and a self-paced reading experiment. Neither on-line experiment found evidence for coreference being the trigger of case-matching effects. Instead, mismatching conditions were read more slowly in line with the similarity-based CBRI account. A second eye-tracking experiment ensured that the observed effects are really due to matches in (abstract) case and cannot be reduced to other types of information associated with case marking. Thus, an approach in terms of CBRI provides an explanation of case-matching effects, as well as other unrelated phenomena. Moreover, as the authors note, one important implication of their account is that different readings of case ambiguous NPs must be represented in working memory by distinct chunks before disambiguation.

Moving away from case marking effects on processing **Kepa Erdocia, Itziar Laka and Antoni Rodriguez-Fornells** present a study investigating processing difficulty associated with non-canonical word orders in their contribution **Processing**

Verb Medial Word Orders in a Verb-final Language. According to many syntactic analyses, SOV sentences reflect the canonical word order in Basque, with all other word orders being syntactically derived. Assuming this to be the correct analysis, the authors hypothesize that SOV should be the easiest to process, with other word orders (OSV, SVO and OVS) showing increased processing costs due to the additional syntactic operations involved. Indeed, earlier work by the authors supports the claim that SOV word order is syntactically simpler than OSV word order. In the present study, Erdocia et al. report results obtained from experiments designed to investigate how verb-medial sentences (SVO/OVS) are processed by native speakers of Basque. Using self-paced reading and a comprehension task, they measured the complexity associated with unambiguous sentences with two singular or two plural arguments as well as sentences in which the two arguments were ambiguous due to syncretism of the ergative (subject) and plural morphology. The results revealed that verb-medial SVO and OVS sentences are associated with equal processing costs. Sentences containing singular constituents were read faster than ones containing plural arguments, which is hypothesized to be due to the fact that plural morphology is marked both phonologically and semantically. Ambiguous sentences were processed as fast as sentences with plural arguments. Interestingly, the comprehension task showed no preference for an SVO or OVS interpretation of ambiguous sentences. This makes Basque on the one hand similar to other SOV languages such as German and Japanese, which also show a processing advantage for SOV over OSV. On the other hand, Basque differs from German, in that subject-initial sentences display no advantage in the processing of verb-medial word orders. The authors argue that this difference may be due to the fact that German, unlike Basque, is a V2 language and hence exhibits a higher frequency of SVO orders.

The subject first preference in German is a central topic in the chapter **Prominence Facilitates Ambiguity Resolution: On the Interaction between Referentiality, Thematic Roles and Word Order in Syntactic Reanalysis** by **Franziska Kretzschmar, Ina Bornkessel-Schlesewsky, Adrian Staub, Dietmar Roehm and Matthias Schlesewsky**. More specifically, these authors examine the interaction of the subject first preference with thematic-role assignments and noun phrase specificity/referentiality in reading. Earlier work has suggested that the reanalysis from a subject-first order towards an object-initial order is influenced by the interaction of multiple prominence hierarchies. Nevertheless, there is diverging evidence as to the phase in which these effects emerge. Correspondingly, the present chapter considers the time course with which prominence information is used and whether it modulates the subject preference. The authors try to answer this question through two eye-tracking experiments in which they presented subjects with embedded verb-final clauses containing two case ambiguous arguments. The relative referentiality of the arguments was manipulated (Experiment 1) together with their thematic prominence (Experiment 2). In both experiments a clear subject-first preference was found with additional processing costs for a reanalysis toward an object-initial structure. The authors did not find evidence that any of the prominence hierarchies lowered the parser's preference to adopt a subject-initial analysis when encountering a case-ambiguous noun phrase. Instead, these prominence hierarchies were found to modulate the relative ease or difficulty of the reanalysis towards an object-initial order and their effects only reached significance in later eye-movement measures on the critical verb. According to Kretzschmar et al. their data suggest that the human parser preferably links the unmarked variants of each hierarchy to one another when computing the final sentence meaning and that, in the case of conflicting hierarchies, verbs show different weightings as to which hierarchy outranks another.

The influence of prominence hierarchies on ambiguity resolution is further investigated by **Jana Häussler and Markus Bader** in their contribution **Grammar- versus Frequency-driven Syntactic Ambiguity Resolution: The Case of Double-Object Constructions**. They investigate whether the human sentence processor, when it has to resolve a syntactic ambiguity, relies on grammar-internal information or on probabilistic information derived from usage-based frequencies. To tease these two types of information apart they focus on linearization preferences in German double object constructions with two locally case-ambiguous animate object NPs. With respect to the grammar-based strategy the authors consider the interaction of the case hierarchy and the animacy hierarchy. According to the former there will be a preference for interpreting the first ambiguous NP as accusative. However, to account for linearization preferences in ditransitive constructions an additional case hierarchy has been proposed: dative arguments preferably precede accusative ones in ditransitive constructions. The authors argue this 'ditransitive' case hierarchy to be an epiphenomenon as datives are typically animate and accusatives inanimate and according to the animacy hierarchy animate NPs preferably precede inanimate NPs. Häussler and Bader hypothesize that when animacy is neutralized one should again find a preference for accusative before dative. For the frequency strategy, predictions depend crucially on the grain size of measurement: one can consider the overall frequency of dative and accusative arguments, restrict frequency counts to double object constructions, or one can only look at double object constructions with two animate arguments. Corpus counts by the authors show that the first and third measure would predict a preference for accusative before dative, whereas the second would favor the reverse order. On the basis of three experiments eliciting speeded grammaticality judgments the authors conclude that there is a strong preference for accusative before dative order. These findings are in line with a purely grammar-based parsing strategy and are taken as confirmation of the *Case Preference Principles* proposed by Bader et al. (1996). A frequency-based processing explanation can only account for the observed preference when one considers frequency at the level of syntactic functions or at the level of sentences with two animate objects.

The issue of grain size, this time in production, also plays a central role in **Clare Huxley, Janet McLean, Holly Branigan and Martin Pickering**'s contribution **Lexical Preference and Global Structure Contributions to Syntactic Choice in Sentence Production**. In this chapter, the authors relate findings from psycholinguistic studies on language production to different theoretical grammar approaches. Reviewing the psycholinguistic literature they show that there is evidence that verb-subcategorization and lexical preferences affect choice of syntactic structure. At the same time, there is psycholinguistic research showing that syntactic information that exists independently of lexical items can affect syntactic processing. The authors discuss three different grammar frameworks coming from different disciplines

(Tree-Adjoining Grammar, Incremental Procedural Grammar and Construction Grammar) and their implications/predictions for language production processes. They show that although these frameworks are closely related in their approach to language production and share many fundamental assumptions and principles of processing, they vary in how they choose to incorporate and implement these ideas as processing strategies. However, in order to try to distinguish between these different mechanisms the authors believe that closer examination of the interaction between lexical and structural influences on syntactic processing is needed. They present the findings of two recall tasks that examined the production of simple matrix clauses as well as subject and object relative sentences that occurred in either the active or passive voice. The first experiment showed that the choice of structure is clearly influenced by the complexity of the global syntactic structure. From the second experiment, which also manipulated verb type, it became clear that syntactic choice involves an interaction between lexical preferences and the structural preferences exhibited in the global syntactic structure. Huxley et al. propose that like lexical items, syntactic structures themselves are stored in the lexicon, independently of any specific lexical entry. Hence, like lexical items, syntactic structures can receive activation and inhibition in a way that affects their current selection or subsequent use. Moreover, such a view makes it possible that, when lexical and structural preferences favor different structures, these two structures compete.

Together, the chapters collected in this volume provide a more detailed picture of the interaction between case, word order, prominence features and argument structure in both language production and comprehension. In the various languages discussed they emerge as preference principles guiding the language user towards an interpretation or utterance. These principles may point in the same or in opposite directions. In the latter case the hearer/speaker has to resolve this competition by giving priority to one principle over the other. In some cases the effect of a principle surfaces only when those of others have been partialled out. In addition, the chapters demonstrate that the importance of these preference principles may differ from one language to another and that even within a single language they depend on the structures being processed. As such, the volume as a whole illustrates the immense complexity of the interplay between case, word order, prominence and argument structure. It shows the necessity for careful cross-linguistic examination combined with methodologies from diverse fields including theoretical linguistics, psycholinguistics, corpus linguistics and computational linguistics. Needless to say, the research combined in this volume can only be a first step on the road to a cross-linguistically valid account.

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A Lexical-Functional Account of Spanish Dative Usage

Raúl Aranovich

1 Introduction

Spanish, like other Romance languages, has a rich system of pronominal clitics. In the third person, these clitics express overtly the distinction between accusative and dative complements. A peculiar fact about Spanish clitics is that in some cases they may double an overt NP. Accusative clitics double a complement that is a strong pronoun or a topicalized NP (1a), but doubling of an NP by a dative clitic (1b) seems to be an entirely optional feature.[1]

(1) a. *A esta niña la malcrían demasiado.*
to this girl ACC spoil:3PL too.much
'This girl, they spoil her too much.'
b. *El cartero le entregó un sobre al abogado.*
the postman DAT gave:3PL an envelope to.the attorney
'The postman gave an envelope to the attorney.'

A question that arises regarding the optionality of Dative Clitic Doubling (DClD) is whether it interacts with animacy, definiteness/specificity, affectedness, volitionality, and other factors that are known to affect variation in overt case marking (Bossong 1998; Enç 1991; Butt and King 2004; Aissen 2003; de Hoop and Malchukov 2007). In this paper I limit the investigation to the role of definiteness (both of theme and goal) and to the relative word order of theme and goal. What I will show is that word order and the definiteness of the goal factor in the probability

[1] In some dialects of Spanish, most notably River Plate Spanish, accusative clitics may also double overt NPs.

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of DClD, but the definiteness of the theme does not. This, I will argue, is an important difference with respect to the English dative alternation, and can be explained in a lexical-functional model of argument-function mapping.

The paper is structured as follows: Section 2 presents the results of a corpus search for Spanish sentences with the verb *dar* 'give'. A statistical analysis of these results is developed in Sect. 3, showing an interaction between DClD, the relative order of theme and goal, and also the definiteness of the goal. In Sect. 4 I use these results as evidence for a lexical-functional analysis in which the functions of the goal alternate between an object (obligatorily marked by a dative clitic) and an oblique. Section 5 discusses the alternative pattern of argument realization for goals in primary object languages. In this Section I present a lexical-functional analysis of the English dative alternation, which lays the foundation for a comparison with DClD in Spanish in Sect. 6. There, I argue that certain similarities between ditransitives in English and Spanish follow from the hypothesis that the goal alternates between an oblique function and an objective function, and that certain differences follow from the hypothesis that the goal may be realized as a primary object in English, but not in Spanish. In Sect. 7 I discuss how the definiteness of the theme and the goal affect the alternations in both languages. Section 8 concludes the paper, pointing to areas that will require further study.

2 Spanish Ditransitives, an Empirical Investigation

In order to find out if there are any word order or definiteness effects in structures with DClD, I examine a corpus of one million words from the Argentine daily *La Nación*. The text comes from the full editions of the newspaper during the first two weeks in February of 2008. It includes regular journalistic writing, as well as articles from the supplements (including a literary supplement), notes from the weekly magazine, and on-line commentary by the readers. The search is restricted to clauses with the ditransitive verb *dar* 'give'. Since I am interested in the relative word order of theme and goal, and in the definiteness of the two complements, the search is also restricted to clauses with two overt complements. 320 such examples can be found in the corpus.

An examination of these clauses reveals the variability of DClD. The dative clitic may be absent or present (indicated by [LE] in the examples that follow) regardless of whether the theme precedes the goal [TH>GL] or the goal precedes the theme [GL>TH]. Goals are in boldface in the examples in (2).

(2) a. [-LE, TH >GL] (*La Nación* 02/07/2008)
Las encuestas dan un ventaja ***a la derecha de Silvio Berlusconi***.
The polls give an advantage to the right of Silvio Berlusconi
'The polls give an advantage to Silvio Berlusconi's right wing party.'
b. [+LE, TH>GL] (*La Nación* 02/02/2008)
Eso le dio un inpulso decisivo ***al proyecto***.

That DAT gave:3SG a push decisive to.the project
'This gave the project a decisive push.'

c. [-LE, GL>TH] (*La Nación* 02/02/2008)
… los obispos acaban de dar ***al Partido Socialista Obrero***
the bishops finish.3PL of giving to.the Party Socialist Worker
Español (PSOE) *una excelente excusa para reconducir la campaña…*
Spanish (PSOE) an excellent motive to refocus the campaign
'The bishops have just given the Spanish Socialist Worker's Party an excellent motive to justify refocusing their campaign.'

d. [+LE, GL>TH] (*La Nación* 02/02/2008)
cuando pido contribuciones para el museo le estoy dando ***a***
when ask.for:1SG donations for the museum DAT be:1SG giving to
la ciudad de Buenos Aires *una actividad extraordinaria...*
the city of Buenos Aires an activity extraordinary
'When I ask for donations for the museum I am giving the city of Buenos Aires an extraordinary activity'.

Also, definite and indefinite goals, marked as [GL$_{\pm def}$] in (3), may be doubled or not. The same is true of goals that co-occur with definite and indefinite themes, marked as [TH$_{\pm def}$] in (4). Goals are underlined in (3), themes in (4).

(3) a. [-LE, GL$_{+def]}$ (*La Nación* 02/11/2008)
El presidente de Uruguay… dio este fin de semana los últimos
the president of Uruguay gave:3SG this end of week the final
retoques ***al rediseño de su gabinete.***
touches to.the rearrangement of his cabinet
'Over the weekend, the president of Uruguay put the final touches on the rearrangement of his cabinet.'

b. [+LE, GL$_{+def}$] (*La Nación* 02/12/2008)
No le damos entradas ***a la barra.***
not DAT give:1PL tickets to the hooligans
'We don't give the hooligans any tickets.'

c. [-LE, GL$_{-def}$] (*La Nación* 02/12/2008)
… cuando uno planta una vid está haciendo patria, dando
when one plant:3SG a grapevine is making fatherland giving
trabajo ***a otros argentinos***.
employmnet to other Argentines
'When one plants a grapevine one strengthens the fatherland, giving employment to other Argentines.'

d. [+LE, GL$_{-def}$] (*La Nación* 02/02/2008)
También está contemplada la posibilidad de darles uso
also is:3SG considered the possibility of give:DAT usage
profesional ***a algunas unidades.***
professional to some units
'The possibility of turning some apartments into office space is also being considered.'

(4) a. [-LE, TH_{+def}] (*La Nación* 02/04/2008)
El sistema de salud de Tucumán está dando ***todas las respuestas*** *a los*
the system of health of Tucuman is:3s giving all the answers to the
problemas oftalmológicos en forma gratuita…
problems opthalmologic in form free
'The health system of Tucumán is giving all the answers to the opthalmologic problems for free…'

b. [+LE, TH_{+def}] (*La Nación* 02/02/2008)
le dio a la zona ***el nombre de "Villa Catalinas"***.
DAT gave:3SG to the area the name of Villa Catalinas
'He gave the area the name "Villa Catalinas".'

c. [-LE, TH_{-def}] (*La Nación* 02/01/2008)
También había lámparas para dar ***calor y luz*** *a las plantas*
also have:3SG lamps to give heat and light to the plants
durante la noche.
during the night
'There were also lamps to give heat and light to the plants during the night time.'

d. [+LE, TH_{-def}] (*La Nación* 02/13/2008)
El cardenal Bergoglio suele darle ***un crédito*** *a todo*
the Cardinal Bergoglio tends.to:3SG give:DAT a credit to any
gobierno que empieza
government that starts
'Cardinal Bergoglio usually extends some credit to any budding administration.'

Table 1 presents the number of examples in the corpus, cross-classified according to whether they do or do not have a clitic doubling the goal. The examples are also classified according to word order, definiteness of the goal, and definiteness of the theme, in a multidimensional table.

The initial observation I am able to make after inspecting the results of the corpus search is that DClD is more variable than suggested in previous studies. For instance, the row marginals in Table 1 show an even distribution of ditransitive clauses with and without DClD. This goes against Jaeggli's assertion that "the clitic ... is highly preferred in most dialects of Spanish" (Jaeggli 1986:20). Parodi (1998:87) echoes this statement when she asserts that "although it is possible to have just the full NP..., doubling by a [dative] clitic is the strongly preferred option."[2] But in addition to finding interesting and unexpected examples or

[2]The two varieties Parodi (1998) studies are Iberian Spanish and River Plate Spanish. She claims that the latter has obligatory DClD of a full NP (not just of pronominal datives). Since the corpus I am analyzing represents the norm for River Plate Spanish, the results I have obtained show that the variation in DClD within this variety of Spanish is more pronounced than Parodi claims it to be.

Table 1 Cross-classification of clauses with the verb *dar* 'give'

	W.O:	Theme > Goal				Goal > Theme				
	Goal:	Definite		Indefinite		Definite		Indefinite		
Clitic	*Theme:*	Def.	Indef.	Def.	Indef.	Def.	Indef.	Def.	Indef.	
−*LE*		20	94	2	32	2	7	NA	NA	*157*
+LE		17	97	1	14	20	14	NA	NA	*163*
		37	*191*	*3*	*46*	*22*	*21*	*NA*	*NA*	*320*

frequency distributions, corpus analysis can reveal statistical tendencies that provide evidence for interaction among variables. The fact that not all columns show a balanced distribution between clauses with *le* and clauses without *le*, as in the full sample, suggests that DClD interacts in some way or another with the variables represented in Table 1 (word order and definiteness of theme and goal). The answer to this question can be found by applying a multivariate statistical test to the data in Table 1.

3 Variable Ineraction with DCLD: A Multivariate Statistical Analysis

The question of whether these imbalances are due to sampling error or to the effect of one variable over the others can be answered with log-linear analysis, a multivariate statistical method to find associations between variables. An early application to this method to the study of syntactic variation can be found in de Haan and van Hout (1986). Log-linear analysis proceeds by testing the fit of the data to a model of association among variables. A model is rejected if the probability of obtaining the observed cell frequencies in that model is lower than an acceptable threshold (0.05 for my study). The goal is to find the simplest model that fits the data.

The occurrence of zeros in Table 1 presents an initial problem for a log-linear analysis of DClD. To circumvent this problem, I follow one of the accepted procedures, collapsing variables when necessary. I will therefore reduce Table 1 to two simpler tables. Collapsing the table over values of the goal variable yields a complete table that makes it possible to test for the interaction between word order and DClD (Table 2). Collapsing the table over the values of the word order variable, on the other hand, makes it possible to test for the association between the definiteness of the goal and DClD (Table 3). The association between the definiteness of the theme and the other variables can be assessed in both tables.

Starting with the analysis of Table 2, it is clear that there must be some degree of association among clitic doubling (CL), the relative word order of theme and goal (WO), and the definiteness of the theme (TH). Following the conventions of log-linear analysis, I will denote the models being tested by grouping the variables that

Table 2 Cross-classification of DClD, word order, and theme

	W.O.:	Theme > Goal		Goal > Theme		
	Theme:	Def.	Indef.	Def.	Indef	
−LE		22	126	2	7	*157*
+LE		18	111	20	14	*163*
		40	*237*	*22*	*21*	*320*

Table 3 Cross-classification of DClD, goal, and theme

	Goal:	Definite		Indefinite		
	Theme:	Def.	Indef.	Def.	Indef	
−LE		22	101	2	32	*157*
+LE		37	111	1	14	*163*
		59	*212*	*3*	*46*	*320*

Table 4 Log-linear analysis of Table 2

Model	LRT value	p value
{CL}{TH}{WO}	47.02263	<0.001
{CL}{TH WO}	20.71124	<0.001
{CL TH}{CL WO}	27.01655	<0.001
{CL TH}{TH WO}	17.38693	<0.001
{CL WO}{TH WO}	4.029467	<0.2

are associated between braces. The analysis of Table 2 is presented in tabular form in Table 4 (only selected models shown). For each model I indicate the LRT value (or Likelihood Ratio Test value, a statistical measure of significance), and the probability value (p value). The lower the LRT value, the more likely the model is to fit the data.

The model {CL}{TH}{WO}, which presupposes no association, does not fit the data. The chances that the difference between the expected frequencies and the observed frequencies in the cells are due to sampling error, and not to the effects of one or more variables over the others, is less than 0.001. The model, then, has to be rejected. A better fitting model can be obtained by adjusting the expected frequencies in some of the cells, by making them a function of the association of one or more variables. The models in which there is an association {TH WO} between the definiteness of the theme and the relative word order of theme and goal decrease their LRT value, reflecting the fact that there is a significant proportional increase of definite themes when the goal precedes the theme. These models, however, are still rejected at $p < 0.001$. A model in which clitic doubling is an effect of the relative word order of goal and theme, on the other hand, achieves the best fit. With a p value of less than 0.2, the chances that the discrepancy between the observed and expected frequencies in the model {CL WO} {TH WO} are due to sampling error are just below 20%, a value high enough to prevent the model from being rejected.

Table 5 Log-linear analysis of Table 3

Model	LRT value	p value
{CL}{TH}{GL}	19.84566	<0.001
{CL GL}{TH}	10.08456	<0.02
{CL TH}{CL GL}	6.760242	<0.05
{CL GL}{TH GL}	2.029037	<0.5

Table 6 Word order and definite goal frequencies in DClD

	T > G(−def.)	T > G(+def.)	G(+def.) > T
−LE	0.69 (34)	0.5 (114)	0.21 (9)
+LE	0.31 (15)	0.5 (114)	0.79 (34)
	1.0 (49)	*1.0 (228)*	*1.0 (43)*

The remaining model with two interaction factors, {CL TH}{CL WO}, is rejected at $p < 0.001$, reflecting again the importance of taking into account the effect of word order on the definiteness of the theme. The conclusion, then, is that there is an association between word order and clitic doubling, but no association between the definiteness of the theme and clitic doubling.

The log-linear analysis of Table 3, presented in Table 5, also shows that there must be some degree of association between variables.

The model that has no interaction factors, {CL} {TH} {GL}, does not fit the data, since its p value is less than 0.001. Models with one two-variable interaction factor also fit the data rather poorly, with $p < 0.02$ for {CL GL} {TH}. Models with two interaction factors, on the other hand, offer a better fit. The model {CL TH} {CL GL} is still rejected at $p < 0.05$, but the model in which the definiteness of the goal is associated with clitic doubling and with the definiteness of the theme, {CL GL} {TH GL}, fits the data well enough. This model has a p value of less than 0.50, meaning that there is a significant chance that the difference between observed and expected values under this model is due just to sampling error.

The conclusion I arrive at as a result of a log-linear analysis of the data is that the alternation in DClD is not entirely unconstrained. There is statistically significant evidence for an association among the relative word order of theme and goal, the definiteness of the goal, and DClD. The definiteness of the theme, on the other hand, is not directly associated with the presence or absence of the dative clitic. When frequencies are considered, it is clear that DClD is favored in those constructions in which the goal precedes the theme, and also when the goal is definite. When those two factors coincide, the frequency of clitic doubled goals relative to the non-doubled ones is the highest. The frequency is the lowest when the theme precedes an indefinite goal, with an even chance of doubling when a definite goal follows a theme. These frequencies are summarized in Table 6, and plotted in Figure 1.

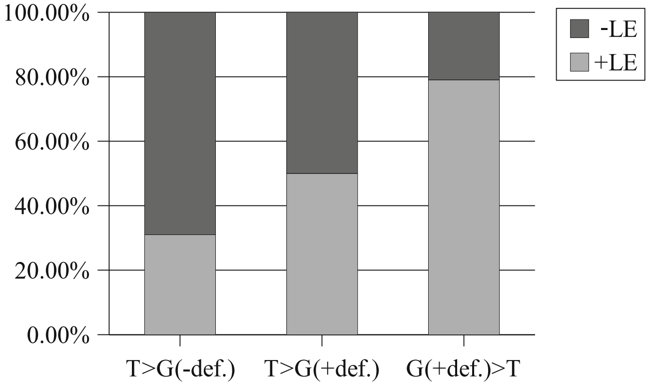

Fig. 1 Word order and definite goal frequencies in DClD

4 Modeling Syntactic and Semantic Conditions on Doubling

One of the conclusions from Sect. 3 is that there is a significant association between DClD and structures in which the goal precedes the theme. Adjacency to the verb is one of the properties that distinguishes objects from obliques, as the contrast between (5a) and (5b) illustrates.

(5) a. *Corté la sandía con un cuchillo*
cut:1SG the watermelon with a knife
'I cut the watermelon with a knife.'
b. *?Corté con un cuchillo la sandía*
cut:1SG with a knife the watermelon
'I cut the watermelon with a knife'

The tendency to double goals by a dative clitic when they precede the theme can thus be explained by the following hypothesis:

(6) **Spanish Dative Object Hypothesis (SDOH)**: A goal is doubled by a dative clitic iff it is an object.

A corollary of the SDOH is that goals that are not doubled by a dative clitic are obliques, not objects. In ditransitive constructions, then, goals can be alternatively mapped as objects or obliques. This alternation is analogous to the phenomenon known as dative shift in English, illustrated by the sentences in (7).

(7) a. Max gave Sandy a present.
b. Max gave a present to Sandy.

The claim that Spanish sentences with DClD are similar to the English double object construction in (6a) is advanced by Demonte (1995), Bleam (1999), Anagnostopoulou (2003), Cuervo (2003), among others. Anagnastopoulou argues that the same analysis applies to clitic doubling of genitive goals in Greek. Their analysis is framed in the Principles and Parameters model. I will adopt some of their proposals in this paper, but my analysis of DClD is based on an alternative framework, Lexical-Functional Grammar. I will defer a detailed discussion of the differences between my analysis and theirs until Sect. 6.

One of Demonte's (1995) arguments in support of the suggestion that Spanish manifests dative shift in the alternation in dative clitic doubling is based on judgments about word order. She claims that a sentence in which the goal precedes the theme is stylistically marked (nearly ungrammatical for some speakers) without the clitic. The contrast is illustrated by the sentences in (8).

(8) a. (Demonte 1995:20)
%Di a María el libro.
gave:1SG to Maria the book
'I gave the book to Maria.'
b. (Demonte 1995:22)
Le di a María el libro
DAT gave.1SG to Maria the book
'I gave Maria the book.'

In spite of Demonte's judgment, sentences similar to (8a) are attested in the corpus. An example was presented in (2c). Nevertheless, doubling of a goal by a dative clitic is the most frequent option when the goal precedes the theme. This kind of gradience effect, in which low frequency corresponds to a degradation in grammaticality, is not uncommon (Vogel 2006). Arguments based on frequency, however, need to be articulated with one additional step. The SDOH claims that any time a goal is doubled by a dative clitic, that goal is an object (and that every object that is linked to a goal will be doubled by a dative clitic). There is no gradience in that respect. What is subject to variation is the position of a goal relative to the theme. Goals may always follow themes, but they do so less frequently in the DClD construction because objects are more likely to occur next to the verb than obliques.

The case for the SDOH is weakened somehow by the morphosyntactic similarity between those goals that are doubled by the clitic and those that are not. Both types of goal are marked by the preposition *a* 'to'. According to my analysis, then, *a*-marked goals are ambiguous. This ambiguity disappears, however, in cases that require obligatory clitic doubling of an object marked with the preposition *a* (Jaeggli 1986, Masullo 1992). This occurs when the DClD object is a possessor (9a), or when it is an experiencer (9b). If a possessor is not doubled by a dative clitic, it is realized as the complement of the preposition *de*, inside the possessed NP (10a). Likewise, an experiencer is realized as a nominative constituent when the dative clitic is absent (10b).[3]

[3] It is generally assumed that possessive datives like the one in example (9a) are licensed by inalienable possession, but it is more likely that they mark an affected possessor, contrasting with simple possession in an example like (10a). Dative experiencers also alternate with accusative experiencers, but not in all cases (the verb *gustar* does not allow for accusative experiencers). Ackerman and Moore (1999) have a detailed discussion of case marking of experiencers in Spanish. Space limitations force me to gloss over some details of the grammar of possessors and experiencers in Spanish.

(9) a. *María *(le) lavó las orejas al niño.*
María DAT washed:3SG the ears to.the child
'María washed the child's ears.'
b. *A María *(le) gusta un taxista.*
To Maria DAT like:3SG a cab.driver
'María likes a cab driver.'

(10) a. *María lavó los juguetes del niño.*
Maria washed:3SG the toys of.the child
'Maria washed the child's toys.'
b. *María gusta de un taxista.*
Maria like:3SG of a cab.driver
'María likes a cab driver.'

The overt morphosyntactic changes in the expression of experiencers and possessors that take place when there is no DClD show that these arguments are doubled by a clitic if and only if they are objects. The SDOH generalizes this condition to DClD of goals.

The alternative analysis would have obligatory DClD for possessors and experiencers when they are realized as objects, but optional DClD for goals. This analysis would miss two generalizations. The first one is that the arguments that have an alternative functional realization (possessors and experiencers) are precisely those for which DClD is obligatory. The second one is that the goal that is more likely to show object-like word order behavior is the one that is doubled by a clitic. These generalizations do not need to be stipulated under the SDOH, they follow from the analysis of doubled goals as objects. An analysis based on the SDOH, then, is more explanatory than the alternative.

Alternations between oblique and secondary object functions in argument realization are not unusual in the Romance languages. Causative constructions with embedded transitive verbs display an alternation of exactly this kind in some languages. As shown in Alsina (1996b), the causee can be realized as an object (11a) or as an oblique (11b) in Catalan (similar facts are valid for French, as shown in Gibson and Raposo 1986).

(11) (Alsina 1996:195)
a. *He fet netejar els lavabos al general.*
have:1SG made clean the toilets to.the general
'I made the general clean the toilets.'
b. *He fet netejar els lavabos pel general.*
have:1SG made clean the toilets by.the general
'I had the toilets cleaned by the general.'

Alsina suggests that the syntactic alternation in the realization of the causee (i.e. indirect object or oblique) is due to a semantic difference between the two constructions. Across languages, causative constructions display a contrast between direct and indirect causation. In a direct causative, the subordinate event is under the immediate influence of the subject of the CAUSE predicate. The causee (i.e. the subject of the subordinate event), then, is directly affected by the actor. In the indirect causative, on the other hand, the actor may bring about the subordinate event without exerting immediate influence over it.

I propose to extend Alsina's analysis of Romance direct and indirect causatives to lexical ditransitives. Following some lexical decomposition analyses that have been proposed for English ditransitives (Oehrle 1976, Pinker 1989, Harley 2002, Krifka 2004, among others), I analyze *dar* 'give' as CAUSE-TO-HAVE. The goal corresponds to the most prominent argument of the embedded predicate HAVE. As a cloaked causative, a ditransitive with *dar* has two alternative argument structures. In one of them, the agent of the embedded event, i.e. the goal, is realized as an object. This is the DClD construction. In the other one, the goal is realized as an oblique. This is the prepositional goal construction. According to this analysis, the alternation in DClD has a corresponding semantic alternation: the goal that is doubled by a clitic is more affected, since it is under the direct influence of the agent of *dar*. I will postpone a discussion of the semantics of DClD until Sect. 7, where I analyze the role of definiteness in the alternation. The rest of this section formalizes the analysis of causatives and ditransitives in Lexical Mapping Theory (LMT).

LMT is a theory about the correspondence between argument structure (a-structure) and functional structure (f-structure) in Lexical Functional Grammar, or LFG (Bresnan and Kanerva 1989; Alsina and Mchombo 1993; Butt et al. 1997). LFG recognizes four different grammatical functions: Subject (S), Primary Object (O), Secondary Object (O2), and Oblique (Obl). The terms 'Primary Object' and 'Secondary Object' are also used in the typological literature on ditransitives. Their definitions, however, are slightly different. Dryer (1986) makes the observation that the object of a monotransitive patterns with the theme of a ditransitive in some languages, but with the goal (i.e. the indirect object) of a ditransitive in others. In a language of the latter type, he says, "a nominal is a PO [primary object] if it is an IO [indirect object] in a ditransitive clause, or a DO [direct object] in a monotransitive clause; it is an SO [Secondary Object] if it is a DO in a ditransitive clause" (Dryer 1986:814). The use of the term Primary Object in LFG is more general, since it also applies to the direct object of a ditransitive where this argument patterns with the object of a monotransitive. To avoid confusion, I will borrow two terms from Kisseberth and Abasheikh (1977), replacing the LFG terms 'primary object' and 'secondary object' with 'principal object' and 'subsidiary object', respectively.

LMT classifies grammatical functions according to the features [±r] (restricted) and [±o] (objective): S and O are [−r], S and Obl [−o], O2 and Obl are [+r], O and O2 are [+o].[4] A set of rules and principles adds these features as specifications to the

[4]The features [±r] and [±o] group grammatical functions into natural classes. [+o] functions "complement transitive predicators such as verbs and adpositions, and not (...) intransitive predicators such as basic nouns and adjectives" (Bresnan and Moshi 1990:166–167). The feature [−r] is sometimes characterized as defining a class of semantically unrestricted functions, i.e. functions that are not necessarily associated with a particular thematic role, or that may have no thematic role at all (as when they are assigned to an expletive pronoun, for instance). Given the crosslinguitic variation regarding the semantic roles that can be mapped onto principal and subsidiary objects, I am less inclined to define [−r] functions on semantic terms, limiting its use to define the object function that can link to the same arguments as the subject of a passive.

semantic roles in argument structure, until all arguments have a syntactic function and a syntactic function is uniquely assigned to every argument (the Biuniqueness principle, or BIUQ). An additional principle, the Subject principle, requires that every clause has one. Agents are intrinsically [−o], which constraints their syntactic functions to either S or Obl. By default, external arguments are [−r], and all other arguments [+r]. Thus, agents will be mapped onto S unless a morpholexical rule assigns the feature [+r] to them. Internal arguments (i.e. themes and patients) are intrinsically [−r]. Features are specified monotonically, so the default specification [+r] cannot apply to internal arguments once they are specified as [−r]. Internal arguments, then, may be mapped onto S or O. The first option will be forced by the Subject principle if no other argument is mapped onto a S (as in passives or unaccusatives), and it will be blocked by the Biuniqueness principle if the clause already has a S. In some cases, however, it is not possible to assign a [−r] feature to more than one internal argument. This may be due to an explicit constraint (a parameter that distinguishes 'symmetrical' from 'asymmetrical' languages), or because this would eventually run afoul of the Biuniqueness principle in a symmetrical language (Bresnan and Moshi 1990). When this is the case, one of the internal arguments has to be marked [+o]. This argument is specified [+r] by default, and it is mapped onto an O2.

An analysis of the alternation between the two types of Romance causatives in terms of Lexical Mapping Theory is developed in Falk (2001). Following Alsina (1996b), Falk argues that the causative predicate has an internal argument that controls one of the arguments of the embedded predicate. The internal argument of CAUSE, which is interpreted as a patient of sorts, will be realized as a complement (an indirect object). In the direct causation reading, the internal argument of CAUSE controls the agent of the embedded predicate. In the indirect causation reading, on the other hand, it is the patient of the embedded event, and not its agent, that is controlled by the internal argument of CAUSE. The causee is not mapped onto an argument of CAUSE, but onto an oblique. After predicate composition takes place, CAUSE has two internal arguments if the embedded event is transitive. Since the Romance languages are asymmetrical, only one of these internal arguments can be marked [−r]. This creates a potential conflict when the internal argument of CAUSE controls the agent of an embedded transitive predicate. To avoid this situation in Romance, Falk argues, the internal argument of CAUSE is specified as [+o]. The mapping of arguments in a direct causative like (11a), then, is as in (12a). Notice that the causee is mapped onto an O2, and the embedded patient onto an O. (12b) shows the mapping for an indirect causative like (11b). Here, since the internal argument of CAUSE controls the embedded patient, no conflict arises when it is assigned the [−r] feature (the other argument of the embedded event is intrinsically [−o]). This results in a mapping in which the embedded agent is an Obl, and the embedded patient an O.

(12) a. Direct casusative (Romance)

	AG	X_i	[AG$_i$	PAT]
IC	[–o]	[+o]		[–r]
DEF	[–r]	[+r]		
	S	O2		S/O
BIUQ	S	O2		O

b. Indirect causative (Romance)

	AG	X_i	[AG	PAT$_i$]
IC	[–o]	[–r]	[–o]	
DEF	[–r]		[+r]	
	S	S/O	Obl	
BIUQ	S	O	Obl	

The LMT analysis of Romance direct and indirect causatives can be extended to lexical ditransitives, assuming the analysis of *dar* 'give' as CAUSE-TO-HAVE. As with periphrastic causatives, there are two alternative mappings from a-structure to f-structure in lexical causatives. In a construction with DClD, the agent of the embedded event, i.e. the goal, is controlled by the internal argument of CAUSE (13a). In the construction without DClD, the internal argument of CAUSE controls the theme (13b). As in the case of Romance periphrastic causatives, the controller (the internal argument of CAUSE) is realized as a complement of *dar*. When the controlled argument is the goal, it is linked to an O2. When the controlled argument is the theme, on the other hand, the goal cannot map onto an object, and therefore cannot be doubled by a dative clitic.

(13) a. *Dar (+le)*:
x CAUSE y [y HAVE z]

	AG	X_i	[AG$_i$	PAT]
IC	[–o]	[+o]		[–r]
DEF	[–r]	[+r]		
	S	O2		S/O
BIUQ	S	O2		O

b. *Dar (-le)*:
x CAUSE z [y HAVE z]

	AG	X_i	[AG	PAT$_i$]
IC	[–o]	[–r]	[–o]	
DEF	[–r]		[+r]	
	S	S/O	Obl	
BIUQ	S	O	Obl	

Thus, by extending this lexical-functional analysis of the alternation between direct and indirect causatives to Spanish ditransitives, I provide an explanation for the SDOH, since the same principles that allow for a causee to be mapped as an O2 or an Obl ensure that the functions of the goal alternate between an O2 and an Obl.

5 Crosslinguistic Differences in Argument Realization

The Romance pattern of argument realization, in which the theme is mapped as a principal object and the goal/causee is mapped as a subsidiary object, is characteristic of accusative languages in Dryer's (1986) classification. In primary object languages, on the other hand, the goal/causee maps onto the principal object, and the theme onto the subsidiary object. Gibson and Raposo (1986) show that Chamorro follows the primary object pattern. The embedded agent is mapped as the principal object (14a), diverging from the Romance pattern. Alsina (1997) argues that in Chichewa too the causee, not the patient, is mapped as a principal object (14b).

(14) a. (Gibson and Raposo 1986)

Ha	*na'-taitai*	*häm*	*i*	*ma'estru*	*ni*	*esti*	*na*	*lebblu*
3SG	CAUS-read	1PL	the	theacher	OBL	this	CN	book

'The teacher made us read the book.'

b. (Alsina 1997:209)

Mlīmi	*a-ku-lémb-éts-a*	*mkángó*	*ndakatūlo.*
farmer	SM-OM-write-CAUS-FV	lion	poem

'The farmer is making the lion write a poem.'

In Chichewa, as in Romance, there is a contrast between direct and indirect causation. In addition to the direct causative in (14b), Chichewa has an indirect causative, shown in (15). In this structure, the embedded patient is the primary object, but the embedded agent is an oblique.

(15) a. (Alsina 1997: 213)

Mlīmi	*a-ku-lémb-éts-a*	*ndakatulo*	*(kwá*	*mkângo*
farmer	SM-OM-write-CAUS-FV	poem	to	lion

'The farmer is having the poem written by the lion.'

Since Chichewa is an asymmetrical language, the two internal arguments cannot be both marked [−r] (Alsina and Mchombo 1993; Alsina 1996a; Bresnan and Moshi 1990). The way to resolve the potential conflict that two internal arguments create in a Chichewa direct causative is to specify the lower argument of the embedded predicate as [+o], keeping the [−r] feature specification for the direct internal argument of CAUSE, as in (16a). In the indirect causative, on the other hand, no conflict arises, since only one internal argument is specified as [−r] (16b).

(16) a. Direct causative (PO lang.)

	AG	X_i	[AG_i	PAT]
IC	[–o]	[–r]		[+o]
DEF	[–r]			[+r]
	S	S/O		O2
BIUQ	S	O		O2

b. Indirect causative (PO lang.)

	AG	X_i	[AG	PAT_i]
IC	[–o]	[–r]	[–o]	
DEF	[–r]		[+r]	
	S	S/O	Obl	
BIUQ	S	O	Obl	

According to Falk's (2001) analysis, the parameter responsible for the crosslinguistic difference in argument realization between accusative and primary object languages is the assignment of the [+o] feature. In accusative languages, a non-patient-like internal argument cannot be [+o]. In primary object languages, on the other hand, a patient-like internal argument cannot be [+o].[5] Since the internal

[5]Falk follows Jackendoff's (1990) two-tier theory of semantic structure, in which there is an action tier running in parallel with a motion tier. The action tier pertains to the domain of causality, with agents and patients. Beneficiaries are in this tier, too, as a sort of causally affected argument. Instruments, too, are in this tier, since they relate to agents. The motion tier has Themes and different types of locations, including goals. The resulting thematic hierarchy is *agent* > *patient/beneficiary* > *instrumental* > *theme* > *path/location*. Falk argues that the direct

argument of CAUSE is an affected argument, it is a patient-like argument as well. Thus, in a primary object language like English, the internal argument of CAUSE cannot receive a [+o] feature, and it is never a subsidiary object.

There seems to be a strong crosslinguistic generalization to the effect that languages in which the causee is realized as a principal object are also languages in which a benefactive or a goal is realized as the principal object of a ditransitive (Wunderlich 1997). Thus, in Chichewa, the theme is realized as an O in a transitive clause (17a), but as an O2 in the applied construction (17b), when a benefactive is the O (Baker 1988; Alsina and Mchombo 1993)

(17) (Baker 1988:353)
a. *Mavuto a-na-umb-a mtsuko.*
Mavuto SM-PST-mold-FV waterpot
'Mavuto molded the waterpot.'
b. *Mavuto a-na-umb-ir-a mfumu mtsuko.*
Mavuto SM-PST-mold-APPL-FV chief waterpot
'Mavuto molded the waterpot for the chief.'

Like Chichewa and Chamorro, English is a primary object language. In a double object construction like (18a), the goal is the primary object. In the prepositional goal construction, on the other hand, the goal is realized as an oblique (18b). The theme, being the only objective function, is then the primary object.

(18) a. Max gave Sandy a present.
b. Max gave a present to Sandy.

I analyze the argument structure of *give* as a complex event with a causative predicate, of the form CAUSE-HAVE. The goal/beneficiary is the most prominent argument of the embedded HAVE predicate. The alternation between the double object and the prepositional goal constructions follows from the same principles that underlie the alternation between direct and indirect causatives. In the double object construction the goal is controlled by the direct complement of CAUSE, as in a direct causative construction. The goal, then, is the affected argument. Since English is a primary object language, the affected complement of CAUSE cannot be specified as [+o]. To avoid having two [−r] internal arguments, the theme must bear the [+o] feature, as in (19a). After the default [+r] feature is specified for the theme,

internal argument of CAUSE is a patient/beneficiary, given its interpretation as affected. A theme or a goal (as a type of locative), then, can also be a patient or a beneficiary, if it is controlled by an argument of CAUSE. In Direct Object languages (i.e. Romance) patientlike arguments have the option of being marked as [+o] (i.e. arguments *below* PAT/BEN cannot be [+o]). In Primary Object languages (i.e. Chichewa), on the other hand, patientlike arguments cannot be [+o] (i.e. arguments *above* INST cannot be [+o]). It is necessary to stipulate which argument can be [+o] in a particular language, given the arbitrary nature of the distinction between primary object languages and accusative languages. However, once this is stipulated, all other properties of each language type follow.

it is mapped onto the O2, and the goal as the O. In the prepositional object construction, on the other hand, the complement of CAUSE controls the theme, which is then mapped as an O. In this structure, the goal is not affected, and control of the event is not ceded to the agent. Like agents and other external arguments, the goal is intrinsically classified as [−o]. But since it is not the external argument, it is specified as [+r] by default, and therefore it is mapped onto an oblique, as in (19b).

(19) a. Double object:
x CAUSE y (y HAVE z)

	AG	X_i	[GL$_i$	TH]
IC	[–o]	[–r]		[+o]
DEF	[–r]			[+r]
	S	S/O		O2
BIUQ	S	O		O2

b. Prepositional object:
x CAUSE z (y HAVE z)

	AG	X_i	[GL	TH$_i$]
IC	[–o]	[–r]	[–o]	
DEF	[–r]		[+r]	
	S	S/O	Obl	
BIUQ	S	O	Obl	

The semantics of the dative alternation in English is a topic that has received a great deal of attention (Oehrle 1976; Pinker 1989; Harley 2002; Krifka 2004, among others). There are two differences between the double object and the prepositional goal constructions that are often mentioned in the literature. First, the prepositional goal construction highlights the motion across a path. Evidence for this is that certain verbs, i.e. motion verbs of continuous imparting of force, do not appear in the double object construction (20b), only in the prepositional goal construction (20a). Second, as the contrast between (21a) and (21b) shows, the double object construction entails possession.

(20) a. Lift the box to Max.
b. *Lift Max the box.

(21) a. Teach Dutch to the students $\not\supset$ The students learned Dutch
b. Teach the students Dutch $\supset$ The students learned Dutch

The literature on the dative alternation in English explains the semantic differences between the double object and the prepositional goal constructions as a case of polysemy. While the embedded predicate in the argument structure of the double object construction is HAVE, the prepositional object is analyzed as CAUSE-BE or CAUSE-GO instead. In this analysis, possession is entailed only by the double object construction because of the semantics of the embedded predicate (HAVE, as opposed to BE or GO), and the path interpretation is not available to the double object construction because the goal is interpreted as the endpoint of a motion event only when the embedded predicate is BE or GO.

I argue that it is not necessary to propose two different embedded predicates in the argument structure of *give* to account for the facts in (20) and (21). The semantic differences between the double object construction and the prepositional goal construction follow from the treatment of causatives in LMT, and the analysis of *give* as a lexical causative. The double object construction is a direct causative, and the prepositional object construction is an indirect causative. In a direct causative, the goal is an affected entity. Control of the embedded event falls fully with the agent of

CAUSE. Since the goal's role as an endpoint of transfer is secondary to its role as an affected argument, an embedded event cannot be construed primarily as a path in a direct causative. Hence the ungrammaticality of (20b). Also, since the goal in a direct causative is affected and does not exert immediate influence on a transfer (i.e. it cannot prevent the transfer from taking place), direct causation of transfer entails possession, as in (21).

While the polysemy analysis of give and the LMT analysis I have developed here are both capable of providing sound explanations for the semantics of the dative alternation, the LMT analysis is the only one that can be extended to cover the semantics of the alternation between direct and indirect causatives. In both cases the alternation results from the fact that the affected argument of CAUSE can control either argument of the embedded predicate. The polysemy analysis of the dative alternation, on the other hand, cannot be extended to the alternation between the two types of causatives. The semantic differences between a direct causative and an indirect causative cannot stem from a semantic difference between the embedded predicates, since in both cases the embedded predicate stays the same. The semantic alternation between direct and indirect causatives, then, must be accounted for by a different mechanism than the semantic alternation between the double object construction and the prepositional goal construction. To the extent that the two alternations show similar semantic effects, the polysemy analysis is less explanatory than the LMT analysis.

6 Spanish and English Ditransitives in Contrast

The parameters of LMT, then, provide us with a three-way distinction in ditransitives (and also in causatives). In primary object languages like English, the goal is the principal object (i.e. an O) of a double object construction, and the theme the subsidiary object (an O2). In an accusative languages like Spanish, the theme is the principal object, and the goal the subsidiary object. In either type of language, there is an alternative realization of the arguments of a ditransitive in which the goal is an oblique, and the theme a principal object. The results of this analysis are summarized below:

(22)

	English		Spanish	
	THEME	GOAL	THEME	GOAL
DCID / Double Object Const.	O2	O	O	O2
Prepositional Goal Const.	O	Obl	O	Obl

This analysis provides a unified account for some interesting similarities between English and Spanish ditransitives, and for some differences as well. A well-known difference between the two languages concerns the passive counterparts to the double object and the DClD constructions. The goal can be realized as the subject of a passive in English (23a), but not in Spanish (23b). The theme is always mapped onto the subject in Spanish instead (23c).

(23) a. Sandy was given a present.
b. **Gómez fue dado un regalo*.
Gomez was:3SG given a present
'Gomez was given a present.'
c. *El regalo le fue dado a Gómez.*
The present DAT was:3SG given to Gomez
'The present was given (to) Gomez.'

Dryer (1986) takes passivization to be one of the properties that distinguishes primary object languages from accusative languages. Objects of monotransitives can be realized as the subject of a passive in either type of language. In a primary object language, the goal of a ditransitive patterns with the object of a monotransitive in this respect. This is what is observed in English, in examples like (23a). In an accusative language like Spanish, on the other hand, the argument that can be realized as the subject of a ditransitive passive is the theme, as the contrast between (23b) and (23c) shows. In the LFG analysis I have developed, the argument that patterns with the object of a monotransitive is always analyzed as an unrestricted object, or, as I call it for the sake of clarity, a principal object. Being intrinsically [−r], these internal arguments are the ones that can be realized as S in a passive.

My analysis also accounts for similarities in the passivization of the prepositional goal constructions in English and Spanish. In both languages, the theme can be realized as the subject of the passive counterpart to the prepositional goal construction (24a, 24b). This property identifies the theme as the principal object in the prepositional goal construction, in English as well as in Spanish, and the goal as the oblique. These facts also support the analysis in which goals have alternative realizations as obliques or as object-like functions, whether as a principal object (English) or a subsidiary object (Spanish).

(24) a. The present was given to Sandy
b. *El regalo fue dado a Gómez.*
The present was given to Gomez
'The present was given (to) Gomez.'

In the generative literature, there are several well-known analyses of ditransitive clauses. These analyses are developed, for the most part, to account for the grammatical properties of English ditransitives and of the applicative constructions in languages of the Bantu family. Baker (1988) treats applicative verbs as the result of preposition incorporation. Marantz (1993) argues for an applicative phrase. Larson (1988) proposes a structure in which a VP has another VP as a complement as the best way to represent clauses with three arguments. The languages that provide data for these analysis are mostly primary object languages, according to Dryer's (1986) classification. Because of that, the generative analyses tend to miss important generalizations about ditransitive constructions when they are extended to accusative-type languages like Spanish.

This is a shortcoming of the various generative proposals that treat DClD as a double object construction (Demonte 1995; Bleam 1999; Anagnostopoulou 2003;

Cuervo 2003, among others). These proposals fail to account for the ungrammaticality of Spanish passive sentences like (23b), in which the goal is realized as the subject. Analyses that seek to capture generalizations about applicatives, double object constructions, or the DClD, by placing goals and themes in the same structural position across language types, have to introduce stipulations of another sort.[6] In the lexical-functional analysis I have proposed, on the other hand, the similarities between the two constructions are the result of a paradigmatic alternation in the realization of the goal, between an objective function and the oblique function it has in the prepositional goal construction. The lexical-functional analysis developed in this paper, then, provides a better explanation for the grammatical properties of the Spanish DClD construction than alternative generative accounts.

Comparative data about extraction of the goal in ditransitive constructions may offer further support for the analysis of English and Spanish ditransitives in (22). In his detailed investigation of ditransitives in the British English component of the International Corpus of English, Mukherjee (2005) finds attested examples of goal extraction from double object constructions with the verb *give* (25a). I have also found examples of clitic-doubled goal extraction with *dar* 'give' in my Spanish corpus (25b).

(25) a. (Mukherjee 2005:94)
Uh an American lady that I gave a lecture uhm on architecture.

b. (*La Nación* 02/02/2008)
Acabamos de rescindir el contrato con una, a la que le
finished:1PL of nullify the contract with one to the which DAT
dábamos 400.000 pesos mensuales.
gave:1PL 400,000 pesos monthly
'We have just nullified the contract with one of them, (to) which we used to give 400,000 pesos a month.'

Compared to extraction of the theme, goal extractions are less frequent in English (2 against 23) and in Spanish too (6 against 11). Across languages, however, there is a significant difference in the extraction of the goal: The English construction has a lower rate than the Spanish construction (.08 against .35). I attribute this difference to the fact that the goal is a principal object in the English ditransitive construction, but a subsidiary object in the construction with DClD in Spanish. This result is somewhat paradoxical, however, since it suggests that subsidiary objects are more likely to be extracted than principal objects. This tendency seems to contradict Keenan and Comrie's (1977) Relational Hierarchy: Subsidiary objects, being less

[6]Following Larson's (1988) analysis of English double object constructions, Demonte suggests that the theme in a DClD construction is the least prominent argument, in structural terms, being projected as the complement of an inner VP. The dative clitic is base-generated as the head of a Dative Clitic phrase (DClP), and presumably moves along with the main verb in its transit to the head of the higher VP. Goals check their Dative case in the specifier of DClP. Similarly, Anagnostopoulou (2003); Cuervo (2003) suggest that the dative clitic is the head of an applicative phrase, which is the phrase introducing the goal.

prominent than principal objects, should be less likely to be extracted. But there is some evidence that the relational hierarchy may not be a factor in the relative frequency of extractions. As Fox (1987) indicates, extraction of direct objects is more frequent than extraction of transitive subjects in English, pointing to an 'ergative bias' against extractions. When figures from extraction of subjects across clause types (transitive and intransitive) are aggregated, however, the relative frequencies of extraction conform to the relational hierarchy (Gordon and Hendrick 2005).[7] The expectation that principal objects should be more frequently extracted than subsidiary objects may be a result of conflating objects of monotransitives and objects of ditransitives into a single factor. This is a point that needs to be researched further.

7 Definiteness and Other Factors

The hypothesis that goals in Spanish ditransitives alternate between an oblique function and a subsidiary object function, then, explains some similarities and differences between constructions with DClD in Spanish and the double object construction in English. In this section I will argue that the analysis also extends to the crosslinguistic effects of definiteness in the two constructions. My analysis of the Spanish corpus data in Sect. 3 established that goals are more likely to be definite when they are doubled by a dative clitic than when they are not. I also argued that the definiteness of the theme is not associated with the presence or absence of the dative clitic. A cursory examination of the data in Table 1 may suggest otherwise, since the occurrence rate of definite themes is higher when the goal is doubled by a dative clitic (23.3%) than when it is not (15.3%). But the clitic-doubled construction is also in direct correlation with an increase in the proportion of definite goals, and also with a higher relative frequency of the goal-theme word order. These are the same two values (of the definiteness of the goal and the word order of goal and theme) that correspond to a higher proportion of definite themes. Log-linear analysis, then, reveals a spurious association between the definiteness of the theme and DClD, mediated by the definiteness of the goal and the relative word order of theme and goal.

Definiteness effects are also observed in the English double object construction. Ransom (1979) shows that there is a contrast in acceptability between the examples in (26a) and (26b). The double object construction, she claims, is more acceptable when the goal is definite as in (26a), but also when the theme is indefinite. When the definiteness values are reversed, as in (26b), the double object construction is degraded.

[7] Gordon and Hendrick (2005) find out that the ergative bias of extraction is only observed in spoken corpora of English, not in a written one. They argue that the relational hierarchy still offers the most explanatory model of extraction.

(26) a. They fed the Christian a lamb.
b. They fed a lion the Christian.

In her analysis of the double object construction, Ransom evaluates the alignment of the first and second NP with a referential scale based on a combination of the features of definiteness and specificity (which she calls 'referentiality'). Definite-specific NPs are at the top of the hierarchy, followed by indefinite-specific NPs and indefinite-non-specific NPs. A search over a relatively small English corpus (for modern standards) gives Ransom a sample of 51 double object sentences. In 32 of these sentences (63% of the total) the first NP is higher in the animacy-specificity scale than the second NP. The two NPs are equal in referential rank in 18 sentences (35% of the total), with only one sentence (2% of the total) in which the first NP is lower than the second NP in the referential scale.

Unfortunately, Ransom does not discuss the paradigmatic effects of definiteness on the realization of theme and goal, that is, the effects of definiteness on the alternation between the double object construction and the prepositional goal construction.[8] These facts are researched in Bresnan et al. (2007), a more extensive investigation of the observed effects of definiteness on the dative alternation. Applying logistic regression to a set of double object and prepositional goal constructions sampled from a large English corpus, they conclude that indefinite goals tend to favor the double object construction, and that indefinite themes tend to favor the prepositional goal construction.[9] These results are consistent with Ransom's conclusions, and point towards a 'harmonic' alignment of a referential scale and a scale of grammatical functions (like the ones proposed in Aissen 1999, 2003 within the framework of Optimality Theory), such that NPs at the top of the referential scale tend to be aligned with high-ranked functions (i.e. principal object), while NPs at the bottom of the scale tend to be aligned with low-ranked functions (oblique, subsidiary object). The effects of these harmonic alignment constraints are apparent in the syntagmatic dimension (as discussed in Ransom's paper) and also in the paradigmatic dimension (as discussed in Bresnan et al. 2007).

The conclusion from this body of research is that definite goals are more likely to bear an objective function in English and in Spanish, but the definiteness of the theme is a factor in the English dative alternation only. This follows from the analysis

[8]For an extensive discussion of paradigmatic and syntagmatic dimensions in argument realization, see Ackerman and Moore (1999).

[9]Bresnan et al. use logistic regression to model the effects of 14 different variables on the alternation between the double object and the prepositional goal constructions. Indefinite themes have a coefficient of -1.4, meaning that they make a significant contribution against the double object construction. Indefinite goals have a coefficient of $+0.85$. The study does not present a tabulation of the raw data, so a direct comparison with the log-linear analysis of the Spanish data I have presented here is not possible. Nevertheless, I will accept their conclusions concerning the effects of the animacy of the theme on the dative alternation in English.

in (22), since only in the English alternation does the function of the theme change (from a O in the prepositional dative construction to an O2 in the double object construction). In both languages, then, the realization of the goal alternates to satisfy a set of constraints favoring definite objects over definite obliques. These are ‘soft’ constraints (in the sense of Bresnan et al. 2007), since the effect of definiteness is not categorical, showing up in the data just as a difference in rates. In English, a constraint set favoring definite principal objects against definite subsidiary objects is also active, since the definiteness of the theme is also a factor in the alternation. I have attributed this contrast between English and Spanish to a deeper typological distinction, the one between primary object languages and accusative languages. The theme changes its function in the English dative alternation because English is a primary object language. In an accusative language like Spanish, only the function of the goal changes. Thus, a single set of constraints relating definiteness to grammatical function can be hypothesized for both languages, contributing to the generality of the analysis.

There is an alternative analysis of the preference for a definiteness goal in a construction with DClD, based on the hypothesis that doubling of the goal is a case of differential object marking. Definiteness is one of the factors that affect case alternations across languages. In Ossetian (27a) and in Urdu/Hindi (27b), for instance, an object is unmarked when indefinite, but marked accusative when definite or specific.

(27) a. (Bossong 1998:232)
fexston *dur/dur-y*
threw:1SG stone/stone-ACC
‘I threw a stone/the stone.’

b. (But and King 2004:155)
nadya-ne *jiraf/jiraf-**ko*** *dek^h-na hɛ*
Nadya-ERG giraffe.NOM/giraffe-ACC see-INF be.3SG
‘Nadya wants to see a giraffe/the giraffe.’

A plausible hypothesis about the higher rate of DClD with definite goals is that DClD is an instance of differential marking as well. The case marking that differentiates definite from indefinite goals is not expressed on the dependent, but on the verbal head, which hosts a case-marked pronoun cross-referencing the goal. According to this analysis, the goal is always an object, whether it is doubled by a clitic or not. In this paper, however, I argue against this alternative. I have provided evidence that the function of the goal changes depending on whether it occurs in a construction with or without DClD, based on the higher rate of goals preceding themes when the goal is doubled, and also on the obligatory doubling of *a*-marked experiencers and possessor. The effects of the definiteness of the goal on DClD, then, are not directly related to a case distinction. The association is indirect, through an alternation in the functions of the goal. Definite goals are more likely to be realized as subsidiary objects, which in turn requires them to be doubled by a dative clitic.

8 Conclusion

In this paper, then, I have shown that DClD interacts with semantic and syntactic factors. Usage data give statistically significant evidence that a goal is more likely to be doubled when definite or when it immediately follows the verb. These are some of the factors associated with the double object construction in English, a generalization that seems to support the hypothesis of a structural similarity between that construction and the Spanish DClD construction. I proposed a lexical-functional analysis of Spanish ditransitives, the SDOH, according to which goals alternate between an oblique function and a subsidiary object (O2) function. Only in the latter case is a goal doubled by a clitic. In English, on the other hand, goals alternate between an oblique function and a principal object function (O). This analysis accounts for interesting differences between the two constructions: the goal never passivizes in Spanish, and in English the definiteness of the theme also affects the alternation between the double object construction and the prepositional goal construction. A key ingredient of the lexical-functional model I proposed is the analysis of a ditransitive like *dar* 'give' and its English translation as cloaked causatives. In this analysis, the dative alternation is a special case of the alternation between direct and indirect causatives. The differences between English and Spanish in the realization of the goal, then, follow from a more general typological contrast between accusative languages and primary object languages in their treatment of causatives.

There are many questions that this research leaves open. For example, the hypothesis that ditransitive constructions with DClD in Spanish have the argument structure of a direct causative can be turned on its head, so to speak, to examine DClD in periphrastic causatives. Doubling of a causee by a dative clitic in a Spanish causative constructions is also variable, as example (28) illustrates.

(28)	*(Les) hice*	*leer*	*un*	*libro*	*a*	*las*	*niñas.*
	DAT made:1SG	read	a	book	to	the	girls

'I made the girls read a book.'

DClD in a causative should correspond to direct causation, and indirect causation should have no clitic doubling of the causee. This analysis makes some predictions regarding usage: DClD in structures like (28) should also favor definite causees, and it should favor the placement of the causee closer to the verbal complex, preceding the theme. More data must be gathered to answer this question.

Another open question concerns the role of additional syntactic and semantic factors on DClD. In the English dative alternation, the realization of the goal and the theme is affected by other factors besides definiteness. An argument tends to be realized as a principal object if it is discourse-given or pronominal. Moreover, goals favor the double object construction when they are animate or shorter than the theme (Bresnan et al. 2007; Bresnan and Hay 2008). It is possible that these factors also have an influence over DClD. My analysis predicts that animate goals may favor DClD over inanimate ones, and that the animacy of the theme should not be a factor in DClD. To find out an answer it is necessary to have more data, and a more fine-grained coding of the examples. I expect that the results of this research will contribute to a better understanding of the comparative grammar of ditransitives in Spanish and English.

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Case in Conflict: Embedded Subjects in Mongolian

Udo Klein, Dolgor Guntsetseg, and Klaus von Heusinger

1 Introduction

In Mongolian, subordinate object clauses are morphologically marked by the accusative suffix *-(i)g* on the subordinate verb.

(1) *Bi*	*ene*	*oyutan*	*haana*	*amidar-dag-ig*	*med-ne.*
I	this	student	where	live-HAB-ACC	know-NPST

'I know where this student lives.'

The subject of such subordinate object clauses can occur not only in the morphologically unmarked form (*ene oyutan* 'this student'), as in (1), but also in the morphologically accusative form (*ene oyutn-ig* 'this student-ACC'), as shown in (2).

(2) *Bi*	*ene*	*oyutn-ig*	*haana*	*amidar-dag-ig*	*med-ne.*
I	this	student-CC	where	live-HAB-ACC	know-NPST

'I know where this student lives.'

This alternation in morphological form cannot be explained by analysing both the NP *ene oyutan* of (1) and the NP *ene oyutn-ig* of (2) as direct objects, because

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direct objects expressed by definite (and demonstrative) NPs must be in the morphologically accusative form:

(3) **Bi ene oyutan med-ne.* \
I this student know-NPST \
Int.: 'I know this student.'

(4) *Bi ene oyutn-ig med-ne.* \
I this student-ACC know-NPST \
'I know this student.'

For a Japanese alternation similar to that in (1) and (2) Kuno (1976) proposed that in the unmarked form the NP is the subject of the subordinate clause, while in the morphologically accusative form it is (raised to be) the direct object of the superordinate clause. In von Heusinger et al. (2011) we argued at length that the accusative NP in (2) should not be analysed as subject to object raising, but as an accusative subject of the subordinate clause, which may in some cases scramble into the superordinate clause.[1] The aim of this paper is to investigate the conditions under which the accusative on subjects of embedded (object) clauses can be omitted – an issue that is orthogonal to the question of whether the NP *ene oyutn-ig* in (2) is raised from subject to object position. If the NP *ene oyutn-ig* in (2) is analysed as raised to object we want to find out under what conditions it raises – if it is analysed as an accusative subject of the subordinate clause we want to know under what conditions it can be accusative as opposed to being morphologically unmarked.

The results of the questionnaires that were used to investigate the conditions underlying this alternation indicate that the accusative on the subject of an embedded object clause (embedded subject, for short) can be omitted either (i) if the matrix subject and embedded subject are not adjacent or (ii) if they are adjacent and the matrix subject is higher than the embedded subject on the definiteness scale or animacy scale. Put differently, the accusative cannot easily be omitted if the two NPs are adjacent and the second NP is higher than the first NP on either definiteness or animacy scale. In order to explain this pattern of omission we assume the following three principles:

(P1) PROMINENCE PRINCIPLE: the most prominent argument in a sequence of adjacent arguments (the highest argument on the definiteness or animacy scale) has the most prominent grammatical function, i.e. matrix subject.

(P2) ACCUSATIVE PRINCIPLE: an accusative marked NP is not the matrix subject.

(P3) FIRST ARGUMENT PRINCIPLE: the first NP in a sequence of NPs is interpreted as the matrix subject.

We propose that (i) that there is a default and defeasible inference to the effect that the argument which is highest on the definiteness or animacy hierarchy is the matrix subject (P1), (ii) the function of the accusative marker is to indicate that the

[1] For further details on when subject of subordinate clauses scramble into the superordinate clause, see von Heusinger et al. (2011, Sect. 4).

argument is not the matrix subject (P2) and (iii) that the information about syntactic function contributed by word order (P3) differs in status from the information contributed by case morphology. If the ACCUSATIVE PRINCIPLE overrides the PROMINENCE PRINCIPLE, then no conflict can arise if the two principles disagree on which NP the matrix subject is. On the other hand, if the FIRST ARGUMENT PRINCIPLE does not override the PROMINENCE PRINCIPLE, then we can explain the difficulty in omitting the accusative from an adjacent but more prominent embedded subject as resulting from a conflict between the FIRST ARGUMENT PRINCIPLE and the PROMINENCE PRINCIPLE.

If the function of the accusative in Mongolian (and possibly in other SOV languages, too) is to indicate that the NP does not bear the matrix subject role, this would be somewhat unusual since case markers are assumed to either distinguish arguments of the same predicate from one another or to identify semantic or pragmatic properties of the argument. According to de Hoop and Malchukov (2008, p. 567) “[t]he identifying strategy makes use of case morphology to encode specific semantic/pragmatic information about the nominal argument in question”, whereas “[t]he distinguishing strategy is a more specific strategy that is used for distinguishing between the two core arguments of a transitive clause, i.e. the subject and the object”.

Since the conditions governing the accusative-nominative case alternation on subjects of object clauses are different from the conditions underlying the differential object marking of direct objects, we will begin by summarising in Sect. 2 the conditions for differential object marking in Mongolian. In Sect. 3, we will introduce some case alternations on subjects of subordinate clauses, and will then focus on the case alternation on subjects of object clauses. Based on native speaker intuitions about this case alternation we formulated some generalisations, which we tested by means of a written and then a web questionnaire. In Sects. 4 and 5 we present the questionnaires and their evaluation. In Sect. 6, we propose an explanation of the phenomenon of accusative omission on subjects of object clauses. Section 7 concludes.

2 Differential Case Marking in Mongolian

Modern Mongolian is an SOV language with nominative-accusative alignment. The subject of matrix clauses is morphologically unmarked (nominative), whereas the direct object is either morphologically accusative or morphologically unmarked.[2]

[2]To avoid potential confusion, we emphasise that the glosses indicate morphological case, not syntactic case (see e.g. Spencer 2009 for a clear exposition of the relevance of this distinction). So, the lack of glossing information on some direct objects simply indicates that this object is morphologically unmarked, and should not be taken to imply that it is in the syntactic case nominative.

In particular, the direct object must be ACC-marked if it is expressed by a pronoun, a name or a definite NP, and it may be ACC-marked if it is indefinite, with the preference depending mainly on specificity. See Guntsetseg (2009) for a detailed description of the factors conditioning differential object marking in Modern Mongolian.

(5) *Tuya* ***ene hun*(–ig)*** *med-ne.*
Tuya this person-ACC know-NPST
'Tuya knows this person.'

(6) *Tuya* ***neg oyut(a)n(–ig)*** *med-ne.*
Tuya a student-ACC know-NPST
'Tuya knows this person.'

The subjects of subordinate clauses can be realised in different cases. For example the subject of a relative clause can be either morphologically unmarked, genitive (GEN) or ablative (ABL) (7), whereas the subject of adverbial clauses is either morphologically unmarked or ACC (8).

(7) *Bi* ***jerunhiilegch/-in/-ees*** *bich-sen zahia-g unsh-san.*
I president/-GEN/-ABL write-PST letter-ACC read-PST
'I read the letter which the president wrote.'

(8) ***Bold/-ig*** *ir-sn-ii daraa bi yav-na.*
Bold/-ACC come-PST-GEN after I go-NPST
'I will go after Bold comes.'

Note that in (8) the embedded clause is a complement of the postposition *daraa* ('after'), making it unlikely that the matrix verb *yav-na* ('go-NPST') somehow governs the embedded subject *Bold* if it is accusative marked. To the extent that these subordinate clauses are structurally similar to the object clauses to be discussed in the next section, they appear to provide evidence against an analysis of the embedded subjects as being governed by the matrix verb.

So in Mongolian there are different case alternations on subjects of subordinate clauses, but no case alternation on subjects of main clauses.

3 Case Alternation on Subjects of Object Clauses

In this paper we will focus on the case alternation on subjects of object clauses. Object clauses are propositional complements suffixed with the accusative marker *-ig*, as illustrated in (9).

(9) *Bi ene oyutn-ig haana amidar-dag-**ig** med-ne.*
I this student-ACC where live-HAB-**ACC** know-NPST
'I know where this student lives.'

The object clause may occur either after the matrix subject (10a) or before it (10b).

(10) a. ***Bi*** *ene oyutn-ig haana amidar-dag-ig med-ne.*
I this student-ACC where live-HAB-ACC know-NPST
'I know where this student lives.'
b. *Ene oyutn-ig haana amidar-dag-ig* ***bi*** *med-ne.*
this student-ACC where live-HAB-ACC I know-NPST
'I know where this student lives.'

As can be seen from these examples, the subject of such an object clause can be realised in the accusative, but under certain conditions the accusative suffix on the subject may be omitted, leading to an accusative-nominative case alternation on subjects of object clauses.

(11) a. *Bi* ***ene oyutn-ig*** *haana amidar-dag-ig med-ne.*
I this student-ACC where live-HAB-ACC know-NPST
'I know where this student lives.'
b. *Bi* **ene oyutan** *haana amidar-dag-ig med-ne.*
I this student where live-HAB-ACC know-NPST
'I know where this student lives.'

Note that unlike English subordinate clauses, the embedded object clauses in Mongolian do not have a clause-initial complementiser. Together, the fact that Mongolian is verb-final and the fact that embedded object clauses do not have a clause-initial complementiser allow for the possibility that the embedded subject immediately follows the matrix subject, resulting (in some cases at least) in a temporary uncertainty about the grammatical function of the second NP. For example, immediately after parsing the NP *ene oyutn-ig* ('this student-ACC') in sentence (11a), this NP could be understood as the object of the main clause, which would not be possible if the two NPs were separated by a clause-initial complementiser.

From a syntactic point of view two questions should be asked about the structure of these object clauses. The first question is whether all instances of non-finite verb forms occurring in these object clauses are to be analysed as infinitives, and the second is whether the accusative subject of the object clause has raised to the object position of the main verb.

If all non-finite verb forms occurring in this construction are analysed as infinitives, then one could claim that this construction is an *Accusativus Cum Infinitivo* (ACI), as has been done in e.g. Binnick (1979, Sect. 4). If this were the case, then it would not be obvious how to account for the fact that some verb forms can occur as main verbs (12) whereas others cannot (13):

(12) a. *Tuya ene hun hulgai* ***hii-sn****-ig med-ne.*
Tuya this person theft do-PST-ACC know-NPST
'Tuya knows that this person did the theft.'
b. *Ene hun hulgai* ***hii-sen***.
this person theft do-PST
'This person did theft.'

(13) a. *Tuya ene hun hulgai* ***hii-h****-ig har-san.*
Tuya this person theft do-INF-ACC see-PST
'Tuya saw this person do(ing) the theft.'

b. **Ene hun hulgai* ***hii-h****.*
this person theft do-INF
Int.: 'This person is doing the theft.'

See also Koptjevskaja-Tamm (1993, p. 37) for another argument why these non-finite verb forms should not be analysed as infinitives in Mongolian.

Concerning the second question, there is an important difference between accusative subjects of subordinate clauses and accusative objects (of main or subordinate clauses). If for example a demonstrative NP is the direct object of a main clause, then the accusative cannot be omitted (14a), but if the same demonstrative NP is the subject of an embedded object clause, then the accusative can be omitted (14b). Therefore, the claim that the subject of the object clause has raised to the object position of the main clause leaves this difference unexplained.

(14) a. *Tsagdaa ene hulgaich****(–ig)*** *bari-san.*
Police this thief-ACC arrest-PST
'The police arrested this thief.'

b. *Bi ene* hulgaich**(–ig)** *tsagdaa-d bari-gd-san-****ig*** *med-ne.*
I this thief-ACC police-DAT arrest-PASS-PST-ACC know-NPST
'I know that this thief was arrested by the police.'

In this paper we do not have to take a stand on these questions about the proper analysis of the non-finite verb form and the subject of the object clause, since as it turns out the main questions that concern us here, namely under what conditions the accusative is omitted from the subject of the object clause and why, appear to be independent of the answer to these questions.

In the next two sections we will present two questionnaires, the first written and the second via the internet, that we performed in order to investigate the conditions under which the accusative marker on the subject of object clauses can be omitted, and in the last section we will propose an explanation for why the accusative marker can be omitted under these conditions.

4 First Questionnaire

4.1 Conditioning Factors

So let us turn to the conditions under which the accusative on the subject of the object clause may or may not be omitted. The first observation, based on the intuition of one of the authors, is that the accusative on the embedded subject of

(15) cannot easily be omitted, whereas the accusative on the same embedded subject can be omitted in (16):

(15) a. *Ene bagsh* ***Tuya-g*** *ire-h-ig hus-ej bai-na.*
this teacher Tuya-ACC come-INF-ACC want-CVB be-NPST
'This teacher wants Tuya to come.'

b. ?*Ene bagsh* ***Tuya*** *ire-h-ig hus-ej bai-na.*
this teacher Tuya come-INF-ACC want-CVB be-NPST
'This teacher wants Tuya to come.'

(16) a. *Bi* ***Tuya-g*** *ire-h-ig hus-ej bai-na.*
I Tuya-ACC come-INF-ACC want-CVB be-NPST
'I want Tuya to come.'

b. *Bi* ***Tuya*** *ire-h-ig hus-ej bai-na.*
I Tuya come-INF-ACC want-CVB be-NPST
'I want Tuya to come.'

Put differently, in (15) there is a clear preference for using the accusative, whereas in (16) both the accusative and the nominative subject appear equally acceptable. Note that in (15) the embedded subject *Tuya-g* ('Tuya-ACC') is higher on the definiteness scale (DS) of Aissen (2003, p. 437) than the matrix subject *ene bagsh* ('this teacher').

(DS) Pronoun > Name > Definite > Indef. Specific > Indef. Nonspecific

On the other hand, in (16) the embedded subject *Tuya-g* ('Tuya-ACC') is lower on the DS than the matrix subject *bi* ('I'). The underlying generalisation appears to be that if matrix and embedded subjects are adjacent, then there is a preference for accusative marking of an embedded subject if the embedded subject is higher than the matrix subject on the definiteness scale.

4.2 Method

To test this generalisation, we designed a written questionnaire, which we describe below. The results will be presented and discussed in Sect. 4.3.

4.2.1 Design

The two independent factors were (i) the case on the embedded subject, with the two values NOM or ACC, and (ii) the relative definiteness of matrix subject (MS) and embedded subject (ES), with the two values MS > ES or MS < ES. The dependent factor was the acceptability judgement.

Table 1 Conditions of the first questionnaire

Cond.	Relative definiteness	Case ES	Definiteness MS	Definiteness ES
1	MS > ES	NOM	Pronoun	Name
			Pronoun	Definite
			Name	Definite
2	MS > ES	ACC	Pronoun	Name
			Pronoun	Definite
			Name	Definite
3	MS < ES	NOM	Name	Pronoun
			Definite	Pronoun
			Definite	Name
4	MS < ES	ACC	Name	Pronoun
			Definite	Pronoun
			Definite	Name

4.2.2 Materials

Each of the four conditions was tested with three sentences, instantiating subjects with different positions on the definiteness scale, but with the same relative definiteness, as shown in Table 1.

The sentences in (17) are from the first questionnaire. Sentence (17a) is one of the items used for the condition 2: the accusative marked embedded subject is a definite NP and thus lower on the definiteness scale than the matrix subject which is a pronoun. Sentence (17b) is one of the items used for the condition 3, in which the nominative embedded subject is a name and is thus higher on the definiteness scale than the matrix subject, which is a definite NP.

(17) a. *Bi ene huuhd-ig duula-h-ig huse-j bai-na.*
I this child-ACC sing-INF-ACC want-CVB be-NPST
'I want this child to sing.'
b. *Ene bagsh Tuya duula-h-ig huse-j bai-na.*
this teacher Tuya sing-INF-ACC want-CVB be-NPST
'This teacher wants Tuya to sing.'

4.2.3 Participants, Procedure and Scoring

One half of the 320 participants were students from the University of Ulaanbaatar, and the other half consisted of employees and civil servants, also from Ulaanbaatar. The 12 sentences were distributed across four questionnaires. These items were mixed (i) with items for another experiment on differential object marking in Mongolian and (ii) with filler sentences. Every questionnaire was answered by around 80 participants. The participants had to judge on a scale from 1 (very bad) to 6 (very good) how good the sentences sound.

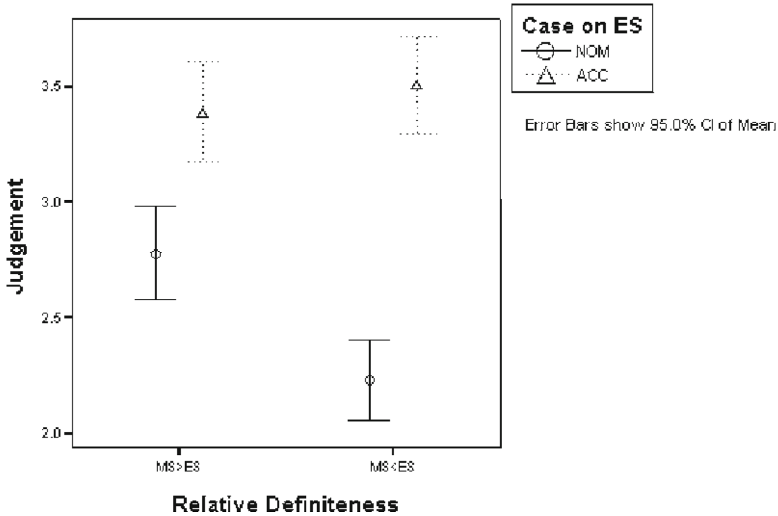

Fig. 1 Interaction between case and relative definiteness

4.2.4 Data Analysis

The data were analysed by means of a crossed 2-way between-subjects analysis of variance.

4.3 Results

We found a significant effect of case ($F(1.887) = 84.6$; $p < 0.001$), a significant effect of relative definiteness ($F(1.887) = 4.4$; $p < 0.05$), and a significant interaction between case and relative definiteness ($F(1.887) = 10.5$; $p < 0.001$). While there was no significant difference between the accusative marking of embedded subjects higher than matrix subjects and the accusative marking of embedded subjects lower than matrix subjects, we found a significant difference between the nominative marking of embedded subjects depending on the relative definiteness. If the embedded subject was higher on the DS than the matrix subject, then nominative marking was significantly worse than if the embedded subject was lower on the DS than embedded subjects. In fact the mean of nominative marked embedded subjects which are higher on the DS than the matrix subjects is around 2, which is similar to the mean for the ungrammatical filler sentences. Moreover, the accusative marking was on average judged better than the nominative marking, both if the embedded subject was higher and when it was lower than the matrix subject (Fig. 1).

With the influence of the relative definiteness of the embedded subjects on nominative marking (or equally on the omission of the accusative marking) established at least for these lexicalisations, the next question is whether this difference holds also when the two subjects are not adjacent. Moreover, since high definiteness and high animacy often correlate, it is worth examining whether relative animacy of matrix and embedded subjects is also a factor conditioning the omission of the accusative marker. To find this out, we designed a second questionnaire which will be discussed in the next section.

5 Second Questionnaire

5.1 Conditioning Factors

With the second questionnaire we wanted to investigate the following two questions. Firstly, does relative animacy of matrix and embedded subjects influence the accusative-nominative alternation on the embedded subject? If this is the case we should find a difference in the marking of embedded subjects, depending on whether or not they are higher on the animacy scale (AS) than the matrix subjects.

(AS) human > animal > inanimate

In (18) the embedded subject is lower on the AS than the matrix subject, in (19) the matrix and embedded subjects are both human and thus on the same position on the AS, and in (20) the embedded subject is higher on the AS than the matrix subject.

(18) ***Tuya neg shiree(−g)*** *end bai-sn-ig har-san.*
Tuya a table-ACC here be-PST-ACC see-PST
'Tuya saw a table was here.'

(19) ***Sarnai neg oyut(a)n(−ig)*** *end amidar-dag-ig med-ne.*
Sarnai a student-ACC here live-HAB-ACC know-NPST
'Sarnai knows that a student lives here.'

(20) ***Ene GPS bagaj neg hun(−ig)*** *haana yamar gazar*
this GPS instrument a person-ACC where which place
bai-gaa-g todorhoil-j chad-dag.
be-PRS-ACC determine-CVB can-HAB
'This GPS instrument can determine where a person is.'

Secondly, does the adjacency of matrix and embedded subject influence the accusative-nominative alternation on the embedded subject? If this is the case, then we should find a difference in the marking of the embedded subject, depending on whether it is adjacent to the matrix subject (21) or not (22)-(23).

(21) ***Neg bagsh Tuya(−g)*** *hicheel-d idevhtei orolzo-h-ig*
a teacher Tuya-ACC lesson-DAT diligently participate-INF-ACC
sanuul-av.
warn-PST
'A teacher warned that Tuya has to participate diligently at the lesson.'

(22) ***Neg bagsh*** *unuudur* ***Tuya(−g)*** *hicheel-d idevhtei orolzo-h-ig*
a teacher today Tuya-ACC lesson-DAT diligently participate-F-ACC
sanuul-av.
warn-PST
'Today, a teacher warned that Tuya has to participate diligently at the lesson.'

(23) ***Tuya(−g)*** *hicheel-d idevhtei orolzo-h-ig* ***neg*** *bagsh sanuul-av.*
Tuya-ACC lesson-DAT diligently participate-INF-ACC a teacher warn-PST
'A teacher warned that Tuya has to participate diligently at the lesson.'

5.2 Method

To answer these questions we designed a questionnaire with acceptability judgements on a scale from 1 (very bad) to 4 (very good) as the dependent variable, and with case, relative definiteness, relative animacy and adjacency as independent variables. To keep the experiment manageable, we investigated the case preferences for subjects of intransitive embedded clauses only.

5.2.1 Design

Independent factors:

- Adjacency
  - 1: embedded subject immediately follows matrix subject
  - 2: matrix and embedded subjects are separated by an adverb
  - 3: matrix subject follows the embedded clause
- Relative definiteness
  - MS > ES: matrix subject higher on definiteness scale than embedded subject
  - MS = ES: matrix and embedded subject have equal definiteness
  - MS < ES: matrix subject lower on definiteness scale than embedded subject
- Relative animacy
  - MS > ES: matrix subject higher on animacy scale than embedded subject
  - MS = ES: matrix and embedded subject have equal animacy
  - MS < ES: matrix subject lower on animacy scale than embedded subject

- Case on subject of subordinate clause:
  - nominative
  - accusative

Dependent factors:

- acceptability judgement

5.2.2 Materials

For each of the 54 conditions (shown in Table 2) below we used exactly one item.

Table 2 Conditions of the second questionnaire

Cond.	Case ES	Adjacency	Relative definiteness	Relative animacy
1	NOM	1 MS ES (embedded subject immediately follows the matrix subject)	MS > ES	MS > ES
2			MS > ES	MS = ES
3			MS > ES	MS < ES
4			MS = ES	MS > ES
5			MS = ES	MS = ES
6			MS = ES	MS < ES
7			MS < ES	MS > ES
8			MS < ES	MS = ES
9			MS < ES	MS < ES
10		2 MS ADV ES (matrix and embedded subjects are separated by an adverb)	MS > ES	MS > ES
11			MS > ES	MS = ES
12			MS > ES	MS < ES
13			MS = ES	MS > ES
14			MS = ES	MS = ES
15			MS = ES	MS < ES
16			MS < ES	MS > ES
17			MS < ES	MS = ES
18			MS < ES	MS < ES
19		3 ES … MS (matrix subjects follows the embedded clause)	MS > ES	MS > ES
20			MS > ES	MS = ES
21			MS > ES	MS < ES
22			MS = ES	MS > ES
23			MS = ES	MS = ES
24			MS = ES	MS < ES
25			MS < ES	MS > ES
26			MS < ES	MS = ES
27			MS < ES	MS < ES
28-54	ACC	The same as in conditions 1–27.		

Sentence (24) was used to test condition 5, sentence (25) was used to test condition 22, and sentence (26) was used to test condition 38 (Case ES: ACC; Adjacency: 2; Relative definiteness: MS > ES; Relative animacy: MS = ES):

(24) *Tsetsegee Bold unuudur huduu-nuus ir-sn-ig sons-son.*
Tsetsegee Bold today country-ABL come-PST-ACC hear-PST
'Tsetsegee heard that today Bold came from country.'

(25) *Ene nom haana zar-agd-aj bai-gaa-g ene oyutan asuu-j bai-na.*
this book where sell-PASS-CVB be-PRS-ACC this student ask-CVB be-PRS
'This student asks where this book is being sold.'

(26) *Sarnai end neg oyutn-ig amidar-dag-ig med-ne.*
Sarnai here a student-ACC live-HAB-ACC know-PRS
'Sarnai knows that a student lives here.'

5.2.3 Participants, Procedure, Scoring

The 156 participants were all native speakers of Mongolian, and most of them accessed the questionnaire website by means of an advertisement link placed on a popular Mongolian website (http://www.medeelel.com). The 54 sentences were distributed over 6 questionnaires, so that each participant saw only 9 out of 54 conditions/items. The test sentences were mixed with an equal number of filler sentences in the questionnaires. We collected 26 judgements per item via a web questionnaire, using the WEBEXP2 software, where the participants had to choose 1 (very bad), 2, 3, or 4 (very good), as a response to how good the sentence displayed sounded.

5.2.4 Data Analysis

The data were analysed by means of a crossed 4-way between-subjects analysis of variance.

5.2.5 Results

The first result of the factorial analysis of variance is that there is a significant interaction between the case of embedded subject and adjacency of matrix and embedded subjects ($F(2.1398) = 10.2$; $p < 0.001$), as illustrated in Fig. 2.

This interaction can be interpreted in the following way. Firstly, if matrix and embedded subject are adjacent, then there is a significant preference for ACC-marking of the embedded subject. And secondly, if matrix and embedded subject are not adjacent, then there is no significant preference for ACC-marking of the embedded subject.

The second significant interaction, illustrated in Fig. 3, is between the case of the embedded subject and the relative definiteness of matrix and embedded subjects ($F(2.1398) = 10.9$; $p < 0.001$). Firstly, there is no significant preference for ACC-marked

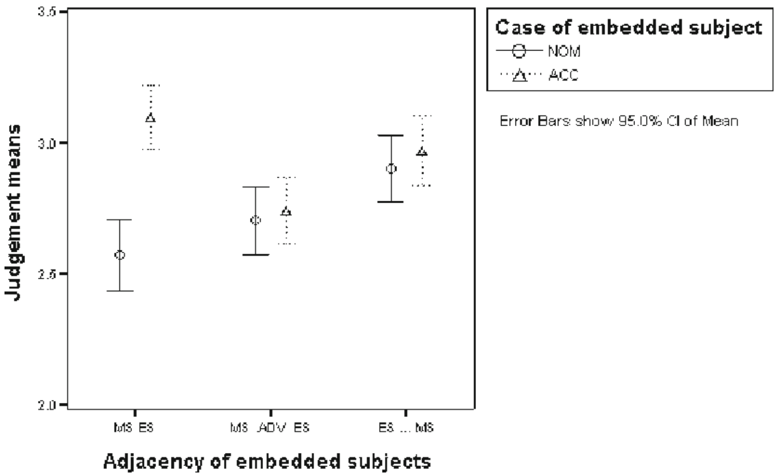

Fig. 2 Interaction between case and adjacency

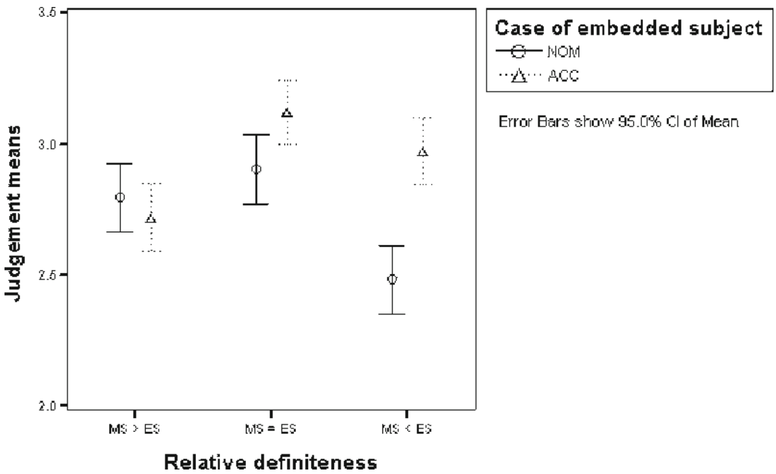

Fig. 3 Interaction between case and relative definiteness

embedded subjects if they are lower on the definiteness scale than the matrix subject. Secondly, there is a slight preference for ACC marked embedded subjects if they have the same definiteness as matrix subjects. Thirdly, there is a statistically significant preference for ACC-marking (half a point on the judgement scale) if the embedded subject is higher on the definiteness scale than the matrix subject.

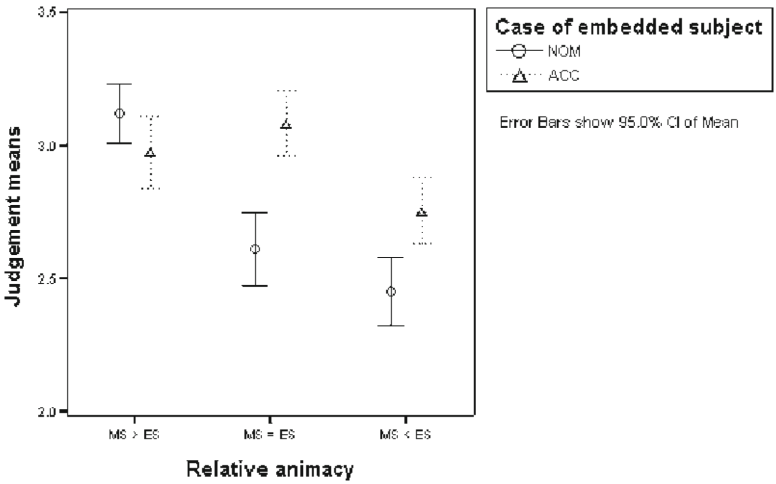

Fig. 4 Interaction between case and relative animacy

The third significant interaction, illustrated in Fig. 4, is between the case of embedded subject and the relative animacy of matrix and embedded subjects (F(2.1398) = 14.2; p < 0.001). Firstly, there is a significant preference for ACC-marked embedded subjects if their animacy is equal to or higher than the animacy of the matrix subject. And secondly, there is no clear preference for NOM or ACC on the embedded subject if it is lower in animacy than the matrix subject.

Next we will look more closely at the interaction between case, relative animacy and definiteness if both subjects are adjacent. The three examples where the subjects are adjacent but differ in relative definiteness are repeated below:

(27) ***Tuya neg shiree(−g)*** *end bai-sn-ig har-san.*
Tuya a table-ACC here be-PST-ACC see-PST
'Tuya saw a table was here.'

(28) ***Tsetsegee Bold (−ig)*** *unuudur huduu-nuus ir-sn-ig sons-son.*
Tsetsegee Bold-ACC today country-ABL come-PST-ACC hear-PST
'Tsetsegee heard that Bold today came from countryside.'

(29) ***Neg zereg ene buu(−g)*** *yaj ajilla-dag-ig nadad zaa-j ug-sun.*
A soldier this gun-ACC how function-HAB-ACC I.DAT show-CVB give-PST
'A soldier showed me how this gun works.'

The interaction between case and relative definiteness if the subjects are adjacent is illustrated in Fig. 5:

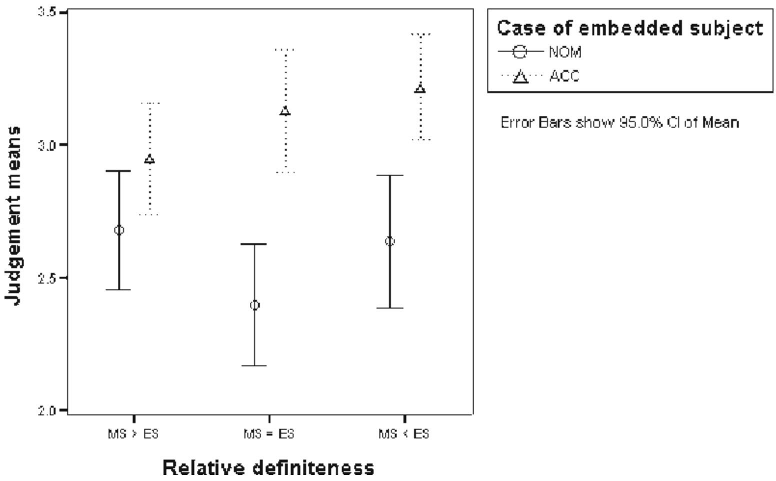

Fig. 5 Interaction between case and relative definiteness of adjacent subjects

If the two subjects are adjacent, then ACC-marked embedded subjects are significantly preferred **only if** they are equal to or higher than the matrix subject on the definiteness scale.

Finally, we illustrate in Fig. 6 the case alternation results if the adjacent subjects have different relative animacy, with the examples repeated below:

(30) ***Tuya neg shiree(−g)*** *end bai-sn-ig har-san.*
Tuya a table-ACC here be-PST-ACC see-PST
'Tuya saw a table was here.'

(31) ***Sarnai neg oyutn-ig*** *end amidar-dag-ig med-ne.*
Sarnai a student-ACC here live-HAB-ACC know-NPST
'Sarnai knows that a student lives here.'

(32) *Ene GPS bagaj neg hun-ig haana yamar gazar*
this GPS instrument a person-ACC where which place
bai-gaa-g todorhoil-j chad-dag.
be-PRS-ACC determine-CVB can-HAB
'This GPS instrument can determine where a person is.'

Again, the accusative marking on the embedded subject cannot easily be omitted if its animacy is equal to or higher than the animacy of the matrix subject.

Summing up the main results of the two questionnaires, the accusative marking on the embedded subject of an object clause may be omitted in one of three cases:

- if the matrix and embedded subjects are not adjacent
- if the matrix and embedded subjects are adjacent, and the matrix subject is higher than the embedded subject on the definiteness scale
- if the matrix and embedded subjects are adjacent, and the matrix subject is higher than the embedded subject on the animacy scale

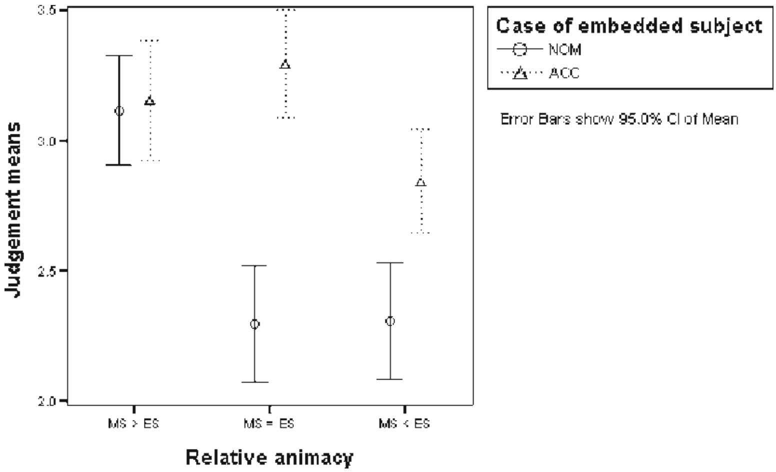

Fig. 6 Interaction between case and relative animacy of adjacent subjects

Before we proceed with the interpretation of these results, it is necessary to point out that due to the fact that only one item has been tested per condition, we cannot generalise from the judgements about this particular sentence to the acceptability of the condition (or sentence type). For example, since condition 5 (matrix and embedded subjects are adjacent and on the same position on both definiteness and animacy scale) was tested by exactly one sentence, namely sentence (24), we cannot generalise from the judgements for this particular sentence to the judgements of all other sentences satisfying condition 5. Given the experiment setup, we can conclude that if we repeated the same experiment with different participants the results would very likely be the same, but we cannot conclude that if we repeated the experiment with different items per condition, the results would be the same. Due to this limitation we interpret our results as indications (not evidence) on what the omission of the accusative on embedded subjects depends on.

6 Interpretation

Why does the omission of the accusative on embedded subjects of object clauses depend on the relative animacy and on the relative definiteness of the embedded subject if both subjects are adjacent? Put differently, why is it easy to omit the accusative if the embedded subject is lower than the matrix subject, but hard (if not ungrammatical) if the embedded subject is higher than the matrix subject? (Remember that if these arguments were direct objects the accusative could not be omitted if the argument is a pronoun, name or definite/demonstrative NP.)

We propose to account for this difference by the interaction of the following principles:

(P1) PROMINENCE PRINCIPLE: the most prominent argument in a sequence of adjacent arguments (the highest argument on the definiteness or animacy scale) has the most prominent grammatical function, i.e. matrix subject.
(P2) ACCUSATIVE PRINCIPLE: an accusative marked NP is not the matrix subject.
(P3) FIRST ARGUMENT PRINCIPLE: the first NP in a sequence of NPs is interpreted as the matrix subject.

The PROMINENCE PRINCIPLE is taken to be a defeasable processing principle motivated by the harmonic alignment of prominence scales.[3] The ACCUSATIVE PRINCIPLE is taken to be a grammatical hard-wired principle, which cannot be overridden by other principles. The FIRST ARGUMENT PRINCIPLE is again taken to be a processing principle that can be overridden. The motivation for this principle is the observation that "in the case of an ambiguity, the first argument is preferentially interpreted as the subject of the clause", as pointed out in Schlesewsky and Bornkessel (2004, p. 1216) and references therein.

Let us now look at the individual structures in turn and see what effect these principles have. In the first structure illustrated in (33) the first NP is higher on one of the definiteness or animacy scales than the adjacent accusative marked NP. The NP in a sequence of NPs which is the most prominent one (the highest on the definiteness or animacy scale) is indicated by boldface.

(33) $\mathbf{NP}_{NOM}\ \mathrm{NP}_{ACC}$

By (P1) the first NP is the matrix subject since it is more prominent, and by (P2) the second argument cannot be the matrix subject. So there is no conflict between what these two principles imply. Secondly, if the structure is as in (34)

(34) $\mathrm{NP}_{\mathrm{NOM}}\ \mathbf{NP}_{\mathrm{ACC}}$

By (P1) the second NP is the matrix subject as it is the more prominent one, but by (P2) the second NP cannot be the matrix subject, because it is accusative marked. If we assume that case information overrides default information, then no conflict results. Note that if the ACCUSATIVE PRINCIPLE specified that an accusative marked NP cannot be the subject (as opposed to the matrix subject), the subjects of object clauses could not be accusative marked, contrary to fact. It is therefore important to emphasise that the function of the accusative marker in these cases cannot be analysed as (i) distinguishing subject from object or as (ii) indicating some semantic/pragmatic property of the argument, but should be analysed as distinguishing matrix subject from non-matrix subject. If this is correct then the distinguishability of the arguments of a transitive relation proposed e.g. by de Hoop and Lamers (2006), de Swart (2007) and Næss (2007) should be complemented, for Mongolian at least, by the distinguishability of matrix subject from non-matrix subjects.

[3] See Aissen (2003, p. 440) for the notion of harmonic alignment of prominence scales.

Thirdly, if the structure is as in (35) then both by (P1) and (P3) the first argument is the matrix subject, so again no conflict arises.

(35) $\mathbf{NP}_{NOM}$ NP_{NOM}

Fourthly if the structure is as in (36) then by (P1) the second NP is the matrix subject, since it is the more prominent one, but by (P3) the first NP should be the matrix subject. If we assume that word order does not override the default information provided by (P1), then we predict a conflict in the assignment of grammatical roles.

(36) $\mathrm{NP}_{\mathrm{NOM}}$ $\mathbf{NP}_{\mathrm{NOM}}$

In other words, we claim that the crucial difference between structures like (34) and structures like (36) is that in (34) the case information overrides the defeasable inference based on relative prominence, whereas word order information cannot override this inference, resulting in conflicting information about grammatical role assignment.

The second question is why the conditions for the omission of the accusative on embedded subjects are dependent on the adjacency of the two subjects. Note that this has been built into the PROMINENCE PRINCIPLE (P1). One possibility is that the assignment of grammatical roles in SOV languages is sensitive to clause boundaries. If a clause boundary (e.g. a clause-initial complementiser) also indicates that certain NPs cannot be the matrix subject, then the accusative would not be necessary to indicate this. On the other hand, if like in Mongolian there is no such clause boundary indicator between two morphologically unmarked NPs, then the PROMINENCE PRINCIPLE may or may not conflict with the FIRST ARGUMENT PRINCIPLE. If the most prominent argument is not the first but the second NP, then the PROMINENCE PRINCIPLE conflicts with the FIRST ARGUMENT PRINCIPLE, and the presence of the ACC can be interpreted as settling the conflict by overriding the FIRST ARGUMENT PRINCIPLE. If on the other hand the most prominent argument is the first NP, then no conflict arises, and the ACC is not necessary for the assignment of the matrix subject role.

To sum up, in order to account for the difference between the acceptability of the structures (34) and (36) we postulated (i) a principle to the effect that the most prominent argument in a sequence of arguments (the highest argument on the definiteness or animacy scale) is the matrix subject, and (ii) a difference in the status of case and word order information about grammatical role assignment – case overrides (the effect of) the PROMINENCE PRINCIPLE so that there is no conflict, whereas word order does not override the PROMINENCE PRINCIPLE, resulting in a conflict of grammatical role assignment.

Since this explanation does not depend on the type of the subordinate clause, it predicts that this case alternation between the morphologically unmarked form and the accusative form on subjects of embedded object clauses should also be found on subjects of other subordinate clause types. To test this prediction we performed a follow-up written questionnaire (in Mongolia, August 2008) comparing this NOM/ACC alternation on subjects of object clauses with the same alternation on subjects of adverbial clauses. The details of the experiment design, method, results and interpretation are discussed in Guntsetseg (2010). Here we summarize the design and the main results of this experiment.

The four independent variables of the experiment were: case (NOM or ACC), subordinate clause type (object clause or adverbial clause), adjacency (adjacent or non-adjacent) and relative definiteness (were the matrix and subordinate subjects were PRO-PRO, PRO-DEF, DEF-PRO and DEF-DEF). The dependent variable was the acceptability judgment of the native speakers. The resulting 32 conditions were tested by means of 15 lexicalizations each, resulting in 480 items. These items were split onto 30 questionnaires, which were distributed to 720 native speakers, so that each questionnaire was filled in by 24 participants. The results were analyzed by means of a factorial analysis of variance (by subjects and by items).

The main results of the experiment can be summarized as follows: first, the adjacency of matrix and embedded subjects turned out to be a significant factor not only in object clauses, but also in adverbial clauses: when the matrix subject immediately preceded the embedded subject there was a clear preference for marking the embedded subject as accusative in both object and adverbial clauses, whereas in those cases were the embedded subject did not immediately follow the matrix subject there was no significant difference between ACC and NOM marking. Secondly, we found that the preference for ACC marking on the subjects of adverbial clauses also depends on the referentiality of the embedded subject. What the results also indicate is that the preference of ACC marking does not depend on the referentiality of the matrix subject, so that we can cautiously conclude that what matters is the absolute referentiality of the embedded subject, and not its referentiality compared to that of the matrix subject. And thirdly, we found no significant interaction between the subordinate clause type and case marking – whenever there was a clear preference for ACC marking on the subject of an object clause with a certain combination of factors, there was also a clear preference for ACC marking on the subject of adverbial clauses with the same combination of factors, and whenever there was no clear preference for ACC marking on the subject of an object clause for a certain combination of factors there was no clear preference for ACC marking on the subject of adverbial clauses with the same combination of factors either.

Since we used 15 lexicalizations per condition we can confidently generalize these finding across lexicalizations, i.e. we can be reasonably confident that the observed preference patterns are not a quirk of some lexemes, but hold across lexemes. But most importantly, the result that this NOM/ACC alternation is independent of the type of the subordinate clause supports our explanation of this alternation, since our explanation in terms of the interaction of the three postulated principles does not make reference to the subordinate clause type.

7 Conclusions

In Mongolian the conditions under which the accusative on embedded subjects can be omitted are different from the conditions under which the accusative on direct objects can be omitted. On the one hand, with direct objects the accusative can only be omitted if the NP is an indefinite NP, whereas this is not the case for embedded subjects. On the other hand, the omission of the accusative on embedded subjects depends on the adjacency of this subject to the matrix subject and/or on which of the two NPs is more prominent, which is again not the case for direct objects. We conclude from this that the accusative marking on an NP does not indicate that this NP is a direct object, but that this NP is not the matrix subject. If this is on the right track, then in addition to the other functions case may have (see e.g. Butt (2006)), it can also be used to distinguish NPs across clause boundaries – an unusual function of case.

In order to explain why the accusative on embedded subjects of object clauses can be omitted, we proposed (i) a PROMINENCE PRINCIPLE according to which the most prominent NP in a sequence of NPs is the matrix subject and (ii) a difference in the status of case morphology and word order information about grammatical role assignment. The ACCUSATIVE PRINCIPLE overrides the PROMINENCE PRINCIPLE whereas the FIRST ARGUMENT PRINCIPLE conflicts with the PROMINENCE PRINCIPLE, explaining why the accusative cannot easily be omitted from the embedded subject, if it immediately follows the matrix subject and is more prominent than the matrix subject.

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Animacy, Generalized Semantic Roles, and Differential Object Marking

Beatrice Primus

1 Introduction

This chapter explores the connection between animacy and semantic roles in patterns of case selection where the animacy of the noun phrase referent is assumed to trigger differential object marking (DOM) in previous approaches. In this traditional view, which will be criticized below, case marking is considered to be a cue to animacy. The basic DOM-patterns and some facts that are still unexplained in alternative approaches will be presented in Sect. 2 of this chapter.

By using generalized semantic roles, i.e. decomposing a few general roles into more basic notions, I take a different view on the DOM-patterns under consideration. The interaction between animacy and semantic roles turns out to be closer than usually assumed. Many agentive properties – volition (or control), sentience, alienable possession, and certain patterns of motion – imply the involvement of a higher animate participant. By contrast, no patient-like concept implies animacy on the part of the respective participant. This will be shown in Sect. 3 of this chapter. This type of approach to semantic roles offers a straightforward explanation for phenomena connected to DOM that remain unexplained in previous approaches. Taking case in DOM-patterns as a cue to animacy, as in previous approaches, fails to explain why the same case may be used for certain inanimate patients, why it may be missing for animate patients with ditransitive verbs, why it may be conditioned by the semantic verb type or by individual verb lexemes, and finally, why it is used as a cue to semantic roles in other contexts of use (Sect. 4). I will show for Spanish that case

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selection in animacy-driven DOM is explicable by role-semantic case constraints tied to agentivity (Sect. 5). The present approach takes a role-functional view on animacy for the phenomena under discussion: animacy is only relevant as a cue to role-semantic interpretation. This view does not eliminate animacy from linguistic explanation. On the contrary, a better understanding of the basic notions that characterize semantic roles may be achieved by taking animacy into account (Sect. 6).

2 Animacy-based Differential Object Marking

In some languages certain direct objects are marked by an object marker, while other objects remain unmarked. In the traditional view, this pattern of variation is assumed to be driven by semantic features of the noun phrase such as animacy, definiteness or specificity, or a combination of these factors. I will focus on animacy-based variation. Definiteness and specificity will be addressed later (Sects. 3 and 6). I will illustrate DOM by examples from Spanish, an accusative language, in (1a, b) and from Hindi, an ergative language, in (2a, b). These are two languages that have been considered to have a typical DOM-pattern.

Spanish (García García 2007: 63)

(1) a. *Conozco *este actor / a este actor.*
know:PRS.1SG this:M.SG actor / OM this:M.SG actor
'I know this actor.'
b. *Conozco esta película / *a esta película.*
know:PRS.1SG this:F.SG film / OM this:F.SG film
'I know this film.'

Hindi (Mohanan 1994: 80)

(2) a. *Ilaa-ne bacce-ko / *baccaa uṭ*^{h}*aayaa.*
Ila-ERG child-OM / child lift.PRF
'Ila lifted the/a child.'
b. *Ilaa-ne haar-ko / haar uṭ*^{h}*aayaa.*
Ila-ERG necklace-OM / necklace lift.PRF
'Ila lifted the/a necklace.'

In Standard European Spanish, which is discussed in this chapter, animacy seems to be the most important factor. (1b) shows that a definite or specific object is not marked by the differential object marker, the preposition *a*, unless the referent is human or at least animate, as in (1a). In Hindi, definiteness plays a more important role. The differential object marker, the postposition *ko*, must be used with human noun-phrase referents, which can be interpreted as definite or indefinite, as shown in (2a). If an inanimate participant is marked, it is interpreted as definite, if it is unmarked, it is indefinite, as shown in (2b).[1] In both languages, animacy, more specifically a human participant in Hindi, seems to be a sufficient condition for overt marking. With indefinite or unspecific noun phrases, animacy (or being human) is also a necessary condition for DOM.[2] In Hindi and other Indic languages, the ergative marker is only used in the perfect. In other tenses the respective argument is zero-marked. This leads to case ambiguity if the patient is zero-marked as well.

The animacy criterion turns out to be less reliable than usually assumed, if one takes more data into consideration. In Spanish, animacy is not a necessary condition, as DOM occurs with certain inanimates, as shown in (3):

Spanish (García García 2007: 64)

(3) *En esta receta, la leche puede sustituir al huevo.*
in this:F.SG recipe the:F.SG milk can:PRS.3SG replace OM:DEF.M.SG egg
'In this recipe, egg can be replaced by milk.'

As we will see later (cf. Sect. 4), the verbs showing DOM with inanimates form a uniform group in terms of role semantics. This indicates that role semantics strongly influences DOM.

Furthermore, animacy is not a sufficient condition in Spanish, as there is no DOM with animate patients of ditransitive verbs, as shown in (4a, b):

(4) a. *La madre le da *al niño al padre.*
the:F.SG mother CL.3SG.DAT give:PRS.3SG OM:DEF.M.SG child OM:DEF.M.SG father
'Mother gives the child to the father.'

b. *La madre le da el niño al padre.*
the:F.SG mother CL.3SG.DAT give:PRS.3SG the:M.SG child OM:DEF.M.SG father
'Mother gives the child to the father.'

The lack of DOM in ditransitives in Spanish (and in some other languages with DOM) is explicable by the fact that the animate object marker is identical with the recipient marker, i.e. the dative. The recipient takes the dative leaving the animate patient unmarked, as double datives are prohibited in Standard European Spanish. This is another type of construction in which role selection (the recipient) influences DOM.

[1] In ergative languages, the zero-marked patient can be interpreted either as a direct object or as a morphosyntactic subject, depending on the language and the phenomenon under discussion (cf. Dixon 1994; Primus 1999). The zero-marked patient will be treated as an object in this chapter, for convenience only, following commonly used terminology.

[2] These observations are rough estimates. Acceptability judgements vary considerably in some cases.

In some languages, DOM is extended to ditransitive constructions with two animate objects (cf. Kittilä 2006). This is illustrated in (5) by examples from Punjabi:

Punjabi (Bhatia 1993: 89)

(5) a. *mãi mãã nüü kaake nüü dittaa.*
I mother DAT child DAT give.PST
'I gave the child to the mother.'

b. *mãi mãã nüü kaake dittaa.*
I mother DAT child give.PST
'I gave the child to the mother.'

c. **mãi mãã kaake nüü dittaa.*
I mother child DAT give.PST
'I gave the child to the mother.'

d. *mãi kuRii nüü vekhiaa.*
I girl DAT see.PST
'I saw a girl.'

If a ditransitive sentence has a recipient object and an animate patient object, then both objects can receive the dative marker *nüü* in some dialects of Punjabi, as shown in (5a).[3] An animate object of a monotransitive clause receives the same marker, cf. (5d). This means that the DOM pattern of monotransitive clauses is extended to ditransitive clauses as well. The ambiguity resulting from the double dative marking is resolved by word order (Bhatia 1993: 89): the recipient has to precede the direct object.

In the Majhi dialect of Punjabi it is only the recipient that takes the dative, as shown in (5b) and (5c). This pattern was also illustrated with Spanish examples in (4) above. A similar situation is found in Hindi (cf. Mohanan 1994: 85).

The fact that DOM is conditioned by the semantic verb type or by individual verb lexemes is another indicator that animacy and role subcategorization are interrelated. Hindi is illustrative in this respect (cf. Mohanan 1994: 81f.). The objects of the verbs *lik^h* 'write', *banaa* 'make', *paḍ^h* 'read', *gaa* 'sing', and *pii* 'drink', which subcategorize for inanimate objects in Hindi, do not allow the postposition *ko* even if the object is definite. Conversely, verbs that subcategorize for animate objects such as *piiṭ* 'beat, spank', *maar* 'kill', and *bulaa* 'call' tolerate only the postposition *ko*. Thus, a verb may impose an animacy restriction on its object, suspending the other conditions for alternation.

Likewise, the diachronic development of DOM in Spanish is conditioned by the semantic class of the verb (cf. von Heusinger 2008). Verbs with a high preference

[3] In Kittilä's (2006) cross-linguistic survey, the animate patient usually inherits the marker of the recipient. Languages with DOM in ditransitives vary with respect to recipient-marking. In some languages, the recipient retains its marking yielding double dative constructions, as shown in the Punjabi example (5a). In other languages the recipient looses its canonical marker in favour of the animate patient and takes another oblique marker (e.g. Sahaptin).

for human objects such as *matar* 'kill' and *herir* 'hurt' were the first to acquire DOM with full noun phrases.

Another type of evidence suggesting that role semantics and animacy are closely related is the choice of the animacy marker. This marker encodes semantic roles in other contexts of use (cf. Bossong 1985, 1998; Lazard 2001). In most of the Indic, Iranian, Semitic, Tupi-Guarani, and Romance languages, the animacy marker is the same as that used for the recipient, addressee, and benefactive (i.e. the dative) in ditransitive constructions, as illustrated above. In many Romance, Iranian and Indic languages the animate patient marker also codes the experiencer of certain psychological predicates. In some Iranian languages (e.g. Jaghnobi) it indicates the agent of transitive clauses (i.e. the ergative). In sum, animacy markers and role-semantic markers are formally related in a systematic way. The semantic roles that donate their marker to the animacy-based function are restricted to roles that include agentive components in approaches using generalized semantic roles, as will be shown in the next section. Such roles are recipients, addressees, benefactives, and experiencers.

The close connection between role-semantic interpretation and animacy is also manifest in language processing. Neurolinguistic research has established that the brain areas and the neuronal patterns that react to animacy effects are also involved in the interpretation of semantic roles. Research using event-related potentials has found the N400 component, a central-parietal negativity at approximately 400 ms post onset of the verbal stimulus, whenever the subcategorization frame of a head is violated (cf. Friederici 1999). This component occurs, for instance, with role-semantic interpretation problems and with certain case violations in German. In addition, N400 was elicited as a reaction to certain animacy effects (cf. Frisch and Schlesewsky 2001; Schlesewsky and Bornkessel 2004, for German; Bornkessel-Schlesewsky and Schlesewsky 2009, for other languages; Wang et al. this volume, for Chinese). Pertinent German data are shown in (6):

(6) a. *welchen Mönch der Bischof begleitete*
which:ACC monk the:NOM bishop accompany:PRT.3SG
'which monk the bishop accompanied'
b. *welchen Mönch der Zweig streifte*
which:ACC monk the:NOM twig brush:PRT.3SG
'which monk the twig brushed'
c. *welcher Mönch der Bischof begleitete*
which:NOM monk the:NOM bishop accompany:PRT.3SG
'which monk the bishop accompanied'
d. *welcher Mönch der Zweig streifte*
which:NOM monk the:NOM twig brush:PRT.3SG
'which monk the twig brushed'

The ungrammatical condition with two animate, identically case marked arguments (6c) triggered a N400 at the point of the second argument in comparison to the control condition (6a). Bornkessel, Frisch, and Schlesewsky interpret their findings as follows. N400 in (6c) reflects the inability to hierarchize the arguments with respect to one another in terms of semantic roles. By contrast, in sentences with two identically case-marked arguments that differ in animacy, as in (6d), the language processing system takes animacy as a cue for a role-semantic hierarchization of the arguments. Hence, there is no N400 effect in (6d) in comparison to (6b). A parietal positivity (P600), which occurs in both ungrammatical conditions, indicates a case reanalysis of the second NP.

Neuroimaging research also indicates that animacy and role-semantic interpretation are closely connected. Grewe and colleagues (Grewe 2006; Grewe et al. 2005, 2006, 2007) have observed that deviations from co-argument distinctness in terms of animacy, as in (7b), correlate with activation in the posterior portion of the left superior temporal sulcus (pSTS) in comparison to the control sentence (7a), in which the co-arguments show a canonical animacy asymmetry. This effect is independent of the relative word order of the co-arguments.

(7) a. *Wahrscheinlich hat der Mann den Garten*
probably have:PRS.3SG the:NOM man the:ACC garden
gepflegt.
take-care.PART.PRF
'The man has probably taken care of the garden.'

b. *Wahrscheinlich hat der Mann den Direktor*
probably have:PRS.3SG the:NOM man the:ACC director
gepflegt.
take-care.PART.PRF
'The man has probably taken care of the director.'

Activation in this brain area was also observed in studies investigating the neural correlates of agency and motion patterns that are attributed to animates (cf. Pelphrey et al. 2004; Schultz et al. 2004, 2005; Thompson et al. 2005). Activation in the pSTS, as observed for (7b), is not likely a lexical phenomenon due to the intrinsic animacy of the noun phrase referent. Animate vs. inanimate nouns at the word (or picture) level lead to activation differences in regions other than the left pSTS (cf. Bornkessel-Schlesewsky and Schlesewsky 2009). In sum, neuroimaging studies also support the view that animacy and role-semantic interpretation are closely connected.

Another pertinent study shows that animacy asymmetries in co-ordinated noun phrases do not trigger reliable effects when the animate-before-inanimate constraint is violated in language production (cf. Branigan et al. 2008). Our interpretation of this finding is that the semantic roles of co-ordinated noun phrases are identical. As a result, animacy asymmetries in co-ordinated noun phrases cannot be used to retrieve role-semantic information.

In sum, there is both grammatical and neurolinguistic evidence that animacy is closely connected to sentence interpretation in terms of semantic roles. Patterns of case variation that are assumed to be determined by animacy in previous approaches may occur with inanimate objects and are absent with animate objects in ditransitive constructions in some languages. The semantic class of the verb influences this type of case variation. The case marker found in DOM is also used for semantic roles that show an affinity to agents. Neurolinguistic research has established that the brain areas and the neural patterns that react to animacy violations are also involved in the interpretation of semantic roles. When semantic role distinctions are absent, as in co-ordinated noun phrases, animacy ceases to influence noun phrase word order. In order to reveal the close interaction between animacy and semantic roles we need an approach that uses generalized semantic roles.

3 Generalized Semantic Roles and Animacy Entailments

Earlier work on semantic roles, notably Fillmore (1968), used animacy as a characteristic property of several roles, deep cases in his terminology. For him, the agentive is the typically animate instigator of the action, the dative is characterized as the animate being affected by the state or action, while the instrumental is the inanimate force or object causally involved in the action or state (1968: 24). The main critical argument against Fillmore's view was that animacy is a categorial semantic distinction, an intrinsic (or inherent) property of a noun phrase referent, whereas semantic roles are relational concepts determined by the semantic subcategorization frame of a predicate. In reaction to this criticism, Fillmore (1977) and subsequent research on semantic roles have discarded animacy as a role-semantic criterion. Unsurprisingly, correlations between animacy and certain semantic roles, including agent and recipient (Fillmore's dative), are often noted only in passing (cf. VanValin and LaPolla 1997; de Swart et al. 2008).

The interaction between animacy and semantic roles turns out to be closer than usually assumed in approaches that decompose semantic roles into more basic notions (cf. Lakoff 1977; Dowty 1991; Primus 1999; Ackerman and Moore 2001). Semantic decomposition reduces the inventory of superordinate, generalized roles dramatically without neglecting finer-grained distinctions. Dowty's account, which needs only proto-agent and proto-patient as generalized roles, will be taken as a theoretical starting point in this chapter. In this kind of approach, nearly all agentive properties but none of the patient-like properties entail the involvement of a higher animate participant, as will be shown below.

The agent proto-role is characterized by Dowty (1991: 571–572) and Primus (1999, Chap. 4) as follows:

(8) Proto-agent entailments:

a. x does a volitional act: *John refrains from smoking*.
b. x is sentient of or perceives another participant: *John knows/sees/fears Mary*.
c. x causes an event or change of state in another participant: *His loneliness causes his unhappiness*.
d. x is moving autonomously: *Water filled the boat.*
e. x is a possessor of another entity: *Peter has a new car*.

Although most verbs select more than one proto-agent property for their subject argument (e.g. *murder, nominate,* or *give*), each of these properties can occur in isolation as shown by the subject argument in the examples in (8a)–(8e). The properties mentioned in (8a)–(8d) are Dowty's proposal (1991: 572).[4] Possession is included as an agentive component following, among others, Jackendoff (1990). Each of these characteristics is semantically independent. Nevertheless, some of them tend to co-occur (e.g. volition or causation and movement) and one property may unilaterally imply another. Thus, for instance, volition implies sentience (cf. Dowty 1991: 606).

The concepts defining proto-agent are nothing new to the linguistic community: volition or control, causation, movement, sentience, and possession. Volition is used by Dowty in the sense of intentionality: the participant in question intends this to be the kind of act named by the verb. In von Wright's (1963) approach intentionality is a teleological causal concept that defines the notion of action.

Sentience is used as a cover term for a cognitive state, emotion, or perception. Including sentience in the list of proto-agent properties is uncommon within linguistic tradition, but it is in conformity with neuroscientific research (Ochsner and Gross 2005; Gross 2007). This line of research assumes that a particular mental state is produced by the experiencer in reaction to an external stimulus and that emotions, in particular, can be cognitively controlled by the experiencer.

Movement is a proto-agent property only if it is autonomous, i.e. not caused by another participant (cf. Dowty 1991: 574). This is in conformity with cognitive linguistic research that demonstrates the relevance of the concept of self-propelled movement for the cognitive development of the notion of agentivity and causation (cf. Leslie 1995; Premack and Premack 1995). If movement is caused by another participant, it will be considered a proto-patient property in the present approach. Thus, for instance, in *John threw the ball* both entities move, but only John, the proto-agent, moves in a self-induced way. The ball, the proto-patient, moves as a response to John's movement.

As to possession, Premack and Premack (1995: 193f.) point to a crucial difference between the notion of group and that of possession. Both notions imply that two or more objects are physically or spatially connected and capable of co-movement. But only possession is characterized by the ability of the possessor to control the possessed object. Alienable possession has this agentive quality, as shown by Folli and Harley (2008). Thus, for instance, *Peter has three cars*, is perfectly acceptable as opposed to **The garage has three cars* in a possessive reading. With inalienable possession, potential control and the correlating animacy contrast are irrelevant: *Peter has black hair. The garage has a front window.*

The most important departure of the present approach from Dowty is the central status given to the various manifestations of causation, including psychological concepts related to volition and control, and to the distinction between independent

[4]Tentatively Dowty also mentions independent existence as a proto-agent entailment. This means that the participant exists independently from the situation denoted by the verb. This property is omitted here because it is a reference-related property that should be treated separately.

and dependent involvement (cf. Primus 1999, 2006; Lamers this volume). In this view, a general role-semantic dependency notion is the underlying criterion that distinguishes proto-agents from proto-patients. The patient proto-role is defined in this approach as follows: its kind of involvement is dependent on the kind of involvement of another participant, the proto-agent. Consequently, the list of properties characterizing the proto-patient is derived from the basic notions in the definition of the proto-agent. Thus, for instance, causal affectedness as a proto-patient property is the converse of the causer notion in the proto-agent list. In this approach, the converse relation is generalized over all involvement properties: controller vs. controlled, causer vs. causally affected ("changed"), mover vs. moved, experiencer vs. experienced ("stimulus"), and possessor vs. possessed. This view on proto-patient departs from Dowty's approach. Dowty's proto-patient entailments are change of state, incrementally affected (i.e., incremental theme), causally affected, and either stationary or moving as a result of being causally affected. The two views on proto-patient have in common that none of the proto-patient properties entail the involvement of an animate participant. The co-argument dependency model of Primus (1999, 2006) is better suited to incorporate different types of co-argument dependencies. Pertinent to DOM is the connection between role-semantic and reference-related co-argument dependencies that will be discussed further below in this section. Furthermore, this model is in line with the neurolinguistic Argument Dependency Model of Schlesewsky and Bornkessel (2004, cf. also Wang et al., this volume).

A specific trait of the generalized role approach that makes it particularly suitable to explain DOM is that it allows for arguments having a combination of proto-agent and proto-patient properties. Independently of DOM, roles such as recipient, addressee or benefactive are mixed. They are selected by verbs denoting a transfer in possession (*x gave y something z, x baked y a cake z*) or a caused sentience (*x told y a story z, x showed y a picture z*). As a possessor or an experiencer of the entity *z*, the argument *y* in these examples is a proto-agent relative to the entity *z*. At the same time it is a proto-patient relative to the first argument *x*, which causes the situation denoted by the verb and causally affects *y*. Animacy-driven DOM involves a similar role overlap. It occurs whenever a noun phrase subcategorized for patient properties acquires potential agent properties due to its intrinsic meaning (cf. (10) in Sect. 4 of this chapter).

In sum, what characterizes agentive participants is that they are capable of producing the activity or state described by the predicate by themselves. The capacity to control the situation or other entities involved in the situation captures a common trait of several agentive notions that were subsumed under volition, sentience and alienable possession. These three agentive properties entail the involvement of a higher animate participant. By contrast, none of the patient-like properties entails animacy on the part of the respective participant, no matter what type of approach to the patient-role one favours (e.g. Dowty 1991; or Primus 1999, 2006).

As to the agentive notion of autonomous movement, a certain type of autonomous motion implies an animate participant. A moving object – a spot of light or a geometric figure in the pertinent neuroscientific experiments – can create the subjective impression that it is alive, based on its pattern of movement, when this pattern suggests that it is caused by an internal rather than an external source of energy (cf. Gelman et al. 1995; Tremoulet and Feldman 2000; Scholl and Tremoulet 2000; Opfer 2002). As mentioned above, neuroimaging studies also confirm the close neural connection between the detection of agency and the attribution of certain motion patterns to animates (cf. Pelphrey et al. 2004; Schultz et al. 2004; Schultz et al. 2005; Thompson et al. 2005). A remarkable result of these experimental studies is that they report an impression of animacy despite the fact that the entity presented in the experiments had no resemblance to an animate being except for its abstract movement pattern. This result supports the assumption defended here that animacy has to be regarded in role-functional terms: anything that has an agentive behaviour that is associated with higher animate beings, i.e. volition, a 'biological' motion pattern, sentience or alienable possession, is treated cognitively as a higher animate entity.

The co-argument dependency model defended here contributes to a better understanding of the connection between animacy-based and reference-related DOM. The basic assumption is that a clear-cut asymmetric co-argument dependency is preferred in grammar and language processing. This means in role-semantic terms that one argument has only agentive properties and the other argument only patient-properties. I will argue that in both types of DOM, an animate or definite second argument blurs maximal distinctness in terms of co-argument dependency. Recall that in Hindi, for instance, an animate argument or a definite (possibly inanimate) argument is overtly case-marked (cf. example (2b) in Sect. 2). As mentioned above, in my view, the patient proto-role is defined by its co-argument dependent status relative to the proto-agent. Under this assumption, the role hierarchy proto-agent > proto-patient is based on an asymmetric co-argument dependency. In animacy-based DOM, the animacy of the proto-patient leads to a situation in which asymmetric co-argument dependency cannot be established unequivocally.

Reference-related distinctions, i.e. definite > indefinite or specific > non-specific, have a similar basis as role-related asymmetries. The reference of a definite or specific noun phrase is established independently of that of a co-argument in a context-dependent way: the referent is identified by contextual information or by the mutual knowledge of the speaker and hearer. By contrast, the interpretation of an indefinite, non-specific noun phrase is determined by a local binder that is structurally more prominent than it, i.e. c-commands it (cf. Heim 1982). This means that the reference of an indefinite, non-specific argument is determined locally by a structurally superior noun phrase. This explains why a definite, specific, structurally superior subject and an indefinite, non-specific, structurally inferior object are favoured in grammar and language processing. This constellation is shown in (9):

(9) *Every woman loves a man/the man.*

In the indefinite, non-specific reading of the object ('every woman loves some man'), the referent of the object is determined by that of the subject. In this reading, the number of men that are loved by at least one woman in the situation is determined by the number of women that love at least one man in the situation. However, in the definite or specific reading of the object ('there is a particular man that every woman loves'), the referent is established independently from that of the subject. In this reading, the referents of the co-arguments are established independently from one another. In sum, the connection between animacy-based and reference-related DOM is that an animate or definite, specific object leads to a departure from a uniform asymmetric co-argument dependency.

A generalized co-argument dependency notion that subsumes role-related and reference-related dependencies is supported by neurolinguistic evidence (Bornkessel-Schlesewsky and Schlesewsky 2009). Activation differences in the left pSTS, which were discussed in connection with animate vs. inanimate objects in (7a, b) above, are also manifest in manipulations of definiteness and specificity. This effect occurs in German sentences with an indefinite, non-specific subject and a definite (specific) object in comparison with sentences with a definite (specific) subject and an indefinite, non-specific object (cf. also Kretzschmar et al. this volume).

4 Generalized Semantic Roles and DOM

With the results of the last section in mind, let us return to DOM. The role-functional view of DOM is formulated in (10) in terms of a licensing condition for a differential object marker.

(10) Working hypothesis: A differential object marker is licensed by an object whose intrinsic meaning properties qualifies it as a proto-agent in the situation denoted by the predicate.

(10) is a working hypothesis as it is formulated too liberally to yield appropriate descriptive results for individual languages. First, there are languages without DOM, in which (10) does not operate: the intrinsic meaning of a noun phrase does not influence case selection. Furthermore, languages may also vary with respect to the nature of intrinsic properties that trigger DOM. DOM may be obligatory with humans only, as in Malayalam, or with all higher animates, as in Spanish. An explanation of the various patterns of variation is beyond the scope of this chapter. For convenience, I assume that the licensing condition in (10) is grammaticalized in various ways yielding patterns of DOM that need further explanatory steps. Distinguishing meaning properties from world knowledge is a notoriously difficult problem that is left aside here. Therefore, 'meaning' is used in a very broad sense in (10).

In order to see how (10) works, let us take a closer look at DOM with inanimate objects in Malayalam. In Malayalam, direct objects of transitive verbs are obligatorily marked with a specific case, the suffix *–e*, if they are human. This also holds for most, but not all animates. Definiteness is an additional factor that influences the selection of the animate object marker. This distribution is similar to that illustrated in Sect. 2 above by examples from Spanish and Hindi. When both arguments are inanimate in Malayalam, it is possible to mark the inanimate object in order to resolve potential ambiguity, as shown in (11a, b).

Malayalam (Asher and Kumari 1997: 204)

(11) a. *Kappal tiramaalakaḷ-e bheediccu.*
ship waves-OM split.PST
'(The) ship broke through (the) waves.'
b. *Tiramaalakaḷ kappal-ine bheediccu.*
waves ship-OM split.PST
'(The) waves split (the) ship.'

With the verb *bheediccu* 'split' in (11a, b), both the ship and the waves qualify as proto-agents due to their intrinsic meaning: *ship* and *wave* refer to an entity with its own source of energy that enables one to split the other. In Dowty's terms, both the ship and the waves have intrinsic meaning properties that qualify them as autonomous movers and causers of the event denoted by the predicate. This situation licenses a differential object marker, as stated in (10).

In the next pair of examples only the subject referent is capable of causing the respective event. Cf. (12a, b) from Asher and Kumari (1997: 204):

(12) a. *Tiiyyə kuṭil naʃippicu.*
fire hut destroy.PST
'Fire destroyed (the) hut.'
b. *Veḷḷam tiiyyə keṭutti.*
water fire extinguish.PST
'Water extinguished (the) fire.'

Part of the meaning of *fire* is that it may cause the destruction of a hut and part of the meaning of water is that it may cause the extinction of a fire, but not vice versa. In (12a, b), the interpretation of the subject as a proto-agent, specifically as a causer, and the interpretation of the object as a proto-patient, i.e. as causally affected, is unequivocal. In this event, the animate object marker is usually omitted in Malayalam, particularly if the object is interpreted as indefinite. In sum, the data in (11) and (12) support the view defended here that animacy-based DOM is motivated by role-semantic interpretation, as stated in (10). Additionally, we have to assume that Malayalam has incorporated (10) in its grammar in ways that have to be specified in greater detail in order to capture further intricacies pertaining to the optionality of the object marker and its reference-related occurrence (p.c. Thomas Anzenhofer).

In the next step, we will take a closer look at DOM in Spanish. The data in (13)–(15) are taken from García García (2007). Let us begin with the straightforward case illustrated in (1) above as a typical specimen of DOM. It is repeated in (13) for convenience:

(13) a. *Conozco *este actor / a este actor.*
know:PRS.1SG this:M.SG actor / OM this:M.SG actor
'I know this actor.'

b. *Conozco esta película / *a esta película.*
know:PRS.1SG this:F.SG film / OM this:F.SG film
'I know this film.'

My interpretation of this pattern is that an animate object but not an inanimate one has intrinsic meaning properties that qualify it as a proto-agent in the situation denoted by the predicate. Part of the meaning of *actor* 'actor' is that it denotes a human being that is capable of knowing something or somebody. This is the agent component of sentience. Thus, *actor* licenses DOM in (13a). In contrast, the meaning of *película* 'film' does not allow an interpretation as an experiencer (or a cognizer). Accordingly, DOM is not licensed in (13b).

The instances involving inanimate objects in Spanish can be explained in a similar way. A remarkable minimal pair is offered in (14a, b):

(14) a. *El profesor reemplaza el libro.*
the professor replace.PRS.3SG the book
'The professor replaces the book (with something else).'

b. *El profesor reemplaza al libro.*
the professor replace.PRS.3SG OM:DEF.M.SG book
'The professor takes the place of the book.'

As noted by García García (2007) among others, there is a subtle, but nevertheless crucial meaning difference between (14a) and (14b). The sentence (14a) without *a*-marking means that the professor replaces the book with another book or with something else, for instance, in a shelf. In this reading the book lacks proto-agent properties, since the capability to replace things in the sense conveyed by (14a) it is not part of the meaning of books. The sentence (14b) with *a*-marking, however, means that the professor takes the place of the book: he fulfils the didactic, entertaining or whatever function is attributed to the book in the situation expressed by this sentence. Part of the meaning of books is that they share with humans the capacity of inform, entertain or bore us. Thus, (14b) implies that the professor and the book have the capability to act as proto-agents in an equivalent way. Since *reemplazar* does not specify the exact nature of the activity in which the professor gets involved instead of the book, we cannot specify the proto-agent entailments with certainty. If, for example, the implicit activity in (14b) is related to tuition, the professor causes that somebody gets to know something and so does the book in other circumstances.

The example offered in (3) above and repeated here in (15) is similar:

(15) *En esta receta, la leche puede sustituir al huevo.*
in this:F.SG recipe the:F.SG milk can:PRS.3SG replace OM:DEF.M.SG egg
'In this recipe, egg can be replaced by milk.'

The interpretation of (15), where object *a*-marking is obligatorily required, is similar to that in (14b): the subject participant and the object participant have the capability to behave in an equivalent way in the situation denoted by the verb *sustituir.* Since *sustituir* does not specify the exact nature of the event in which the milk gets involved instead of the egg, we cannot specify the proto-agent entailments out of context, but a plausible interpretation is that eggs and milk cause a change in the food: it will contain more protein and fat.[5]

The verbs *reemplazar* and *sustituir*, whose meanings entail that both participants have the capacity to exhibit an equivalent proto-agent behaviour, are typical for the class of verbs that are frequently used with an inanimate *a*-marked object. Such verbs denote an interaction or a symmetrical situation (x is/acts like y), for example, *acompañar* 'accompany', *preceder* 'precede', *seguir* 'follow', and *corresponder* 'correspond'. Verbs of classification and identification are semantically similar and also occur with inanimate *a*-marked objects, e.g. *considerar* 'consider', *clasificar* 'classify', *caracterizar* 'characterize', *concretar* 'make specific', *designar* 'designate', *definir* 'define', *distinguir, diferenciar* 'distinguish', *especificar* 'specify', and *llamar* 'call, consider to be' (cf. García García 2007, 2010 for more details).[6]

The data with inanimate objects taking the differential object marker support the role-functional view defended here. It is not animacy *per se* that counts but rather the semantic function of the object. It must be a potential proto-agent in the situation denoted by the predicate.

Previous studies have acknowledged the agentivity-related function of DOM. Closest to the present approach is García García (2007, 2010). His study is based on generalized semantic roles (e.g. Primus 1999) and focusses on inanimate objects. My treatment captures both animate and inanimate objects and the dative prepositional marker in all types of constructions, as will be shown below.

In his cross-linguistic study, Kittilä (2006) also assumes that the function of DOM is to distinguish between two potential agents. Regarding Spanish, Delbecque (1998, 2002) assumes that the *a*-marker indicates in dynamic processes that they involve potential agents as their objects. For Delbecque, these are participants susceptible to trigger an action in reaction to their own way of

[5]Instead of causing a problem to a generalized approach to semantic roles (as suggested by a reviewer of this chapter), underspecified verbs such as *sustituir* and *reemplazar* rather support this approach. Strict entailments are that both participants have the capacity to exhibit an equivalent proto-agent behaviour, with the difference that only the subject participant is actually involved instead of the object participant. These entailments suffice to licence the *a*-marker on the object. Specifications regarding the type of involvement are added by the context and are not part of the verb meaning in a narrow sense.

[6]Locative verbs select the *a*-marker according to the original locative meaning of this preposition and fall beyond the scope of the present discussion, e.g. *colocar* 'place', *poner* 'put', *situar* 'locate', *llegar* 'reach'.

being or behaving. Kittilä's and Delbecque's approaches are very close to the approach presented here but the scope of their explanation is unduly narrowed as a result of using a traditional agent concept that is restricted to volitional processes. As a consequence, DOM with stative verbs in Spanish, including *conocer* 'know', illustrated in (1) and (13) above, as well as the high number of stative verbs selecting the *a*-marker for inanimate objects cannot be explained. There is in fact no language where DOM is restricted to verbs that subcategorize for volition.

DOM in ditransitive constructions with two animate objects also pose a problem for approaches using the traditional agent notion. Such approaches lack the theoretical means to treat a recipient as a proto-agent, a move that is necessary in order to explain DOM in ditransitive clauses. By contrast, in my approach, a recipient (or a recipient-like role) is characterized by a combination of proto-agent and proto-patient components, as stated in the previous section. This explains why in ditransitive constructions, two animate objects may receive the same marker (cf. the Punjabi example in (5a) above). An additional explanation is needed for the suppression of DOM in ditransitive clauses, as shown in the Spanish example (4a) above. This may be due to a higher-ranking constraint that bans multiple datives in Standard Spanish (as in some other languages). Under these circumstances, two roles compete for the dative: the recipient and the animate patient. In Standard Spanish, the competition is resolved in favour of the proto-agent components that are entailed by the meaning of the verb, i.e. subcategorized for by the verb. This means that the dative is used for the recipient and blocked for the animate patient (cf. also footnote 8 below).

The polyfunctionality of the animate object marker can be straightforwardly explained in the present approach. As mentioned earlier in this chapter, in most of the Indic, Iranian, Semitic, Tupi-Guarani, and Romance languages, the animate object marker is also used for the recipient, addressee, and benefactive (i.e. the dative) in ditransitive constructions. In some Romance, Iranian and Indic languages it also codes the experiencer of certain psychological predicates. In some Iranian languages (e.g. Jaghnobi) it also indicates the agent of transitive clauses (i.e. the ergative). In Malayalam the object marker is used, besides the dative and comitative, with the addressee or recipient of a few ditransitive verbs, e.g. *pahippiccu* 'taught' and *eelpiccu* 'entrusted' (cf. Asher and Kumari 1997: 108). All these roles include agentive components and all the above-mentioned cases, specifically the dative and the ergative, are regularly linked to roles with agentive components.

5 An Optimality-Theoretical Treatment of DOM in Spanish

In order to demonstrate the features of the present approach in more precise terms, I will offer an optimality-theoretical treatment of DOM in Spanish. Optimality Theory (OT) views grammar as an optimization procedure. For a given input the grammar generates a set of output candidates by means of a generator. These candidates are evaluated with respect to a set of constraints, which are violable, potentially conflicting, and ranked with respect to one another. The output candidate with the best constraint violation profile is the optimal candidate. OT is a convenient method of capturing the competition between functional transparency, i.e. faithfulness to the role-semantic input in our discussion, and formal economy, specifically avoidance of overt case marking. A faithful expression of meaning (BE PRECISE) is optimal for the hearer, formal economy (BE BRIEF) is optimal for the speaker.

In the DOM patterns under discussion, overt case marking of the object is restricted to situations in which the meaning of the object is marked. Semantically unmarked objects are linked to patients, but in DOM, the patient referent has also properties that qualify it for the agent role. Assuming that objects with mixed role properties have marked meanings, the DOM patterns under discussion are instances of constructional iconism. Constructional iconism means that unmarked forms have unmarked meanings, and conversely, that marked forms are associated with marked meanings.

In standard OT, syntax and semantics are disconnected. The independent application of syntax and semantics does not yield a model that assigns the consistent relation between form and meaning that is found in constructional iconism. Bidirectional OT, an extension of regular (unidirectional) OT, is an appropriate method to capture the form-meaning relation found in constructional iconism.[7] In bidirectional OT, the input and the candidates consist of form-meaning pairs <f, m>. For our discussion we need case-role pairs. There are different possibilities for comparing pairs of form and meaning. The one we need for the Spanish data (and for variation due to constructional iconism in general) is weak bidirectional OT. In this model, the notion of superoptimality plays an important role and is defined as follows (cf. Jäger 2002; Krifka 2002):

(16) A pair <f, m> of a set of candidates is superoptimal iff:

i. There is no superoptimal <f’, m> in the candidate set such that <f’, m> is more optimal than <f, m>.
ii. There is no superoptimal <f, m’> in the candidate set such that <f, m’> is more optimal than <f, m>.

The notion of superoptimal pairs <f, m> is restricted to those pairs that have no competitor on the expression level or on the meaning level that is itself superoptimal. Pairs that do not share an identical form or meaning are not competitors. As a result, more than one candidate may emerge as superoptimal.

[7]Another version of bidirectional OT has been successfully applied to DOM in de Swart (2007). However, in this approach animacy and traditional semantic roles are taken as distinct factors for case selection.

The two competing violable constraints that are needed to capture DOM in Spanish are given in (17) and (18):

(17) ECONOMY (BE BRIEF): Overt case is not used.

(18) EXPRESS ROLE (BE PRECISE): The dative is used for an argument with a low number of proto-agent properties that are i) subcategorized by the verb or ii) assigned according to the intrinsic meaning of the direct object referent.

The economy constraint is explicitly or tacitly formulated in this or in a similar way by many approaches to cases in various lines of research.

The dative constraint is taken from Primus (1999, Chap. 4) where it is used for various typological data. In (18) it is adapted to capture the dative as a differential object marker along the lines of the more general working hypothesis in (10) above. In DOM-languages using the dative as a differential object marker, the dative is sensitive to the intrinsic meaning of the object referent, as discussed in the previous section. This is achieved in (18) by taking both subcategorized properties (condition (18i)) and intrinsic properties (condition (18ii)) into account. In languages with DOM, condition (18ii) holds in addition to condition (18i), which is the basic condition holding irrespective of DOM in all languages with an agentive function of the dative.[8] This in accordance with the assumption that subcategorization is a universal condition for case selection. The restriction to a low number of proto-agent properties is meant to exclude dative volitional agents. Volitional agents must surface as nominative subjects in the basic (active) construction in Spanish as in many other accusative languages.

If the dative preposition *a* is selected for subcategorized roles in Spanish, the respective argument is usually cross-referenced by the dative clitic (e.g. *le* for masculine, singular, as in the examples in this paragraph). In DOM, the dative-marked argument is usually taken up by an accusative clitic (*lo* for masculine, singular). This means that the clitic is selected according to the subcategorized role-properties of the cross-referenced argument.

The verbs that select the dative in Spanish are very similar to the dative verbs in other languages (e.g. German). These are experiencer verbs (e.g. *al artista le gusta la cerveza* ‘the artist (DAT) likes the beer’), verbs of alienable possession (e.g. *a Pedro le pertenece esta casa* ‘this house belongs to Peter’), verbs denoting an involuntary action (e.g. *a Pedro se le ha roto el vaso* ‘Pedro (DAT) broke the glass inadvertently’), verbs denoting an interaction or a symmetrical situation such as *ayudar* ‘help’, *seguir* ‘follow’, and *parecer* ‘resemble’, and last but not least, ditransitive verbs selecting a recipient, an addressee or a benefactive (cf. the examples given in (4a, b) earlier in this chapter).

[8] The interaction between the subcategorization condition (18i) and the DOM-condition (18ii) can be captured in OT-terms, in principle. In case of conflict, (18i) is higher ranked than (18ii) in Spanish. This is illustrated by the ditransitive construction (4a, b) in section 2 of this chapter. In this construction, the animate patient looses is marker in favour of the subcategorized recipient.

For illustrative purposes I restrict the number of OT candidates to those that have a chance to win the competition imposed by the two constraints under discussion. I take the options for *conocer* and *reemplazar*, see (13)–(14) above, as illustrations. The potential winners fall into four form-meaning pairs, which are discussed in turn.

In the first type of candidates, the object lacks overt case and has no intrinsic agentive property. This form-meaning pair is abbreviated as <Zero, Pat>. The candidates are *conozco esta película* and *el profesor reemplaza el libro* in the patient reading 'the professor replaces the book with something else'. They perform best relative to their competitors with respect to ECONOMY and EXPRESS ROLE. They have no overt case and fulfill the dative constraint vacuously since the object lacks agentive properties. This type emerges as superoptimal.

The second type is characterized as follows: the object bears dative marking and has no intrinsic agentive property. This type is abbreviated as <Dat, Pat>. The candidates are *conozco a esta película* and *el profesor reemplaza al libro* in the patient reading 'the professor replaces the book with something else'. These candidates violate both ECONOMY and EXPRESS ROLE, i.e. the dative constraint, and are eliminated. This happens because they loose against a legitimate competitor. i.e. <Zero, Pat>, that has the same meaning but incurs no violation. They also loose against the fourth type of candidate, i.e. <Dat, Ag>, which has the same case but a better meaning for this case.

In the third type, the object lacks overt case and has intrinsic agentive properties. This type is abbreviated as <Zero, Ag>. The candidates are *conozco este actor* and *el profesor reemplaza el libro* in the agentive reading 'the professor takes the place of the book'. These candidates violate EXPRESS ROLE, i.e. the dative constraint, and are eliminated. This happens because they loose against their legitimate competitors. <Zero, Pat> has the same form but a better meaning for this form; <Dat, Ag> has the same meaning but a better form for this meaning.

Finally, in the fourth type, the object bears dative marking and has intrinsic agentive properties. This type is abbreviated as <Dat, Ag>. The candidates are *conozco a este actor* and *el profesor reemplaza al libro* in the agentive reading 'the professor takes the place of the book'. These candidates violate ECONOMY, but fulfill EXPRESS ROLE, i.e. the dative constraint. They loose only relative to candidates that are not winners, so that <Dat, Ag> turns out to be superoptimal as well.

The tableau in (19) illustrates the evaluation procedure for the input *conocer(x,y)* that entails SENTIENCE(x,y). The arguments x and y are specified in the input as follows: x is the first person singular (the speaker) and y is *esta película* or *este actor*. The evaluation considers both ranking options of the two constraints under discussion since their relative ranking is not crucial. This is indicated by the dotted line. The winner is the candidate that has the smallest number of violations of the relevant highest constraint. A hand (☞) points to the winner. The plus sign (+) indicates the candidate that does not compete with the winner. Recall that pairs that do not share an identical form or meaning are not competitors in this model. According to the logic of weak bidirectional OT, the winner and the non-competitor come out as superoptimal.

(19) Evaluation for the input *conocer*(x,y); x = 1SG; y = *esta película* or *este actor*

		ECONOMY	EXPRESS ROLE
1	☞ *conozco esta película* <Zero, Pat>		
2	*conozco a esta película* <Dat, Pat>	*	*
3	*conozco este actor* <Zero, Ag>		*
4	+*conozco a este actor* <Dat, Ag>	*	

<Zero, Pat> would be the only winner in unidirectional OT. In weak bidirectional OT <Dat, Ag> is also a winner (i.e. a superoptimal candidate) because there is no direct competitor that is superoptimal. <Dat, Ag> does not compete with the superoptimal candidate <Zero, Pat> because it has a different form and a different meaning. Since these two candidates do not compete, they emerge as superoptimal in this model. This result is independent of the assumed ranking. The bidirectional model captures the fact that a marked form (i.e. the dative) may be optimal provided it expresses a marked meaning (i.e. a patient with agentive properties).

The OT treatment highlights the claims that characterize the present approach in more explicit terms. Case selection based on animacy (DOM) and role semantics are captured by one faithfulness constraint in Spanish. This explains the polyfunctionality of the differential object marker. Semantic subcategorization, i.e. semantic-role information that is anchored in the meaning of the predicate, is the basic condition for case-selection. In DOM-languages such as Spanish, intrinsic meaning properties of the object referent are interpreted in terms of semantic roles and influence case selection as an additional condition. The close connection between subcategorized and intrinsic properties also explains why the semantic verb class may influence DOM. The appeal of the present proposal is that the constraints are not restricted to DOM, but needed on independent grounds. The present proposal incorporates most of the explanations of DOM offered in the literature but captures more data in more precise terms.

First, as already mentioned above, it accommodates the claim of previous proposals that the function of DOM is to mark potential agents (cf. Kittilä 2006; Delbecque 1998, 2002). As mentioned, the scope of these approaches is unduly restricted to traditional agents and to verbs that select an agent.

Furthermore, the present proposal incorporates the markedness view on DOM (cf. Comrie 1989; Aissen 2003). It is formulated by Comrie (1989: 128) in terms of the grammatical functions used in typological research – A for transitive subject and P for object – as follows: "In a standard transitive scenario, A is animate and definite while P is inanimate/indefinite (or at least less animate and definite than A), so any deviation from this scenario should be marked". This account correctly predicts that animate objects should be case-marked, while inanimate objects need not be marked. The advantage of the present approach is that it explains the correlations of the standard transitive scenario. Roles that are canonically linked to A fall under proto-agent and entail animacy in most cases, whereas roles canonically reserved for P are proto-patients that lack animacy entailments.[9] A further appeal of the present approach is that it also explains the standard ditransitive scenario, in which recipients are also preferably animate. Their bias towards animacy results from the fact that they have proto-agent properties that entail animacy, e.g. alienable possession or sentience. Taking recipients into account is particularly useful in view of the fact that many animate object markers are also recipient markers.

Finally, there are recent approaches that explain DOM by the distinguishability and characterizing function of cases (e.g. de Hoop and Lamers 2006; de Swart 2007; Malchukov 2008). The two functions of cases are described in the typological literature as follows (cf. Comrie 1989: 117f., Song 2001: 156 f.): In their distinguishing function, cases are used for discriminating concomitant constituents with different semantic or syntactic properties. This function explains the fact that the subject of a one-place predicate is generally marked by the same case, the nominative or absolutive, irrespective of its semantic role. Ideally, a second case is only used with predicates selecting at least two roles and a third case is only required by predicates with at least three roles. The second broad function of cases is the characterising one. Ideally, a case has this function if it is used for all and only the noun phrases with a certain type of semantic role or syntactic function. The explanation of DOM in terms of distinguishability is that two animate participants have to be distinguished formally. A distinction is not needed if agents and patients are distinguished by animacy. The present approach captures both functions of cases by combining economy and role faithfulness constraints. As shown by de Swart (2007) and Malchukov (2008), these two factors do not compete in DOM-patterns. This is also the result of the present treatment. Recall that the DOM-pattern emerges as a winner, irrespective of the ranking of the two constraints proposed in (17) and (18). The advantage of the present approach is that it pins down the characterizing function in more precise terms. It suffices to repeat here that the dative constraint explains subcategorized datives as well as datives used for animate patient objects in Spanish.

6 Explaining the Interaction Between Animacy and Semantic Roles

The previous sections were focussed on the claim that animacy and role semantics are closely connected. They have presented grammatical and processing evidence for this claim as well as a formal treatment in optimality-theoretic terms. This last section will address the deeper question regarding the nature of this connection.

[9] Corpus studies support the correlations between animacy and grammatical or semantic functions. Subjects of transitive clauses (A), which bear an agentive role, are predominantly animate. This percentage varies according to the language or the language variety under investigation, for example, from 69% in Norwegian (Øvrelid 2004) to 93% in spoken Swedish (Dahl 2000). In contrast, objects, which bear a patient-like role, refer predominantly to inanimate entities (89% of the direct objects in Dahl's corpus, 90% in Øvrelid's sample).

Given the fact that animacy is unilaterally implied by most of the agentive basic notions, such as volitional causation, sentience, alienable possession, and certain patterns of autonomous movement, I still need to explain why the inference is reversed from animacy to agentivity. A plausible explanation is abductive reasoning (cf. Levinson 2000). This is a standard type of pragmatic inference by which a unilateral implication or conditional is reversed. As a result, a unilateral implication is pragmatically strengthened to a bilateral implication thereby increasing the informative content of an utterance. This tendency to increase the informativity of a linguistic expression explains why animacy is used as a cue for agentivity in language processing.

The pragmatic inference from animacy to agentivity has not gone unnoticed in role-semantic approaches. An intriguing aspect of agentivity is that volition or control is not subcategorized for as often as expected from its prime status in role semantics. Take for example the verbs in (20):

(20) a. *John/the stone rolled down the hill.*
b. *This medicine/Jogging/Rebecca helped Jamaal.*

The most straightforward analysis of the meaning of *roll* and *help* is that these verbs are semantically underspecified for volition. This captures the range of uses illustrated in (20). As assumed by Foley and Van Valin (1984) and Engelberg (2005), among others, volition is assigned by default interpretation if the subject argument is animate (or human).

The pragmatic explanation is in compliance with the principle of incremental language processing, which is adopted by many neurolinguistic investigations (cf. Friederici 1999; Schlesewsky and Bornkessel 2004; de Hoop and Lamers 2006 with a focus on language comprehension, and Branigan et al. 2008 for language production). According to this principle, linguistic information is parsed as soon as possible, thereby maximizing processing efficiency. Incremental processing is maximized under the assumption that language users make probabilistic syntactic choices based on violable principles of grammar and multidimensional information (Bresnan et al. 2001). Turning to our topic, this means that there is an advantage in making role-semantic interpretation immediately available by using grammatical principles and any type of relevant information, including case, word order, verb agreement, and animacy (cf. de Hoop and Lamers 2006). Harmonically aligned asymmetries pertaining to semantic roles, cases, word order, and animacy maximize processing efficiency. Disharmonic alignments are costly (cf. Bornkessel-Schlesewsky and Schlesewsky 2009; Lamers this volume). This happens, for instance, when semantic-role prominence (e.g. agent > patient) does not match animacy prominence (e.g. animate > inanimate).

The link that is still missing in the previous argumentation is provided by the assumption that grammar is based on processing preferences to a considerable degree. This assumption is shared by many recent approaches of different provenience (cf. Hawkins 1994; Bybee and Hopper 2001; Bresnan et al. 2001; Culicover and Jackendoff 2005; Newmeyer 2005). In this view, grammatical structures emerge in proportion to their preference in processing. This also means that soft constraints, i.e. tendencies or preferences, in one language may be inviolable hard constraints in another language (Bresnan et al. 2001). Taking a pertinent example, in many languages, a second noun phrase is interpreted as a patient object per default. If this noun phrase refers to an animate being, its intrinsic meaning is incongruous with its default interpretation as a patient. This is a situation that is dispreferred in processing, as mentioned in Sect. 2 above. In OT terms (cf. de Hoop and Lamers 2006), animacy is a low-ranked, soft constraint that only kicks in, if case and word order do not disambiguate semantic roles. However, in languages with DOM, such as Hindi and Spanish, there are grammatical means to express the dispreferred correlation.

So far, I have pinned down the mechanisms by which animacy, an intrinsic property of a noun phrase referent, is interpreted in terms of agentivity. But I have not yet addressed the question of why agentivity implies animacy. This question leads us to the nature of semantic roles. According to Dowty (1991: 561), proto-role features are those semantic features that are relevant for argument (subject or object) selection. This is a good criterion but still leaves one fundamental question unanswered. Why is argument selection sensitive to notions such as volition, motion and sentience, and not to basic geometric features (e.g. being a circle) or basic physical notions (e.g. being fluid)?

A deeper insight into the nature of semantic roles can be extracted from Dahl's and Fraurud's assumptions about the nature of animacy (cf. Dahl and Fraurud 1996; Dahl 2008). In their view, animacy is at the bottom a question of the distinction between "persons, that is, essentially human beings perceived as agents, and the rest of the universe […] Indeed, the notion of "personhood" seems to embody what is quintessential to animate beings, both the roles as agent and experiencer, and the focus on the individual" (Dahl 2008: 145–146). This view supports the present assumption that animacy and agentivity are closely connected.

The additional appeal of this type of explanation is that it ties animacy to individuation, i.e. reference types (Dahl 2008: 149). Dahl assumes that animates are easier to grasp as individuals than inanimates. Within the class of animates the self and other individuals who can perceive the world and act upon it as myself are central. For Dahl, this means that we use ourselves as models for others. In this way, we obtain a finer grained cognitive scale, corresponding to a more elaborate nominal hierarchy: the self with his/her properties (e.g. proto-agent, human, first person, definite, singular, countable, etc.) is the model for others. The position of a category on this scale is determined by the grade of its similarity to the self, i.e. by the number of properties it shares with the self. This is a promising first step towards a better understanding of the interaction between reference types and animacy in grammar and language processing.

If Dahl's claim is correct that animacy is a phylogenetically deeply anchored, fundamental (ontological) category, then proto-agent properties are arguably dependent on individuation and animacy. I therefore hypothesize that proto-agent properties[10]

[10]Recall that proto-patient properties are derivative in my approach and involve the same basic notions that are needed to define proto-agent.

can be explained as those cognitive-semantic properties that characterize how a human individual, in particular oneself, is involved in situations.

Dahl's (2008: 145–146) claim that ANIMATE and INANIMATE are ontological types (in the strict philosophical sense) has another interesting consequence. For Dahl, one feature of ontological types is the common lack of natural ways of referring to them. For instance, English seems to have no generic noun for 'animate being'. Even words for 'human' tend to be identical to or derived from words meaning 'male being'. Rather, ontological types work behind the scene, channeling the ways we speak about entities in the world. In my view, Dahl's assumptions explain why animacy *per se* is not crucial in grammars, as argued in this chapter. Instead, manifestations of animacy, particularly proto-agentivity and individuation, are relevant in language.

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The Role of Animacy in Online Argument Interpretation in Mandarin Chinese

Luming Wang, Matthias Schlesewsky, Markus Philipp, and Ina Bornkessel-Schlesewsky

1 Introduction

Mandarin Chinese is a language which is particularly famous for being "different". In other words, it is a language that has been used to challenge many traditionally accepted concepts in linguistics. For example, Li and Thompson (1976) proposed that Chinese differs from European languages such as English, German and French in that it is "topic-prominent" rather than "subject-prominent", i.e. that topic-comment constructions, rather than subject-predicate constructions, are the basic sentence form.[1]

[1] Two examples which serve to illustrate the topic-prominence of Mandarin Chinese are given in (i) and (ii):

(i) "Double subject" construction in Mandarin Chinese (from Li and Thompson 1976: 468)
nà kē shù yèzi dà
that CLF tree leaves big
'That tree (topic), the leaves are big.'

(ii) Topic-controlled coreference in Mandarin Chinese (from Li and Thompson 1976: 463)
nà kē shù yèzi dà, suǒyǐ wǒ bù xǐhuān __.
that CLF tree leaves big so I not like
'That tree (topic), the leaves are big, so I don't like (it/*them). '

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Taking this line of argumentation one step further, LaPolla (1993) argued forcefully that grammatical relations such as "subject" and "object" do not exist in Chinese and that their imposition essentially derives from a "Euro-centric" perspective. Similarly, in the domain of word categories, it has been proposed that older stages of Chinese lacked a verb-noun distinction (cf. Bisang 2008) and that the modern language still allows for a substantial degree of fluidity in this respect (with the same lexeme functioning as a noun or a verb depending on the sentence context).

The issue of how cross-linguistic unity and diversity is best characterised is of course not restricted to theoretical linguistics, but rather pervades all linguistic subdisciplines. The domain of language comprehension poses no exception in this regard. Here, we may ask whether the processing mechanisms that serve to map a linguistic form (sounds, graphemes or gestures) onto a complex meaning in real time are the same in all languages, or whether they are conditioned by the particular language being processed. Since language processing principles have traditionally been defined with respect to structural configurations, which in turn are based on notions such as word category or grammatical relation (e.g. Kimball 1973; Frazier and Fodor 1978), it would appear to be of paramount importance to test the potential universality of such principles by examining languages in which the categories in question play a much less important role. In view of the considerations outlined above, Mandarin Chinese presents us with an ideal test case for this question.

In this chapter, we examine the mechanisms of incremental argument interpretation in Chinese and assess whether there is evidence to suggest that they differ from those applied in European languages. We conclude that the mechanisms in question overlap cross-linguistically in a number of key respects, but that this observation imposes constraints on the precise specification of the language processing architecture. We do, however, also point to some potentially significant differences between Chinese and other languages previously examined. The remainder of the chapter is structured as follows. In Sect. 2, we begin by introducing a potentially universal strategy of online argument interpretation, the "subject preference", before introducing a cross-linguistically motivated account that can derive this processing preference and raising some open questions in Sect. 3. Section 4 presents an auditory event-related brain potential study on animacy, structural factors and context in incremental argument interpretation in Chinese, the results of which are discussed and integrated with previous findings in Sect. 5.

2 The Subject Preference: A Possible Universal of Incremental Argument Interpretation?

One of the most basic properties of argument processing (or sentence processing more generally) is that it takes place incrementally, i.e. such that the system attempts to immediately integrate each new incoming constituent with the input already processed and the representations built up so far (e.g. Marslen-Wilson 1973; Crocker 1994; Stabler 1994). This rapid structuring of the linguistic input is thought, for example, to decrease memory demands because it avoids the need to hold long lists of unstructured items in working memory (cf. Frazier and Fodor 1978). Obviously, it is also beneficial for efficient real time communication (e.g. in dialogue, Pickering and Garrod 2004). Nevertheless, incremental processing is astounding because it often takes place in the face of incomplete information. Consider the following example from Turkish (from Demiral et al. 2008). (Note that, here and in the following, critical positions at which event-related potentials were measured are underlined.)

(1) a. *Dün* *adam* *gör-dü-m*.
Yesterday man[NOM] see-PST-1.SG
'I saw (a) man yesterday.'
b. *Dün* *taş* *gör-dü-m*.
Yesterday stone[NOM] see-PST-1SG
'I saw (a) stone yesterday.'

In the examples in (1), the argument *adam* ('man')/*taş* ('stone') is locally ambiguous between a subject and an object reading.[2] In accordance with incremental interpretation, the language comprehension system must therefore choose to adopt one of these competing analyses. That such a choice actually takes place becomes apparent at the position of the verb, which disambiguates the ambiguous argument towards an object reading via first person subject agreement. At this position, Demiral et al. (2008) observed increased processing effort in terms of event-related brain potentials (ERPs) for disambiguating verbs (as in 1a/b) in comparison to identical verbs in unambiguous control conditions (with unambiguously case-marked objects, e.g. *adam-ı* (man-ACC)). Strikingly, ERPs showed a comparable processing disadvantage for animate and inanimate ambiguous arguments.

Demiral et al.'s (2008) findings from Turkish illustrate a well-known processing phenomenon known as the "subject preference", namely the human language comprehension system's tendency to analyse an initial ambiguous argument as the subject of the sentence. This preference has been observed in a range of (European) languages including Dutch (e.g. Frazier 1987), German (e.g. Hemforth et al. 1993), Italian (e.g. de Vincenzi 1991), and Spanish (Casado et al. 2005). It has, however, been studied most extensively in German, where it has been demonstrated using behavioural methods (self-paced reading: e.g. Schlesewsky et al. 2000; Schriefers et al. 1995; speeded acceptability judgements: e.g. Bader and Meng 1999; eye-tracking: Hemforth et al. 1993; Kretzschmar et al., see Chap. 11 in this volume; magnitude estimation: Bornkessel-Schlesewsky and Schlesewsky 2007) and neuroscientific techniques (event-related brain potentials, ERPs: e.g. Mecklinger et al. 1995; Bornkessel et al. 2004; functional magnetic resonance imaging, fMRI: e.g. Bornkessel et al. 2005; Fiebach et al. 2004). Like the findings from Turkish

[2] An example for a subject reading of the argument in (1a) is given in (i):

(i) *Dün* *adam* *uyudu.*
yesterday man[NOM] sleep-PST.3SG
'Yesterday (the) man slept.'

described above, previous results from German suggest that the subject preference applies both to animate and inanimate ambiguous arguments (Schlesewsky et al. 2000). Note however that, when a sentence contains both an animate and an inanimate argument, there may be a competing animate-first preference (de Hoop and Lamers 2006; Lamers 2007). The subject preference also does not appear to be driven by thematic relations, e.g. via a preference for the first argument to be the Agent, or at least the thematically higher-ranking argument (Scheepers et al. 2000; Schlesewsky and Bornkessel 2006; cf. also Schlesewsky and Bornkessel 2004).

Interestingly, recent findings suggest that the subject preference (in simple, locally ambiguous sentences) also applies to Mandarin Chinese. This was demonstrated in an ERP study by Wang et al. (2009), who contrasted sentences as in (2).[3]

(2) Critical fragments of the experimental sentences from Wang et al. (2009)

a. *xiǎoshuō*	*lǐjiě-le*	…
novel	understand-PRF	
b. *yǎnyuán*	*lǐjiě-le*	…
actor	understand-PRF	
c. *xiǎoshuō*	*jiàoyù-le*	…
novel	educate-PRF	

In sentences such as (2a–c), the initial NP is ambiguous between a subject and an object reading because of the possibility of object topicalisation in Chinese. This ambiguity is subsequently resolved towards a subject or an object reading via the selectional restrictions of the verb. ERPs timelocked to the onset of the disambiguating verb revealed a central negativity between 300 and 500 ms post verb onset (a so-called "N400" effect) for the object-initial condition (2a) in comparison to the two subject-initial control conditions (2b/c). Whereas (2b) used lexically identical verbs to (2a) to disambiguate towards a subject reading, (2c) disambiguated identical ambiguous arguments to (2a) towards a subject reading. These results thus provide evidence for a subject preference in Chinese, thereby suggesting that the subject preference can affect the time course of comprehension even in a language where the notion of subject plays only an extremely limited role in syntax. Furthermore, as in the other languages examined so far, the subject preference in Chinese applies even to inanimate initial arguments. The findings by Wang et al. (2009) therefore suggest that, in spite of the strikingly different surface characteristics of Chinese, it shows very similar online processing behaviour to the subject-prominent languages in which the subject preference had been examined previously.

Taken together, these findings indicate that the subject preference is a highly robust processing strategy which manifests itself across languages from different language families and with disparate typological characteristics. Of course, it cannot

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[3] Other previous studies on possible subject/object asymmetries during the online processing of Chinese have focused exclusively on the comprehension of subject and object relative clauses (Hsiao and Gibson 2003; Lin and Bever 2006; Packard et al. 2006). Because the processing of relative clauses is subject to a wider variety of influences than argument interpretation in simple sentences (e.g. parallel function or perspective taking), these findings are not directly relevant for the question under discussion here.

be ruled out that the apparent existence of a cross-linguistically valid subject preference is merely an epiphenomenon which results from the – more or less random – convergence of a range of language-specific processing strategies. However, the assumption that we may be dealing with a true cross-linguistic generalisation appears too important to ignore. Indeed, the notion of a cross-linguistically valid processing strategy would clearly provide the most parsimonious explanation for the many findings on the subject preference. Hence, in this chapter, we concern ourselves with the mechanisms which might underlie this hypothetical universal of language processing and how these interact with language-specific properties. In particular, we sought to shed further light on the role of animacy and language-specific structural factors in engendering/modulating the subject preference.

3 Deriving the Subject Preference: A Theoretical Proposal and Some Open Questions

The subject preference is often explained in terms of filler-gap relations, i.e. via the preference for a shorter distance between the ambiguous argument (the filler) and its base position (the gap) (e.g. Frazier 1987; Crocker 1995), or in terms of a preference for structures without movement chains (de Vincenzi 1991). Alternative explanations make reference to the higher frequency of subject-initial structures (e.g. Vosse and Kempen 2000) or to the additional dependencies introduced by an object reading (which leads to the prediction of a subject, while a subject does not require the prediction of an object: Gibson 1998).

However, structurally-based accounts encounter several problems in face of the full range of cross-linguistic findings on the subject preference. For example, the data from Turkish cannot be derived straightforwardly via a filler-gap-based account, since this language allows – or even favours – subject drop (even without special contextual requirements for sentences with first or second person subjects, as in 1). Hence, the initial argument can be analysed as residing in its base position whether it is assigned a subject or an object reading.[4] Similarly, due to the possibility of subject drop, the processing of an initial object does not entail the syntactic prediction of a subject at some later point in the sentence.[5]

On the basis of these considerations, we have previously proposed that the subject preference may be attributable to a cross-linguistic preference for constructing the simplest meaning (e.g. Demiral et al. 2008; Wang et al. 2009). This proposal,

[4]For arguments against a frequency-based account of the subject preference, see Fanselow et al. (1999) and Demiral (2007) for German and Turkish, respectively.

[5]Note that this argument holds whether the dropped subject is represented syntactically as a phonologically null element (pro; Chomsky 1981) or not (e.g. Van Valin 2005). If a syntactic representation is assumed, the pro representing the null subject could simply be postulated and integrated as soon as the ambiguous argument is analysed as an object, thereby circumventing an additional prediction that must be maintained in working memory.

which is couched within a cross-linguistically motivated neurocognitive model of language comprehension (the extended Argument Dependency Model, eADM; Bornkessel and Schlesewsky 2006; Bornkessel-Schlesewsky and Schlesewsky 2008a; Bornkessel-Schlesewsky and Schlesewsky 2009b), assumes that an ambiguous argument is preferentially interpreted as the sole argument in an intransitive relation (S), thus serving to minimise dependencies (cf. Bornkessel-Schlesewsky and Schlesewsky 2009a; Wolff et al. 2008, for evidence in this regard). If the intransitivity assumption cannot be upheld, the argument is interpreted as the more Agent-like participant in a transitive event (the Actor) rather than as the more Patient-like participant (the Undergoer). Since it has been proposed that Undergoers are semantically dependent on Actors (Primus 1999; Primus, see Chap. 4 in this volume), this processing decision again avoids the need to establish unnecessary dependencies. Within the eADM, the S/Actor-over-Undergoer preference can be captured via the assignment of the feature [−dep] (i.e. -dependent, cf. Bornkessel 2002; Schlesewsky and Bornkessel 2004). In an intransitive relation, a [−dep] argument need not be responsible for the state of affairs (i.e. it could be a Patient, as in *John died*): it is independent by virtue of the fact that there is no second argument. In a transitive relation, by contrast, the assignment of [−dep] amounts to an Actor reading, whereas [+dep] signals an Undergoer.

The proposal that the subject preference is a by-product of the processing system's endeavour to minimise dependencies (as formalised via the assignment of the [−dep] feature) can account for the fact that this preference is so pervasive across typologically different languages and why it occurs even when there is no obvious structural motivation for it (e.g. in Turkish) or when the category "subject" only plays an extremely limited role in the syntax of the language in question (e.g. Mandarin Chinese). It further explains why, for ambiguous regions spanning a single argument, the subject-preference is not influenced by animacy, since a [−dep] reading is also possible for an inanimate argument.[6] By contrast, animacy effects are expected to be potentially stronger when the ambiguous region spans two arguments since, in this case, the arguments can compete for the [−dep] feature (for details on the notion of competition for the Actor role, see Bornkessel-Schlesewsky and Schlesewsky 2009b).

To date, the dependency-based account is supported by findings which suggest that structural factors do not suffice for a cross-linguistic derivation of the subject preference. Nevertheless, this proposal does not rule out that the subject preference may be influenced by structural factors. Specifically, the eADM posits that,

[6] Note that this statement is not contradicted by the finding of animacy-based effects at the position of an initial argument (e.g. Weckerly and Kutas 1999; Kuperberg et al. 2003), since these could be due to lexical differences between animate and inanimate nouns. It is also compatible with the notion that the interpretation of an NP-V fragment is influenced by the animacy of the argument (e.g. Kuperberg et al. 2003; Kim and Osterhout 2005; see also Lamers and de Hoop 2005; Lamers 2007), as discussed, for example, in Bornkessel-Schlesewsky and Schlesewsky (2008a). Rather, the crucial claim here is that there is no evidence to date that the inanimacy of an initial argument leads the processing system to adopt an Undergoer reading before the next constituent is encountered.

during a first stage of comprehension, the processing system builds up syntactic structures by selecting and combining syntactic templates akin to those employed in Role and Reference Grammar (Van Valin and LaPolla 1997; Van Valin 2005). Crucially, structure-building in this sense only takes word category information into account and, like argument interpretation, is subject to simplicity-based considerations, such that the simplest structure is preferentially chosen in the case of an ambiguity (Bornkessel and Schlesewsky 2006; Bornkessel-Schlesewsky and Schlesewsky 2009a). Furthermore, and in contrast to traditional "syntax-first" accounts of language comprehension (e.g. Frazier and Fodor 1978; Frazier and Rayner 1982), the structures constructed in stage 1 of the eADM do not determine sentence-level interpretation. Interpretation is accomplished – via the assignment of [±dep] features and further mechanisms of verb-argument linking – in a second stage of processing (for details, see Bornkessel and Schlesewsky 2006; Bornkessel-Schlesewsky and Schlesewsky 2009b). Hence, while argument interpretation is not determined by the syntactic structure, structural assignments can serve to constrain the types of interpretations that are entertained by the system during stage 2 of processing. For example, a simplicity-based choice of a particular structure in stage 1 will lead the processing system to attempt to assign the meaning which is compatible with the minimal structure and also calls for the assumption of the smallest number of dependencies. In the present study, we examined whether simplicity-based structural restrictions of this type can lead to a modulation of the subject preference.

4 The Present Study: Structural and Prominence-Based Influences on Word Order Preference in Chinese NP-NP-V Constructions

In accordance with the motivations in the previous section, the present event-related potential (ERP) study aimed to examine the possible influence of simplicity-based structural considerations on word order preferences in Chinese and how these interact with the (animacy-based) semantic prominence of the arguments. (For an introduction to the ERP methodology, see Kutas et al. 2006; Bornkessel-Schlesewsky and Schlesewsky 2009c). In the following, we will briefly motivate these two critical manipulations in turn, before introducing the experimental design.

4.1 Structural Simplicity

As noted above, the syntactic representations (templates) in the eADM are adopted from Role and Reference Grammar (RRG; see Van Valin 2005, for a recent introduction). An example structure is given in Fig. 1a.

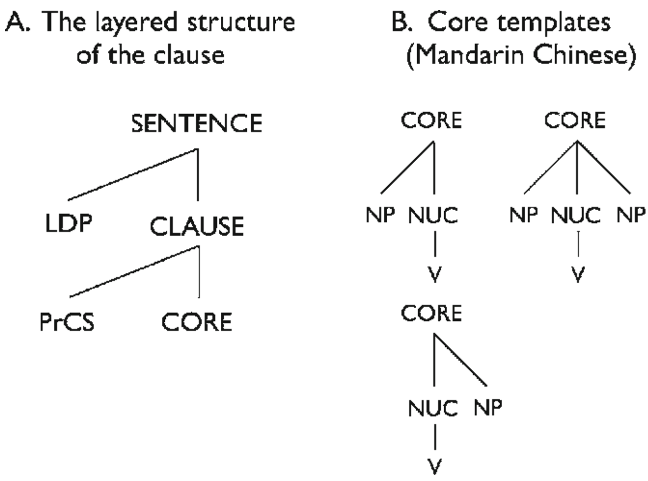

Fig. 1 An illustration of the syntactic templates assumed within the eADM. Note that these templates are adopted from Role and Reference Grammar (cf. Van Valin 2005)

As Fig. 1a shows, the templates combine to form a hierarchical syntactic structure known as the "layered structure of the clause". In addition to the "core" region of a sentence, which includes the verb and its arguments, there is a pre-core slot and a left-detached position. (Note that, depending on the language in question, post-core slots and right-detached positions are also possible.) The positions external to the core, in contrast to the core itself, are typically subject to information structural or pragmatic restrictions.

Now consider how these considerations can be applied to Mandarin Chinese, for which it is typically assumed that the basic and pragmatically neutral word order is SVO (Sun and Givón 1985). OSV and SOV are also possible, but, especially when they do not contain the coverbs bǎ or bèi, are restricted pragmatically. In OSV, the topichood of NP1 is highlighted, while SOV is used to express a contrast (Ernst and Wang 1995) or a meaning that does not match the expectations of the listener (Li and Thompson 1981). Hence, we may assume that there are no NP-NP-V core templates (without coverbs); i.e. core templates (cf. Fig. 1b) are either NP-V-NP (for SVO sentences), NP-V (for intransitive SV sentences) or V-NP (for VO sentences with subject drop and, perhaps, for VS sentences). In addition to the fact that they both contain non-core positions, a further difference between OSV and SOV is that the former can be modelled via the assumption of a pre-core position combined with a core template, whereas the latter requires two pre-core positions (in line with its extreme pragmatic markedness). For a comparable analysis within a Government and Binding Theory framework, see Ernst and Wang (1995), who assume that objects are adjoined to IP in OSV orders but to VP in SOV orders. (Note that we are not making any specific claims as to whether the arguments in question occupy the pre-core slot or the left-detached position. This would require more detailed theoretical examinations.)

If these representational assumptions are correct, processing in stage 1 of the eADM should engender a preference for OSV vs. SOV in NP-NP-V structures in Mandarin Chinese, because these allow for the assumption of a simpler structure with only a single pre-core position.

4.2 Semantic Prominence

If the OSV vs. SOV preference that was predicted for Mandarin Chinese in the last section is indeed borne out, one might ask whether this should not be taken as evidence for a purely structural word order preference. In order to test whether this is the case, we included a second manipulation in which we changed the animacy of the two preverbal arguments. In half of the sentences, the first argument was inanimate and the second was animate, thereby supporting the OSV order via the semantic prominence of the arguments. In the other half, animacy relations were reversed such that NP1 was animate and NP2 was inanimate, thereby supporting an SOV order. Assuming that the word order preference is purely structural in nature, it should not be affected by the animacy manipulation. If, by contrast, it is also affected by interpretive considerations, we would also expect to observe an animacy-based influence.

From the perspective of the eADM, the second scenario appears more likely. Recall that animacy-based influences on the subject preference are assumed to not occur for single NPs because of the possibility of a [−dep] reading even for inanimate arguments (e.g. *The chair was red*). Only when two arguments have been encountered does the processing system need to establish an interpretive relation between them and to determine which argument is more the Actor and which is the Undergoer. At this point, animacy becomes an influencing factor (Bornkessel-Schlesewsky and Schlesewsky 2009a; Bornkessel-Schlesewsky and Schlesewsky 2008b; cf. also de Hoop and Lamers 2006). This assumption is supported by a number of findings on the processing of unambiguous sentences (Frisch and Schlesewsky 2001; Roehm et al. 2004; Muralikrishnan et al. 2008), including a study on Mandarin Chinese (Philipp et al. 2008). Furthermore, offline findings on the interpretation of NP-NP-V sentences in Chinese have demonstrated an influence of animacy: Li et al. (1993) reported only 2% of Agent choices for the first noun in NP(inanimate)-NP(animate)-verb structures, but 84% of Agent choices for the first noun in NP(animate)-NP(inanimate)-verb sentences. Hence, given a locally ambiguous sentence with an animate and an inanimate argument in Chinese, we might expect animacy to influence online argument interpretation as well.

4.3 Experimental Design

In accordance with the considerations presented in Sects. 4.1 and 4.2, the present ERP study examined word order preferences in NP-NP-V constructions in Chinese.

Table 1 Sample contexts and target sentences in the present experiment

Context 1: 侦探		怎么了?	Context 2: 子弹		怎么了?
zhēntàn		zěnme-le	zǐdàn		zěnme-le
detective		how-PRF	bullet		how-PRF
'What is about the detective?'			'What is about the bullet?'		
Target 1:			Target 2:		
a. A(an)-U(in)			c. U(in)-A(an)		
侦探	子弹	保存了。	子弹	侦探	保存了。
zhēntàn	zǐdàn	bǎocún-le	zǐdàn	zhēntàn	bǎocún-le
detective	bullet	keep-PRF	bullet	detective	keep-PRF
'The detective kept the bullet.'			'The detective kept the bullet.'		
b. U(an)-A(in)			d. A(in)-U(an)		
侦探	子弹	击中了。	子弹	侦探	击中了。
zhēntàn	zǐdàn	jīzhòng-le	zǐdàn	zhēntàn	jīzhòng-le
detective	bullet	hit-PRF	bullet	detective	hit-PRF
'The bullet hit the detective.'			'The bullet hit the detective.'		

The condition codes describe both the animacy and the generalised role of the two critical arguments (A = Actor; U = Undergoer; an = animate; in = inanimate). For example, U(in)-A(a) refers to a sentence with an inanimate Undergoer preceding an animate Actor. Note that the assignment of Actor and Undergoer roles was disambiguated at the position of the clause-final verb

The two NPs always differed in animacy and were disambiguated towards an Actor or Undergoer reading via the selectional restrictions of the clause-final verb. In order to render the critical sentences more natural, they were presented auditorily and embedded in a minimal context which rendered the first argument of the target sentence the topic. The four critical sentence conditions are shown in Table 1.

As is apparent from Table 1, the present study employed a 2 × 2 design which crossed the factors word order (WO: Actor-before-Undergoer, A-U (conditions a/d), vs. Undergoer-before-Actor, U-A (conditions b/c)) and animacy (AN: animate-before-inanimate (conditions a/b) vs. inanimate-before-animate (conditions c/d)). Note that, here and in the following, we use the terms "Actor" and "Undergoer" to refer to the roles borne by the arguments in order to circumvent the problems associated with the notions "subject" and "object" in Chinese (e.g. LaPolla 1993).

Our hypotheses for the critical (disambiguating) verb position are as follows:

- Inanimate-initial sentences (U(in)-A(an)/A(in)-U(an))
  Here, both animacy and structure favour the UAV order. We thus expect to observe increased costs of disambiguation towards the dispreferred A(in)-U(an) order (i.e. for condition d vs. c). Previous results on word order disambiguation in verb-final constructions in German suggest that these may be reflected in an N400-like component (Haupt et al. 2008).
- Animate-initial sentences (U(an)-A(in)/A(an)-U(in))
  Here, animacy and structure are in conflict. If the preference for a minimal (UAV) structure overrides animacy, increased costs of disambiguation should be

observable for the Actor-initial condition A(an)-U(in) (i.e. for condition a vs. b). By contrast, the effect should be reversed if animacy overrides the word order preference (i.e. we should observe increase costs of disambiguation for condition b vs. a). If the two factors jointly determine the processing preference, effects for this comparison should be less pronounced than for the comparison between the inanimate-initial conditions (c/d).

- The role of context
  Since context was not manipulated in this study, no differential effects of context were expected. However, given the status of Chinese as a topic-prominent language, it is possible that the presence of a context which renders the first NP a topic may have a general impact upon the behaviour of the language comprehension system. For example, it is possible that the topic status of NP1 overrides the preference for a [−dep] reading of the first argument. However, since the ambiguous region spanned two arguments in the present study, it is unlikely that a potential influence of this type would still be detectable at the position of the disambiguating verb, since it will likely be influenced by the occurrence of a second argument. Hence, specific effects of context are not predicted in the present study.

4.4 *Materials and Methods*

4.4.1 Participants

Twenty-eight monolingually raised native speakers of Mandarin Chinese (Beijing dialect) participated in the experiment after giving informed consent (13 female; mean age 27.6 years; age range 22–34 years). At the time of the experiment, all participants were residing in Berlin, Germany. Participants were right handed (as assessed by an adapted Chinese version of the Edinburgh handedness inventory; Oldfield 1971) and had normal or corrected-to-normal vision. Three participants were subsequently excluded from the final data analysis on the basis of excessive EEG artifacts and/or too many errors in the behavioral control task.

4.4.2 Materials

As shown in Table 1, four critical conditions were examined in this experiment. Each of the critical sentences contained two nouns and a verb in a string of NP1-NP2-verb. Within each of the four conditions, the total number of characters in each sentence was held constant: only two character nouns and verbs were used for all sentences. As Mandarin Chinese lacks overt inflections to distinguish between a set of "words" and a "sentence", the aspect marker 了 ("le") was included after the verb to ensure that the sequence NP1-NP2-Verb-le would be interpreted as a sentence expressing a completed event. Thirty-six sets of the four conditions in Table 1 were constructed. The 144 critical sentences (36 in each condition) were interspersed with 288 filler sentences, which included active sentences with the coverb “把”(bǎ) marking the first argument as the Actor and the second argument as the Undergoer of the event, such as 侦探把子弹保存了(lit: “Detective bǎ bullet keep-PRF”; i.e. “The detective kept the bullet.”) and passive sentences with the coverb “被”(bèi) marking the first argument as the Undergoer and the second argument as the Actor of the event, such as 侦探被子弹击中了(lit: “Detective bèi bullet hit-PRF”; i.e. “The detective was hit by the bullet.”). Over all sentences, there was an equal probability of an initial argument being disambiguated as the Actor or the Undergoer.

Sentences were digitally recorded by two native speakers of Chinese (Beijing dialect), a male speaker for the context questions and a female speaker for the target sentences, using a sampling rate of 44.1 kHz and a 16-bit resolution. They were subsequently checked for naturalness by a native speaker of Chinese and re-recorded where necessary.

The 432 sentences in the experiment (144 critical sentences and 288 fillers) were presented to participants in two different randomized presentation orders.

4.4.3 Acoustic Analyses

As the auditory stimuli were recorded as natural speech and not altered in any way, we conducted acoustic analyses in order to examine possible prosodic differences between our critical conditions. To this end, the following parameters were extracted for each constituent (NP1, NP2, Verb): duration (ms), intensity (dB), and fundamental frequency (F0, Hz) for the onset, the offset and the minimal and maximal F0. Mean values for duration and intensity are given in Table 2 and pitch contours are visualized in Fig. 2.

Descriptively, the values in Table 2 and Fig. 2 indicate that there was a very low degree of variability in the acoustic parameters across conditions. The descriptive impression was confirmed by the statistical analyses. All critical acoustic parameters were subjected to an item-based 2×2 analysis of variance (ANOVA) involving the condition factors Animacy (AN: animate vs. inanimate) and Word order (WO: AU vs. UA). Note that significant pitch differences will only be reported when they exceed the threshold for perception (see Rietveld and Gussenhoven 1985; t’Hart et al. 1990).

With regard to the duration of the constituents, the statistical analysis revealed a marginally significant interaction of AN × WO at the verb position ($F(1,35) = 3.39$, $p < .08$). Resolving this interaction by AN revealed a marginally significant simple main effect of WO in the animate-initial conditions ($F(1,35) = 4.11$, $p < .06$). Note that, since this effect was not observable before the disambiguating region, it cannot have led to a disambiguation of our critical stimuli prior to the clause-final verb. The statistical analysis for intensity showed a main effect of WO for NP2 ($F(1,35) = 14.61$, $p < .001$) and the verb ($F(1,35) = 16.40$, $p < .001$). However, the differences giving rise to this effect were exceedingly small (<1 dB). The analysis of the fundamental frequency showed no significant at any position.

Table 2 Mean intensities and durations per constituent in each of the critical sentence conditions

	Mean intensity (dB)			Mean duration (ms)		
Condition	NP1	NP2	Verb	NP1	NP2	Verb
a. A(an)-U(in)	64.3(2.4)	62.7(2.5)	59.6(1.3)	762.0(78.0)	713.4(64.4)	1,008.9(44.0)
b. U(an)-A(in)	64.4(2.2)	61.9(2.6)	59.6(1.4)	754.1(78.8)	708.7(61.6)	1,034.1(60.7)
c. U(in)-A(an)	64.7(2.4)	62.1(2.7)	59.9(1.6)	741.2(67.8)	712.7(70.5)	1,036.1(63.5)
d. A(in)-U(an)	64.8(2.5)	62.3(2.3)	59.7(1.4)	739.1(72.6)	701.5(55.6)	1,017.3(48.5)

Standard deviations are given in parentheses

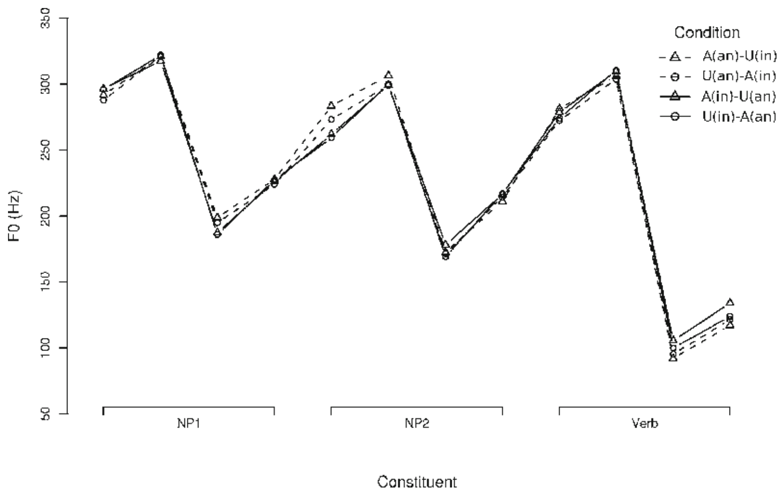

Fig. 2 F0 contour of the critical sentence conditions. Four values are given for each constituent: pitch onset, offset, maximum and minimum

4.4.4 Procedure

The experimental sessions were conducted in a dimly lit, sound attenuated room. Participants were seated approximately 1.2 m in front of a 17 in. computer screen. Context and target sentences were presented via loudspeakers in a question-answer manner. Each answer began with the presentation of a fixation cross (500 ms stimulus onset asynchrony; SOA). The fixation cross remained on the screen during the auditory presentation and for a further 1,000 ms after sentence offset. Following 500 ms of blank screen, participants were asked to judge the acceptability of the current sentence by means of a button press (maximal reaction time: 2,000 ms). As a cue for the acceptability judgment, a question mark was presented on the screen. Following the judgment task and a further 1,000 ms of blank screen, participants performed a comprehension task by judging whether this statement correctly described the content of the preceding sentence or not (maximal reaction time: 4,000 ms).

Comprehension questions were constructed by rephrasing the preceding experimental sentence as a canonically ordered sentence (SVO), an active sentence (S bǎ O V), or a passive sentence (O bèi S V) with a question particle "吗"(ma) at the end. The comprehension task required the answer 'yes' equally often as the answer 'no'. Comprehension questions to be answered with "yes" (50% of all questions) were consistent with the proposition of the preceding sentence. Questions to be answered with "no" were constructed in the same way but included a substituted subject, object, or verb (e.g. "egg" instead of "bullet" or "play" instead of "hit"). Comprehension questions were presented on the screen as a whole and without spaces between the words. The assignment of the left and right buttons to the answers yes and no for the comprehension task was counterbalanced across participants.

Participants were asked to avoid movements and eye blinks throughout the presentation of the fixation cross. The experimental session began with a short training session, followed by 12 experimental blocks comprising 36 sentences each, between which the participants took short breaks. The entire experimental session (including electrode preparation) lasted approximately 3.5 h.

4.4.5 EEG Recording

The EEG was recorded via 25 AgAgCl-electrodes fixed at the scalp by means of an elastic cap (ElectroCap International, Eaton, OH). The ground electrode was positioned at AFZ. Recordings were referenced to the left mastoid, but re-referenced to linked mastoids offline. The electro-oculogram (EOG) was monitored by means of electrodes placed at the outer canthus of each eye for the horizontal EOG and above and below the participant's right eye for the vertical EOG. Electrode impedances were kept below 5 kΩ. All EEG and EOG channels were amplified using a Twente Medical Systems DC amplifier (Enschede, The Netherlands) and recorded with a digitization rate of 250 Hz. The EEG data were filtered with 0.3–20 Hz band pass off-line to exclude slow signal drifts. Average ERPs were calculated per condition per participant from the onset of the critical stimulus items (i.e., the verb) to 1,000 ms post onset, before grand-averages were computed over all participants. Trials for which the comprehension task was not performed correctly were excluded from the averaging procedure, as were trials containing ocular, amplifier-saturation or other artifacts (the EOG rejection criterion was 40 μV).

4.4.6 Data Analysis

For the behavioral data, the mean acceptability/accuracy rates (for the judgment and comprehension tasks, respectively) and reaction times were calculated for each condition. For the comprehension task, incorrectly answered trials were excluded from the reaction time analysis. We computed a repeated-measures analysis of variance (ANOVA) involving the within participants factors ANIMACY (AN) and WORD ORDER (WO) and the random factors participants (F_1) and items (F_2).

For the statistical analysis of the ERP data, repeated measures ANOVAs involving the factor AN and WO were calculated for mean amplitude values per time window per condition. Analyses additionally involved the topographical factor “region of interest” (ROI). Lateral regions of interest were defined as follows: left-anterior (F3, F7, FC5); left-posterior (CP5, P3, P7); right-anterior (F4, F8, FC6); and right-posterior (CP6, P4, P8). For midline sites, each electrode was defined as an ROI of its own: FZ, CZ, PZ. Time windows were chosen on the basis of visual inspection of the data. The statistical analysis was carried out in a hierarchical manner, i.e., interactions were only resolved if they were at least marginally significant ($p \leq .08$). To avoid excessive type 1 errors due to violations of sphericity, we applied the correction of Huynh and Feldt (1970) when the analysis involved factors with more than one degree of freedom in the numerator.

4.5 Results

4.5.1 Behavioural Data

Table 3 presents mean acceptability rates and reaction times for the judgment task and mean percentages of correct responses and reaction times for the comprehension question. Standard deviations (by participants) are given in parentheses.

Judgment Task—Acceptability Ratings

A repeated measures ANOVA revealed significant main effects of AN (F_1 (1,24) = 3.10, $p < .1$; F_2 (1,35) = 8.05, $p < .008$) and WO (F_1 (1,24) = 45.5, $p < .001$; F_2 (1,35) = 139.03, $p < .001$) as well as an interaction AN × WO (F_1(1,24) = 106.65, $p < .001$; F_2 (1,35) = 213.54, $p < .001$). Resolving this interaction by AN showed that it resulted from a significant acceptability drop for Actor- vs. Undergoer-initial sentences in the inanimate-initial conditions (F_1 (1,24) = 144.5, $p < .001$; F_2 (1,35) = 445.7, $p < .001$) and a reversed word order effect (i.e. an acceptability drop for Undergoer-initial

Table 3 Results for the behavioural tasks in the present study

	Acceptability judgment		Comprehension question	
Condition	Acceptability (%)	Reaction times (ms)	Correct responses (%)	Reaction times (ms)
a. A(an)-U(in)	65.7 (24)	638.0 (180.6)	92.0 (6)	1,386.4 (217.8)
b. U(an)-A(in)	44.6 (34)	627.9 (188.4)	93.0 (6)	1,441.1 (271.0)
c. U(in)-A(an)	90.0 (7)	535.1 (134.5)	96.5 (3)	1,319.0 (223.2)
d. A(in)-U(an)	31.2 (26)	653.2 (184.7)	91.8 (6)	1,469.3 (266.5)

The table presents mean acceptability rates and reaction times for the judgment task and mean percentages of correct responses and reaction times for the comprehension task. Standard deviations (by participants) are given in parentheses sentences) in the animate-initial conditions (F_1 (1,24) = 20.57, $p < .001$; F_2 (1,35) = 37.11, $p < .001$).

In summary, the judgment task showed an acceptability advantage for condition U(in)-A(an), in which both the structually-induced preference for an Undergoer-initial order and the preference for an animate Actor/ inanimate Undergoer are fulfilled. All other conditions led to an acceptability drop. Interestingly, while the inanimate-initial conditions showed an acceptability advantage for an Undergoer-initial order, the preference reversed for the animate-initial conditions (which showed a higher acceptability for the Actor-initial order).

Judgment Task—Reaction Times

The statistical analysis of the reaction times for the acceptability task showed main effects of AN (F_1 (1,24) = 5.66, $p < .03$; F_2 (1,35) = 12.10, $p < .001$) and WO (F_1 (1,24) = 24.96, $p < .001$; F_2 (1,35) = 19.34, $p < .001$) as well as an interaction AN x WO (F_1 (1,24) = 7.15, $p < .02$; F_2 (1,35) = 14.09, $p < .001$). In accordance with the acceptability ratings, resolving this interaction by AN showed that the simple main effect of WO only reached significance in the inanimate-initial conditions (F_1 (1,24) = 18.85, $p < .001$; F_2 (1,35) = 37.05, $p < .001$) but not in the animate-initial conditions ($F_1/F_2 < 1$).

Comprehension Task—Accuracy Rates

The main effects of AN and WO only reached significance in the analysis by participants: AN (F_1 (1, 24) = 3.57, $p < .08$; F_2 (1, 35) = 1.19, $p > .2$) and WO (F_1 (1, 24) = 11.84, $p < .003$; F_2 (1, 35) = 2.76, $p > .1$). There was no interaction AN x WO neither by participants nor by items (F_1 (1, 24) = 2.91, $p > .1$; F_2 (1, 35) = 1.04, $p > .3$). Thus, there was a tendency for higher accuracy rates in inanimate-initial sentences and Undergoer-initial sentences. However, accuracy was high for all four critical sentence types (all accuracy rates >90%) .

Comprehension Task—Reaction Times

In the analysis of the reaction times for the comprehension task, the main effect of ORDER only reached significance in the analysis by participants (F_1 (1, 24) = 5.3, $p < .03$; F_2 (1, 35) = 1.92, $p > .1$). In addition, there was an interaction AN × WO (F_1 (1,24) = 31.0, $p < .001$; F_2 (1, 35) = 4.59, $p < .04$). Resolving the interaction by AN revealed that the simple main effect of WO was significant for inanimate-initial conditions (F_1 (1, 24) = 28.2, $p < .001$; F_2 (1,35) = 6.60, $p < .02$) and marginally significant, only in the analysis by participants, for animate-initial conditions (F_1 (1, 24) = 4.14, $p < .06$; F_2 (1,35) < 1). Therefore, the interaction resulted mainly from the large difference in reaction times for the inanimate-initial sentences (with longer reaction times for Actor-initial sentences).

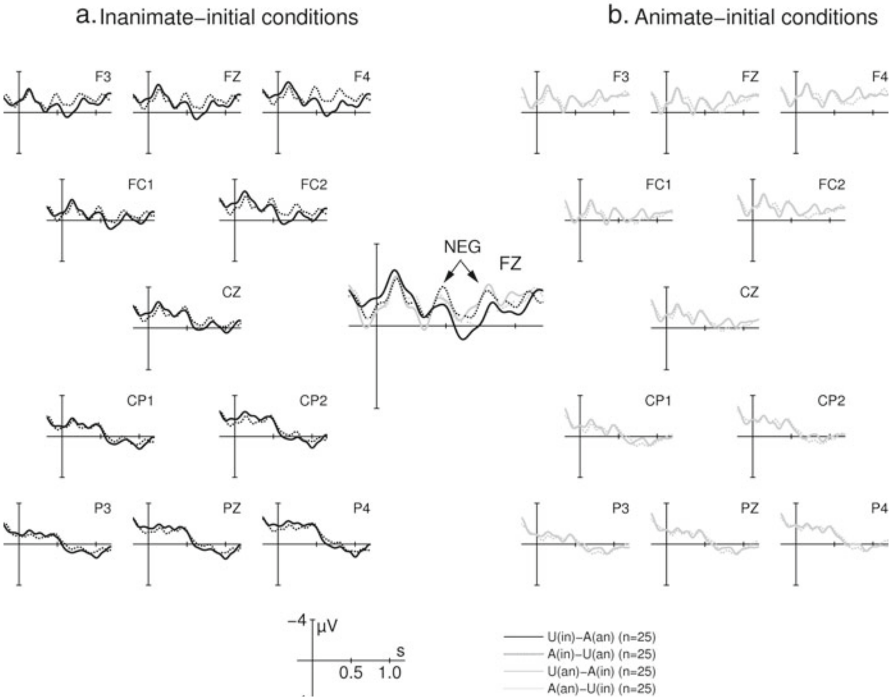

Fig. 3 Grand average event-related potentials (ERPs) at the position of the disambiguating clause-final verb in the present study (onset at the *vertical bar*). (**a**) ERPs for inanimate-initial conditions, whereas (**b**) ERPs for animate-initial conditions. The enlarged centre panel shows a direct comparison of all four conditions at a selected electrode. Negativity is plotted upwards

4.5.2 ERP Data

Grand average ERPs at the position of the disambiguating verb are shown in Fig. 3.

As is apparent from Fig. 3a, inanimate-initial sentences disambiguated towards an Actor-initial order engendered an anterior negativity from approximately 400 to 800 ms post verb onset in comparison to their Undergoer-initial counterparts. For animate-initial sentences, by contrast, Fig. 3b reveals that the Undergoer-initial word order elicited an anterior negativity in comparison to the Actor-initial order. However, this effect is delayed in comparison to that for inanimate-initial sentences, appearing between approximately 600 and 800 ms. In order to be able to provide an objective quantification of these effects and their respective latencies, we conducted an analysis in successive 50 ms time windows from 200 to 900 ms post verb onset. Effects were considered reliable if they reached significance in two or more successive time windows (cf. Gunter et al. 2000). This analysis is summarised in Table 4.

As is apparent from Table 4, the interaction between WO and AN reached significance between 450 and 850 ms post verb onset. Between 450 and 700 ms, this

Table 4 Summary of the statistical analysis of the ERP data in successive 50 ms time windows

		200–250	250–300	300–350	350–400	400–450	450–500	500–550
AN	LAT	–	–	–	–	–	–	–
df=(1,24)	MID	–	–	m	m	–	–	–
AN x ROI	LAT df=(3,72)	–	–	–	–		–	–
	MID df=(2,48)	–	–	–	m CZ: m; PZ: **	–	m PZ: **	–
WO	LAT	–	–	–	–	–	*	*
df=(1,24)	MID	–	–	–	–	–	–	–
WO x ROI	LAT df=(3,72)	m R-POST: m	–	* R-ANT: m	–	–	–	–
	MID df=(2,48)	* (n.s. in ROIs)	–	m (n.s. in ROIs)	–	–	–	–
AN x WO	LAT	–	–	–	–	–	*	–
df=(1,24)	MID	*	–	*	–	–	–	–
AN x WO x ROI	LAT df=(3,72)	–	–	–	–	–	–	*
	MID df=(2,48)	–	–	–	–	–	–	–
Animate-initial conditions (effect of WO)	LAT df=(1,24)	N/A	N/A	–	N/A	N/A	–	–
	MID df=(1,24)	–	N/A	m	N/A	N/A	–	–
Inanimate-initial conditions (effect of WO)	LAT df=(1,24)	N/A	N/A	–	N/A	N/A	**	R-ANT: **
	MID df=(1,24)	m	N/A	–	N/A	N/A	–	–

		550–600	600–650	650–700	700–750	750–800	800–850	850–900
AN	LAT	–	*	*	–	–	–	–
df=(1,24)	MID	–	–	–	–	–	–	–
AN x ROI	LAT df=(3,72)	–	* L-AN: ** R-ANT: *	** L-AN: ** R-ANT: **	–	–	–	–
	MID df=(2,48)	–	–	** FZ: m	–	–	–	–
WO	LAT	**	**	**	–	–	–	–
df=(1,24)	MID	m	m	–	–	–	–	–
WO x ROI	LAT df=(3,72)	–	–	–	–	–	–	–
	MID df=(2,48)	–	–	–	–	–	–	–
AN x WO df=(1,24)	LAT	*	**	**	**	**	**	–
	MID	–	–	*	*	**	*	–
AN x WO x ROI	LAT df=(3,72)	–	*	*	m	**	–	–
	MID df=(2,48)	–	*	*	–	**		–
Animate-initial conditions (effect of WO)	LAT df=(1,24)	–	–	–	L-ANT: * R-ANT: m R-POST: m	L-ANT: ** R-ANT: **	*	–
	MID df=(1,24)	–	–	FZ:*	FZ: *; CZ: *	FZ: *; CZ: *	*	–
Inanimate-initial conditions (effect of WO)	LAT df=(1,24)	**	L-ANT: ** R-ANT: ** R-POST: **	L-ANT: ** R-ANT: m R-POST: **	L-ANT: * R-ANT: ** R-POST: **	L-ANT: ** R-ANT: ** R-POST: **	*	–
	MID df=(1,24)	–	FZ: *	FZ: *	FZ: *	FZ: **; CZ: m	–	–

Effects were considered reliable if they reached significance in at least two successive time windows (cf. Gunter et al. 2000). These effects are indicated by shaded abbreviations: AN (factor animacy: animate-initial vs.inanimate-initial); WO (factor word order: Actor-before-Undergoer vs. Undergoer-before-Actor); LAT (lateral electrodes); MID (midline electrodes); ROI (region of interest); N/A (not applicable, i.e. no simple comparison computed because of the absence of a higher-order interaction); df (degrees of freedom)
Significance codes used: ** (<0.01), * (<0.05), m (<0.08)

interaction resulted from the fact that the inanimate-initial conditions showed a significant effect of word order (in the form of a negativity with a right-anterior focus for A(in)-U(an) vs. U(in)-A(an)), whereas the two animate-initial conditions did not differ significantly from one another. Between 700 and 850 ms, by contrast, both inanimate-initial and animate-initial sentences showed effects of word order. In both cases, these resulted from a negativity for sentences with inanimate Actors and animate Undergoers in comparison to sentences with animate Actors and inanimate Undergoers. This effect was slightly broader in its distribution than the negativity in the earlier time window, but also showed an anterior focus.

Visual inspection of the grand average ERPs suggests that, while the two animate-initial conditions do not differ significantly from one another in the earlier time window, they both engender a negativity in comparison to the U(in)-A(an) condition. To verify whether this was indeed the case, we conducted an additional analysis for the time window 450–700 ms (as defined via the range of consecutive 50 ms time windows in which the earlier negativity was observed), in which we compared the two animate-initial conditions to one another and to the U(in)-A(an) condition via pairwise comparisons. Significance levels were corrected according to a modified Bonferroni procedure (Keppel 1991); hence, effects were only considered significant if they reached a probability level of $p<0.0125$. This analysis confirmed that the two animate-initial conditions did not differ significantly from one another (all ps>0.16). However, both differed from the U(in)-A(an) condition (A(an)-U(in): significant effects of Condition and ROI × Condition at lateral sites, due to significant differences between the two conditions in the two anterior ROIs, all ps<0.01; U(an)-A(in): effects of Condition and ROI × Condition for lateral sites and of ROI × Condition for midline sites, due to significant differences between the two conditions in the two anterior ROIs, all ps<0.01). In summary, while the two animate-initial conditions did not differ from one another in the earlier time window at the position of the verb, they both engendered an anterior negativity in comparison to the most preferred condition, namely U(in)-A(an).

5 Discussion

In the present auditory ERP study, we aimed to examine the influence of animacy and structural simplicity on incremental argument processing in transitive verb-final sentences in Mandarin Chinese. In particular, we wanted to test the hypothesis that animacy would influence incremental argument processing when the ambiguous region spans two arguments, while it has been shown to have no effect in Chinese sentences involving only a single ambiguous argument (Wang et al. 2009). Furthermore, we hypothesised that there should be a preference for Undergoer-Actor-verb vs. Actor-Undergoer-verb orders as the former allow for a structurally simpler analysis.

For inanimate-initial sentences, in which both the structural simplicity and the animacy of the arguments favoured an Undergoer-Actor-verb order, we observed an anterior negativity between 450 and 850 ms for Actor(in)-Undergoer(an) sentences in comparison to Undergoer(in)-Actor(an). By contrast, animate-initial sentences, in which the two information types provided conflicting information, did not differ from one another in this time window. Notably, however, they showed an ERP response that was intermediary between that of the two inanimate-initial conditions. Between 700 and 850 ms, animate-initial conditions showed an anterior negativity for Actor-initial sentences in comparison to their Undergoer-initial counterparts. In the following, we first discuss possible interpretations of this data pattern and how it can be derived within the eADM. We then conclude by discussing the consequences of the overall data pattern for approaches to language comprehension.

5.1 The Interaction of Structural Simplicity and Animacy in Online Argument Interpretation in Verb-Final Sentences in Chinese

The present findings indicate that structural simplicity and animacy interact in the online interpretation of arguments in verb-final sentences in Chinese. Thus, we observed a negativity with an onset latency of approximately 450 ms for Actor- vs. Undergoer-initial sentences with inanimate-initial arguments. In the same time window, animate-initial sentences did not differ from one another, but engendered a negativity that was intermediary between the ERP responses for the two inanimate-initial conditions. This overall data pattern suggests that the language comprehension system of Chinese native speakers has a strong preference for an Undergoer-before-Actor analysis of NP-NP-V sentences in which the first NP is a topic, but only when this analysis is also supported by animacy. When animacy conflicts with the structurally-induced word order preference, there does not appear to be a clear preference for either Undergoer- or Actor-initial sentences. Rather, the intermediary ERP response to the animate-initial conditions could be taken to suggest that the preferred analysis is not stable over trials, i.e. in some cases, the system follows the animacy cue, thereby adopting an Actor-initial analysis, whereas in other cases, it follows the structurally simpler analysis, thereby adopting an Undergoer-initial reading. (For evidence that the analysis adopted by the processing system may change from trial to trial, see e.g. Traxler et al. 1998; van Gompel et al. 2001, 2005) Assuming that both cues are approximately equally strong in determining the initial processing choice, both animate-initial conditions will require a reanalysis in approximately 50% of trials. In this way, both conditions engender a negativity in comparison to the optimal Undergoer(inanimate)-Actor(animate)-verb condition, but this effect is smaller than in the Actor(inanimate)-Undergoer(animate) condition, which requires a reanalysis on all (or most) trials. These results therefore suggest that the online interpretation of arguments in NP-NP-V sentences in Chinese is jointly determined by context and argument prominence information (animacy).

Between 700 and 850 ms, the ERP responses to the disambiguating verb show an anterior negativity for Actor-initial sentences with inanimate arguments and for Undergoer-initial sentences with animate arguments. On the one hand, this finding could be taken as an indication that, in a post-initial processing stage at the position of the disambiguating verb, the animacy cue dominates interpretation in the animate-initial conditions, thereby leading to a disadvantage for the Undergoer-initial structure. This interpretation fits well with the behavioural data, which suggest that, in terms of offline judgments, Actor-initial sentences with animate initial arguments are more acceptable than their Undergoer-initial counterparts. However, since the negativity between 700 and 850 ms essentially amounts to a main effect of verb type (i.e. a negativity for all sentences with inanimate Actors and animate Undergoers), there are also other possible explanations. One possibility which cannot be ruled out on the basis of the present data is that this effect simply reflects lexical differences between the two types of disambiguating verbs employed in the present study. Under this interpretation, the nature of the effect observed is somewhat surprising, because lexically-based differences are usually reflected in N400 effects (i.e. in centro-parietal negativities appearing within a time range from approximately 200–700 ms, depending on the modality of presentation, cf. Kutas et al. 2006). Here, by contrast, we observed a late anterior negativity with a focus to the right for verbs leading to an inanimate Actor/animate Undergoer interpretation. Nevertheless, since this comparison involves different verb types, a lexically-based explanation cannot be excluded. Finally, an alternative possibility is suggested by the ERP data reported in Wang et al. (2009). In this study, we observed a late anterior negativity at the position of NP2 in NP-V-NP sentences in Chinese whenever the sentence involved a relation of an inanimate Actor and an animate Undergoer. In other words, this previous study showed a very similar effect to the late effect observed here, while not being subject to a lexical confound. This tentatively suggests that, rather than being due to inherent lexical differences between the two classes of verbs used for disambiguation in the present study, the late anterior negativity may reflect a more general disadvantage for transitive relations in which an inanimate entity acts upon an animate entity. Possibly, this additional disadvantage serves to tip the scales in favour of the Actor-initial reading in the animate-initial conditions, thereby leading to a higher sentence-final acceptability for Actor(animate)-Undergoer(inanimate) vs. Undergoer(animate)-Actor(inanimate) sentences in spite of the preference for an Undergoer-initial word order.

How can these results be derived in terms of the eADM? At the position of NP1, the system will first posit the simplest syntactic structure (i.e. an NP-V core template) and the most minimal interpretation for the NP (i.e. [−dep]). When the second NP is encountered, a reanalysis is required in all conditions, since a more complex structure with a pre-core NP position needs to be adopted (recall that we assume that there are no NP-NP-V core templates without coverbs). The simplest option is to assume that only a single pre-core position is required. In the subsequent (second) stage of processing, the system is faced with two options: to reanalyse NP1 as [+dep] in accordance with the syntactic structure computed by stage 1 on the basis of structural simplicity or to override the stage 1 preference in order to maintain the

[−dep] analysis of NP1. In the latter case, a reanalysis towards a more complex syntactic structure with two pre-core argument positions is required. Crucially, the system's decision at this point is influenced by the animacy of the arguments: when animacy supports the syntactically simpler structure, the preference for an Undergoer-Actor order is established, thus supporting the structurally simpler analysis. By contrast, when animacy contradicts the structurally-required reanalysis towards a [−dep]-initial order, the two alternative choices appear to be weighted approximately equally, hence leading to no overall preference for one or the other option.[7] This could be taken to suggest variability in the system's behaviour across trials (as suggested above).

Note that this account does not exclude the possibility that the results observed here may have been partly influenced by the context questions which preceded each critical sentence. Recall that these contexts always rendered the first argument of the target sentence a topic. It remains an open question whether this might override the preference for a [−dep] assignment to the initial argument (but see Wang et al. 2010, for initial findings which suggest that this is not the case). Nevertheless, when the second argument was encountered, the absence of a contrastive reading may have favoured an OSV over an SOV reading, thus supporting the preference based on minimal structures. However, since context was not manipulated in the present study, these two factors (i.e. a structurally-induced preference and a possible contextually-induced preference) cannot be disentangled on the basis of the current data. This could be accomplished in a future study via an additional contextual manipulation.

Finally, let us consider whether these results speak in favour of a particularly strong role of animacy in the incremental argument interpretation of multiple arguments in Mandarin Chinese (as suggested by offline findings, cf. Miao et al. 1986; Li et al. 1993). Interestingly, it has been demonstrated that the preference for an Actor-initial order in German NP-NP-V structures is not overridden by animacy (Schlesewsky and Bornkessel-Schlesewsky 2009). Since both Actor-Undergoer-verb and Undergoer-Actor-verb orders can be expressed via core templates in German, structural simplicity is not an issue here. Rather, the data suggest that the initial [−dep] preference for NP1 is not overridden by animacy considerations when NP2 is encountered. In the present findings on Chinese, by contrast, animacy even appears to be able to sway the system to adopt a more complex structural analysis - at least on a certain proportion of trials. If this were not the case, we should have observed a general preference for Undergoer-initial sentences at the position of the clause-final verb, which we did not. Hence, our data support the notion that, in comparison with other languages, Mandarin Chinese assigns a comparatively strong weighting to animacy in online argument interpretation.

[7] The notion that a more complex structural option can be supported by relational properties of the NPs in stage 2 of comprehension is supported by findings from Japanese (Miyamoto 2002). Miyamoto's results indicate that a complex (biclausal) structure may be preferred when two arguments are highly similar to one another in terms of the features required for the assignment of [±dep], hence rendering argument hierarchisation too difficult within the same local domain (for discussion, see Bornkessel-Schlesewsky and Schlesewsky 2009a).

5.2 Consequences for Accounts of Language Comprehension

Taking the present findings into account, the overall cross-linguistic data pattern on the influence of animacy in incremental argument interpretation (as examined via the subject-preference) can be summarised as follows:

(a) Animacy as a relational feature. Animacy does not influence the interpretation of single arguments. Rather, it comes into play as soon as an intransitive reading has been ruled out and several arguments must be related to one another.
(b) Animacy as a feature that is cross-linguistically applicable, but varies in strength of applicability. Whereas animacy generally modulates the processing of several arguments in relation to one another, the degree to which such a modulation takes place depends on the language being processed and on the other information types available to the processing system. In all of the languages examined so far (including Chinese, Tamil and German), animacy modulates the processing of an Actor argument following an Undergoer in unambiguous structures, i.e. when the prediction for a prototypical (animate) Actor is not borne out. In contrast to German, however, Chinese also shows a strong influence of animacy in ambiguous structures, which is on par with strong word order preference based on structural simplicity.

What are the consequences of this overall data pattern for models of language comprehension? First of all, it appears unlikely that we are simply dealing with frequency-based effects here (in the sense that the cross-linguistic differences observed could be due to differences in the likelihood of Actors and Undergoers in transitive relations being animate and inanimate, respectively). As shown in a corpus count by Jäger (2007), for example, sentences with animate Actors and inanimate Undergoers have a frequency advantage over deviating animacy patterns even a language like English, in which animacy cannot ever determine interpretation. Jäger reported a similar pattern for Swedish, as did Demiral (2007) for Turkish, thereby attesting to the cross-linguistic stability of this effect (cf. also Comrie's (1989: 128) definition of "natural transitive constructions"). Nevertheless, the use of animacy as a disambiguating feature in sentences with ambiguous regions spanning two arguments differs across languages: whereas the effects of animacy are on par with a structurally-driven word order preference in Chinese (as shown in the present study), they are considerably weaker in German (Schlesewsky and Bornkessel-Schlesewsky 2009). Of course, in the absence of detailed cross-linguistic corpus studies on this issue, it cannot be ruled out that the different patterns might be due to more subtle frequency differences or interactions between animacy and other information types. Nevertheless, it appears worth noting that the general, apparently cross-linguistically applicable frequency advantage for sentences with animate Actors and inanimate Undergoers impacts upon the processing of individual languages and constructions in distinct ways: whereas animacy appears to have a similar impact in unambiguous sentences cross-linguistically, its effects in ambiguous sentences are much more varied.

Secondly, the overall pattern of results is not easily reconciled with purely structure-based processing accounts. Whereas the preference for Undergoer-Actor-Verb structures in Chinese can be derived via structural simplicity, the modulation of this preference via animacy is not easily explained by a purely structure-based approach. Similarly, the fact that animacy does not impact upon the processing of single arguments but only modulates the analysis of sentences with at least two arguments clearly cannot be explained in structural terms.

By contrast, an account that is clearly semantically-based also cannot derive the present findings. In interpreting their results on the processing of object relative clauses in Dutch, Mak et al. (2002, 2006) argue that animacy – and particularly the relative animacy of two arguments in relation to one another – may serve to guide readers' initial analysis of a relative clause (i.e. determine which argument is analysed as the Actor and which as the Undergoer). This is clearly not the case in the present data, as we should otherwise have found a reversal of the word order effect from 450 ms onwards depending on the animacy of NP1 and NP2, which was not the case. Rather, our findings suggest that, in Chinese, animacy and structural considerations interact in determining the online interpretation of two ambiguous arguments.

In this way, we believe that the eADM provides a relatively good explanation of the present findings (for an alternative multifactorial account of word order preferences, see Lamers and de Hoop 2005; de Hoop and Lamers 2006). By assuming that structural preferences and interpretive preferences are expressed via different levels of representation – and via different processing stages – we can account for the separable influences of structural simplicity and animacy and their interaction in Chinese.

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Argument Linearization in Dutch: A Multi-factorial Approach

Monique J.A. Lamers

1 Introduction

One of the most striking facts about language is that its users can create and understand an unlimited number of utterances. This is possible by combining elements from a large, but finite vocabulary into larger meaningful expressions (phrases, sentences, discourse). Verbs form the heart of this combinatory process and are essential in bringing across the intended meaning. They express eventualities and establish syntactic and semantic relationships between the arguments. Together this creates the argument structure. It matches verb semantic (or thematic) roles (e.g., agent, patient, experiencer) with syntactic functions (e.g., subject, object) and is often considered the interface between syntax and semantics. A meaningful message is only conveyed if the hearer comes to the same semantic and syntactic relation between the verb and its arguments as was intended by the speaker.[1] The hearer has diverse semantic and syntactic sources of information at his disposal for getting the arguments right. The focus of this chapter will be on semantic and syntactic features that play a role in the comprehension of Dutch embedded clauses with different types of verbs. More specifically, I will show how the interplay of multiple factors may influence the preferences on linearization of the two arguments in sentences with different types of verbs (i.e., agentive verbs, subject-experiencer verbs, causative and unaccusative psych verbs).

Firstly, I will introduce different sorts of information and mechanisms that are involved in distinguishing the subject from the object in nominative-accusative

[1] Here 'speaker' will be used for the language user that produces an utterance independent of the modality (e.g., spoken or written); the term 'hearer' will be used for the person comprehending an utterance.

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languages. Three of these sources of information have the ability to directly disambiguate sentences in which either arguments can be the subject or the object (i.e., morphological case and number marking, selectional restrictions of the verb combined with the animacy of the arguments). Other sources may influence the process of getting the arguments right indirectly as they concern basic word order preferences (i.e., configurational ordering, animacy dominancy, and ordering in terms of thematic dependency). Secondly, I will show how these factors may influence word order preferences in Dutch for sentences with different types of verbs and two arguments (one animate, one inanimate). This multi-factorial approach is applied to sentences that were used in an ease of comprehensibility rating study in Dutch, which is presented in Sect. 3. In Sect. 4, I will discuss an alternative way of applying the multi-factorial approach to explain differences in word order preferences. Following de Hoop and Lamers (2006) and Lamers and de Hoop (2005) I will define violable constraints based on the relevant factors used in the multi-factorial analysis. I will explain how these constraints differ from the constraints that were initially used by de Hoop and Lamers (2006) to distinguish the subject from the object in transitive relations. Then I will draw up the constraint violation pattern for each of the sentences used in the rating study. From the mapping of the different constraint violation patterns onto the results of the rating study, the relevancy of each of the constraints will become clear. More specifically, it will become evident that including a factor that represents the thematic dependency of the arguments is necessary to explain the differences in ease of comprehensibility between sentences with different word orders and different types of verbs, and thus, the differences in word order preferences between these sentences.

2 Distinguish the Subject from the Object

2.1 Sources of Disambiguating Information

Morphological marking, such as number agreement between the verb and the subject, is one of the devices many languages have to identify the subject of a sentence. If, for example, the subject and object in a sentence differ in number, *number agreement* disambiguates a sentence into an object- or a subject-initial structure. This is illustrated in (1) with a Dutch[2] object-initial sentence taken from a reading study of Frazier and Flores D'-Arcais (1989).

(1) *De patient* *bezoeken* *de dokters.*
[the patient].NOM/ACC.SG visit.PL [the doctors].NOM/ACC.PL
'The doctors visit the patient.'

[2]In contrast to English, Dutch has a relatively free word order in which main clauses starting with a subject or object can both be grammatically correct.

Next to number agreement,[3] *case marking* of arguments may provide crucial information to distinguish the subject from the object (e.g., Bader and Lamers 2009; Comrie 1989). This is exemplified for German in (2a) with the unambiguous case marking of the masculine subject providing a good cue to identify the subject and object. Although German is a language with a relatively rich case- marking system, marking pronouns, articles and adjectives, it is not always the case that the two arguments of a two-place predicate can be uniquely identified as the subject or the object. This is illustrated in (2b) in which both arguments are feminine, a declination in German with the same morphological marking for nominative and accusative. As in languages with a poor case system, such as English and Dutch, other sources of information have to come into play in order to get the arguments right.

(2) *a. Die Professorin* *hat der Student* *geschlagen.*
[the professor].NOM/ACC has [the student].NOM hit
'The student hit the professor.'
b. Die Professorin *hat die Studentin* *geschlagen.*
[the professor].NOM/ACC has [the student].NOM/ACC hit
'The professor hit the student.'

In contrast to Dutch and German, English has a relatively strict (or rigid) word order. In this language word order forms a very strong cue for the identification of the subject (and the object) (MacWhinney and Bates 1989; MacWhinney et al. 1984; McDonald 1987, 1989). In almost all English sentences the first argument is the subject. Consequently, if the verb *admire* in (3a) is replaced by *please*, as in (3b), the sentence becomes unintelligible. This is because the second argument does not meet the selectional restrictions of the verb *please*.

(3) a. The athlete admired the picture.
b. #The athlete pleased the picture.

Let's consider the *selectional restrictions* of the verbs used in the sentences in (3) more specifically. The verb *admire* needs two arguments, the admirer (someone doing the admiring), and the admiree (the entity being admired). Given the meaning of admire, the admirer must have animate or human characteristics, whereas no such constraints apply to the admiree. The meaning of *please*, on the other hand, requires an animate object.

Depending on language specific characteristics, such as allowing a word order in which the object precedes the subject, the selectional restrictions of the verb in combination with the animacy characteristics of the arguments may provide the crucial information that leads to the final interpretation, as is illustrated in (4) for Dutch. Because the first argument is the only animate argument fitting the selectional restriction on the object of *bevallen* 'please', it has to be the object of the sentence, leading

[3] Number agreement will not concern us further because in the examples discussed in this chapter, as well as in the materials of the experiment presented in Sect. 3, the verb always agrees with both the subject and the object. As a result number agreement does not provide information that helps to distinguish the subject from the object.

to an OS form. Thus, next to case marking and number information, semantic information provided by the meaning of the verb (i.e., the selectional restrictions in combination with the animacy of the arguments) may provide sufficient information to distinguish the subject from the object and help to resolve structural ambiguities.

(4) *De atleet* *beviel* *de foto.*
[the athlete]O pleased [the picture]S
'The picture pleased the athlete.'

However, similarly to case marking and number agreement, semantic information may sometimes provide inconclusive information to identify the subject and the object. If no disambiguating case or number information is available, a main clause as in (5), is in principle ambiguous between a subject-before-object (SO) or an object-before-subject (OS) structure.

(5) *De fotograaf* *verwonderde/beviel* *de atleet.*
[the photographer]S/O amazed/pleased [the athlete]O/S
'The photographer amazed/pleased the athlete.'

From psycholinguistic studies addressing the comprehension of SO and OS sentences, it has become clear that even for languages with a free word order, there is a strong preference for the subject to precede the object (Frazier and Flores d'Arcais 1989; Kaan 1997; Lamers 2001, 2007). This SO preference is, however, not restricted to languages with a free word order. Over the years typological research has shown that in most languages of the world the SO structure is the most frequent structure (Hawkins 1983). In the following section factors and mechanisms that influence this preference will be discussed.

2.2 Factors Affecting Word Order Preferences

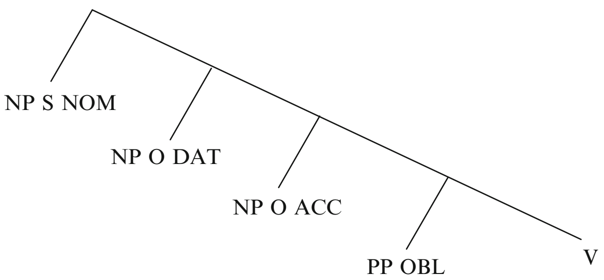
There are numerous mechanisms that may be held responsible for the processing advantage of SO over OS. In the past, most of these mechanisms, such as the Minimal Chain Principle (De Vincenzi 1991), the Principle of Simplicity (Gorrell 1996, 2000), or the Active Filler Strategy (Frazier and Flores d'Arcais 1989) rely fully on syntactic information following some sort of principle of structure or processing parsimony.

The psycholinguistic mechanisms mentioned above are closely related to theoretical explanations for the SO preference. Following a configurational approach this *subject-first preference* may be accounted for in terms of linearization patterns, since this preference follows the base generated word order (or basic word order). Base generated word order refers to the systematic arrangement of constituents in a sentence based on their configurational relation. For example, in Government and Binding Theory this relation is called c-command, defined as in (6) (Haegeman 1991; Reinhart 1983).

(6) C-command:
A node A c-commands a node B iff
(i) A does not dominate B;
(ii) B does not dominate A;
(iii) the first branching node dominating A also dominates B.

For languages such as Dutch and German this results in a syntactic function linearization in which the subject c-commands the indirect object and the indirect object c-commands the oblique object (i.e., a PP).[4] This is illustrated in (7a). In such a configurational approach the subject is the highest argument in the tree, and therefore, it is the highest ranked argument (Levin and Rappaport Hovav 2005). Hence, in an SO-structure arguments are linearly ordered preserving the dominance relations according to the syntactic function hierarchy given in (7b). The word order in such structures is the basic word order, also referred to as the unmarked word order, which is usually the most frequently used word order.

(7) a.



b. subject > indirect object > direct object > oblique

In (7a) not only the syntactic function is given, but also the case marking of the arguments. The *morphological markedness of case* forms a hierarchy of its own. For example, for nominative-accusative languages, such as Dutch and German, nominative case is often indicated as being unmarked, whereas dative case is more marked. In some theoretical frameworks it is argued that accusative falls somewhere in between nominative and dative case marking (Aissen 2003; Blake 2001; Woolford 2001). Although different theories may diverge in the exact ranking of case (as well as syntactic function), they all agree on ranking the subject in nominative case higher than both the direct object in accusative case and the indirect object in dative case.[5] Hence,

[4] In the theoretical linguistic literature, there is an ongoing debate whether the indirect object outranks the direct object or vice versa (see Häussler and Bader this volume). Based on linking characteristics in Dutch I follow the linearization that is argued for by Hoekstra (1984). However, since this chapter focuses on the linearization of subject and direct object on the one hand, and subject and indirect object on the other hand, the ordering of indirect and direct object is irrelevant.

[5] Similarly to number agreement, case marking will not concern us further because in the examples discussed in this chapter, as well as in the materials of the experiment presented in Sect. 4, case marking does not provide any information that helps to distinguish the subject from the object.

the SO word order in a sentence with a two argument predicate not only preserves syntactic function dominance relations, but also case dominance relations (Levin and Rappaport Hovav 2005; Primus 1999, 2009; Wunderlich 1997).

Besides the structural subject-first preference, there is also a semantic (or conceptual) prominence preference for arguments that are higher on a scale of semantic prominence to precede lower ranked arguments. Psycholinguistic studies provide ample evidence for a word order preference in which the animate argument precedes the inanimate argument (for comprehension, see Lamers 2001, 2005, 2007; MacWhinney and Bates 1989; Weckerly and Kutas 1999 for production, see Bock and Warren 1985; Ferreira 1994; Prat-Sala and Branigan 2000). This preference, which is also known as the *animate-first preference*, follows the ranking of an animacy hierarchy in which human entities are being ranked higher than animate, non-human entities, which are higher than inanimate entities, as is illustrated in (8) (e.g., de Swart et al. 2008).

(8) Animacy hierarchy: Human > Animate non-human > Inanimate

In language production, there is a growing consensus on the origin of the 'animate first' effect as being due to characteristics on the conceptual level. The inherent conceptual properties of animacy make animate arguments more accessible in a mental model than inanimate ones. Reasons for this might be what is called by Sridhar (1988:66) "intrinsic semantic vividness". The accessibility of an item is also affected by the intention of the speaker, or recency of mention. Already in the late sixties it was shown that highly accessible elements have a tendency to appear in early sentence positions (e.g., Garnham 2001; Garnham and Oakhill 1992; Gernsbacher 1989; Osgood 1971; Prentice 1967). The animate-first preference is also supported by the findings of several corpus studies addressing word order in constructions with two place predicates. These studies not only report a high percentage of animate subjects, they also show that in almost all sentences with an animate and an inanimate argument, the animate argument precedes the inanimate argument (for Swedish see Dahl and Fraurud (1996), for Dutch, see van Tiel and Lamers (2007); for German see Kempen and Harbusch (2004)). The preference for animate subjects is not that surprising: animate entities are good agents, whereas inanimates are not (cf. Primus 1999; Dowty 1991). Several hundreds of verbs, which are very often used in natural language, assign the role of agent (or experiencer) to the subject (Dahl and Fraurud 1996). Notoriously, for these verbs the subject-first and animate first-preferences coincide (Dahl 2000; Lamers and de Hoop 2005; Lamers 2001).

However, as is discussed above, not all verbs select an animate subject, nor do they all assign the role of agent to the subject. In the following subsection I will discuss argument ordering as a multi-factorial phenomenon. According to this approach, different factors are responsible for the linearization of the arguments. Besides the above mentioned factors, this approach includes a factor that specifically addresses the semantic differences between verbs in terms of thematic role assignment, thus making it possible to explain the linearization of arguments in sentences with different types of verbs.

2.3 *Argument Ordering as a Multi-factorial Phenomenon*

In recent research on the relation between role semantic function, basic word order and case, Primus (1999) argues that the ordering of arguments should be viewed as a multi-factor phenomenon. The above explained configurational approach leading to the syntactic function hierarchy, the hierarchical ranking of case, and the ranking of arguments based on the animacy hierarchy are three out of many factors determining the linearization pattern.[6] Starting point of Primus' discussion is a working hypothesis of basic word order, frequently employed by researchers addressing linearization patterns in the languages of the world (Greenberg 1963; Hawkins 1983; Siewierska 1988; Tomlin 1986).

(9) Working definition of basic word order (as cited by Primus 1998: 421):

Basic order is the order that occurs in stylistically neutral, independent, indicative clauses with full noun phrase participants, where the subject is definite, agentive and human, the object is a definite semantic patient and the verb represents an action, not a state or an event.

According to Primus (1998), this definition is too restricted as it applies only to utterances with clear transitive verbs that assign the role of agent to subject, and the role of patient to the object argument. To capture the linearization patterns of verbs that are not clear transitive verbs, she argues for an approach in which word order is looked upon as a multi-factorial phenomenon with the order of constituents being the result of a competition between multiple preference rules. Each rule is relative to one particular factor that determines the unmarked (or basic) ordering. A linearization pattern in language usage depends on the competition between these preference rules or linearization factors: the more linearization rules it obeys, the more preferred it is (c.f., MacWhinney and Bates 1989; MacWhinney et al. 1984). If, for example, all (or most) word order determining factors lead to an SO linearization, SO structures are highly preferred and more frequently used than OS structures. If, however, certain factors would lead to the OS structure, the preference for the SO order would be less strong.

Next to the hierarchical ranking of syntactic function, case, and animacy, Primus includes a linearization factor that addresses semantic differences between verbs in terms of thematic role assignment. This linearization factor follows the ordering according to the ranking on a scale of *thematic dependency*. This factor captures not only the ranking of the arguments with thematic roles assigned by clear transitive verbs (agent and patient), but also of arguments with other thematic labels assigned by other types of verbs.

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[6] Primus (1998, 1999) also discusses pragmatic and discourse factors. However, the data discussed in this chapter consist of single experimental sentences without systematic manipulation of pragmatic and discourse factors. Although possible influences of pragmatic and discourse factors cannot be fully ruled out in single sentences, it is assumed that they are of minor importance. Since they were not manipulated, it is assumed that possible influences were constant between crucial conditions.

In a clear transitive relation, as in (8), the verb assigns the role of agent to the subject and the role of patient to the object (Hopper and Thompson 1980; Tsunoda 1985, 1999). A transitive verb expresses an event in which there is a clear dependency between the two participants, in the sense that the act of the agent affects the patient. For example, *the girl* in (10a) can only become a *kissed girl*, if the athlete indeed kisses the girl (the girl being kissed in (10a)).

(10) a. The athlete kisses the girl.
b. The athlete kisses the medal.

Crucial for the differences between the different verb types seems to be those properties that tap on the dependency relation between the two participants. From both the syntactic and semantic point of view it has been argued that there is an asymmetrical dependency between the two participants as the direct object requires the concurrence of a subject, whereas a subject can occur with a one place predicate, and is not dependent on the direct object in two place predicates (Primus 1999; Hawkins 1994:50–56). Extending this line of argumentation to the domain of thematic roles, Broekhuis (1997, to appear) among others, has argued that in a clear transitive relation the prototypical patient is dependent on the act of the prototypical agent. The way a prototypical patient is involved, i.e., whether or not it is created, consumed, physically affected, etc., depends on the kind of act intended or caused by the agent (i.e., kissed girl/medal) (see also Levin and Rappaport Hovav (2005), and Primus (1999; 2009)). Among other properties, a prototypical agent[7] has to be volitional. It intends to accomplish the event or act expressed by the verb. It is sentient with respect to the event expressed by the verb. It controls and causes the event that involves the other participant, which in clear transitive verbs is the prototypical patient (Broekhuis to appear, 1997; Levin and Rappaport Hovav 2005; Primus 1999). The prototypical patient is the target of the sentience of the other participant, which in a clear transitive relationship is the prototypical agent, the external cause of the event. It undergoes a change of state that is caused by the action of the agent (Dowty 1991; Primus 1999). Consequently, animate arguments have many properties for being a good agent, whereas they can be good patients as well. Inanimate arguments are less suitable for being the agent, but they can be good patients, as is illustrated in (10b).

Considering the complexity of verbal semantics and thematic role assignment, it is not surprising that in the literature one can find many different orders ranking

[7]Here I adopt the view of Dowty (1991) who regards thematic roles as a set of prototype clusters of concepts, called Proto-Roles. He uses two Proto-Roles to capture the mapping of thematic roles to grammatical functions: Proto-Agent and Proto-Patient, each with their own prototypical properties. Depending on the semantic properties, semantic features of thematic roles such as experiencer, stimulus or undergoer, are described as being more (or less) agent-like or patient-like. In the literature, there are, however, also other theories that make use of generalized semantic roles, such as for example the concept of *macro-roles* in *Role and Reference Grammar* defined by Van Valin and LaPolla (1997).

thematic roles on a hierarchical scale (Dowty 1991; Grimshaw 1990; Jackendoff 1976; Levin and Rappaport Hovav 2005; Primus 1999, 2009; Van Valin and LaPolla 1997; Wunderlich 1997). Despite the many differences between the different rankings, they all place agent-like (or actor) arguments at the top end of the hierarchy whereas patient-like (or undergoer) arguments are placed on the lower end of the hierarchy. The comparison of proto-role properties of the participants makes it possible to rank the two arguments without being concerned with the diversity of thematic role labels and their ranking. Moreover, in order to analyse differences in word order preferences of the arguments of different types of verbs, a ranking that is based on both the dependency relations and proto-role properties as is given in (11), seems to be most appropriate (Primus 1998).

(11) Thematic Dependency Scale:
Proto-Agent $_{\textbf{independent}}$ > Proto-Patient $_{\textbf{dependent}}$

As stated above, not all verbs express clear transitive relationships. Therefore arguments may exhibit more or less prototypical agent or patient characteristics. Arguments that have more prototypical agent characteristics and exist independently of the eventuality expressed by the verb are ranked high on this scale. The argument with more patient-like characteristics that is not in control or the cause of the eventuality, is the dependent argument, which is ranked lower than the independent, more agent-like argument. As with other prominence scales, the unmarked order is the order in which the highest ranked role (i.e., the independent most agent-like argument) precedes the lower ranked role (the dependent more patient-like argument).

Next, I will show the linearization patterns for four different types of Dutch verbs (clear transitive verbs, subject-experiencer verbs, causative and unaccusative psych verbs) that result from the interaction of the factors discussed above. As we will see, these verbs assign different thematic roles resulting in different thematic dependencies between the arguments. Together with the linearization patterns of the other word order determining factors and their preference rules (i.e., configurational approach, animacy hierarchy, thematic dependency scale) predictions will be made about the strength of different word order preferences in a sentence with a specific type of verb combined with an animate and an inanimate argument.

2.3.1 Transitive Verbs

Transitive verbs, such as *kiss* in (10), assign the role of agent to the subject argument and the role of patient to the object argument. As discussed above, the way the patient is affected depends on the act intended or caused by the agent. It is therefore lower ranked than the agent and preferred in a position following the higher ranked agent. This ordering coincides with the configurational preferred SO ordering. Moreover, assigning the role of agent to the animate subject argument, the ordering is also consistent with the animate-first preference. Having

Table 1 Three factors relevant for the linearization pattern of the arguments in Dutch

Verb type	Config. order	Thematic dependency	Animacy
Transitive verbs (e.g., *kiss*)	SO	Proto-ag. - Proto-pat. SO	Animate-inanimate SO
Subject-Exp. verbs (e.g., *admire*)	SO	Proto-ag. - Proto-pat. SO	Animate-inanimate SO
Caus.psych verbs (e.g., *amaze*)	SO	Proto-ag.- Proto-pat. SO	Animate-inanimate OS
Unaccus. Psych verbs (e.g., *bevallen, gefallen, please*)	OS	Proto-ag./pat.- Proto-pat. OS	Animate-inanimate OS

In the last three columns on the first line the ordering is presented in terms of the determining factor. The second line represents that same ordering in terms of syntactic function (SO = subject-before-object; OS = object-before-subject; Proto-ag. = proto-agent; Proto-pat = proto-patient; unaccus.= unaccusative; Exp.=experiencer)

three factors that coincide, a rather rigid word order may be expected for the arguments of a transitive verb. An overview of these factors and the related preference rules is given in Table 1.

2.3.2 Subject-Experiencer Verbs

Not all verbs selecting an animate subject assign the role of agent to the subject and the role of patient to the object. For example, the event expressed by the verb *admire* in (3a), does not express an action that is intended or controlled by either participant. It belongs to a special class of the so-called psych verbs, namely the psych verbs assigning the role of experiencer to the subject whereas the other participant is the target of sentience (or undergoer). Because these verbs express the change in psychological state of an experiencer, which is the subject of the sentence, I will refer to this verb class as subject-experiencer verbs (or S.exp). Although the event expressed by the verb is not an intended action, nor is it fully under control of either participant, it is the state of the experiencer that determines the role of the other argument as a target of sentience to be admired, as in (3a). Essential for the dependency of the target on the experiencer is that the subject/experiencer is sentient for the event expressed by the verb, another proto-agent property (for a more elaborate discussion of this issue, see Primus 2002, 2009). The other participant is the target of sentience/emotion, which makes it the dependent argument. Its role in the situation denoted by the verb is determined by the experiencer (i.e., that the picture is admired). This is a clear proto-patient property. Thus although subject-experiencer verbs are not clear transitive verbs, the roles they assign to the subject and object have many properties of respectively the proto-agent and proto-patient. Given the dependency relation between the two participants the order with the experiencer argument preceding the dependent participant is the preferred order. Because the role of experiencer is assigned to the subject, the preference rule that relates to the thematic dependency as a word order determining factor is in line with the preferred

SO order. Given the obligatory selection of an animate subject, the linearization pattern that results from the animacy hierarchy also points towards the SO order. With three factors relating to the same linearization pattern, a rather rigid SO word order can be expected in language usage (see Table 1 for an overview).

2.3.3 Causative Psych Verbs

Besides the class of psych verbs with a subject experiencer, there are two other classes of psych verbs in Dutch: causative psych verbs, and unaccusative psych verbs. Although these two classes of psych verbs are ostensibly the same with both having two arguments and selecting an animate object, they also differ in many respects. After discussing relevant aspects of causative psych verbs, I will point out the differences with unaccusative psych verbs.

Causative psych verbs, such as *verwonderen* 'amaze' in (5), assign the role of experiencer to the animate object. The role of stimulus (or cause) is assigned to the nominative subject. Since it is the subject argument that causes the change of psychological state of the experiencer, it is the experiencer that is affected by the stimulus. As with the other class of psych verbs discussed above, the experiencer needs to be sentient. In the absence of a cause argument, the change of psychological state does not come about, making the experiencer the dependent argument. Notice that with two animate arguments an agentive reading is possible in which the intention of the subject causes the change of psychological state of the experiencer/object. Having an animate or inanimate subject argument that causes the action/event expressed by the verb, the preferred word order is the word order in which the cause/stimulus precedes the experiencer (cf. Broekhuis to appear, 1997; Primus 2002).

However, if there is an animate and inanimate argument, it is the experiencer/object that is animate. According to the animate-first preference, it is the experiencer/object that precedes the inanimate cause/subject resulting in an OS order. Hence, only two out of the three linearization factors relate to the same linearization pattern (see Table 1). Therefore, a less strong preference for SO ordering may be expected for sentences with a causative psych verb in comparison to sentences with a transitive verb or a subject-experiencer verb.

2.3.4 Unaccusative Psych Verbs

The other class of psych verbs selecting an animate object is formed by the so-called unaccusative psych verbs, such as *bevallen* 'please' in Dutch, as in (3), or *piacere* 'please' in Italian (Belletti and Rizzi 1988; Hoekstra 1984; Levin and Rappaport Hovav 2005; Zaenen 1993).[8] These psych verbs are comparable with a German

[8]In English the characteristics of the verb *please* are different. Dowty (1991) analyses *please* as causative (with a causer stimulus) in English (see also Pesetsky 1995 and Iwata 1995). However, Belletti and Rizzi (1988), as well as Grimshaw (1990), consider it to be unaccusative.

class of psych verbs assigning dative case to the object (12a). The experiencer of a causative psych verb is assigned accusative case in German (12b). In contrast to causative psych verbs, unaccusative psych verbs cannot passivize (or pseudopassivize), nor is an impersonal passive possible (Zaenen 1993).[9]

(12) a. *Dem Professor* *gefällt* *der Film.*
[the professor].DAT pleases [the film].NOM
'The movie pleased the professor.'
b. *Der Film* *amusiert* *den Professor.*
[the movie].NOM amuses [the Professor]ACC
'The movie amuses the professor.'

Another difference concerns the thematic dependency as a preference rule for word order. As causative psych verbs, most unaccusative psych verbs assign the role of experiencer to the object argument.[10] However, the subject argument does not initiate the event expressed by the verb, and hence, is not the cause, but rather the target of sentience (cf. Broekhuis 1997). With these types of verbs no agentive reading is possible if the subject is animate. Consequently, it is the subject argument that is the dependent argument. As discussed above, the participant that is the target of sentience depends on the participant that experiences the change in psychological state. Following the ranking on the thematic dependency scale, the independent argument outranks the dependent argument resulting in a word order preference in which the object experiencer argument precedes the subject argument. In case of an animate and an inanimate NP this preferred order goes hand in hand with the animate-first preference. Hence, two out of three determining factors prefer the OS word order possibly resulting in less rigid word order (see Table 1). This analysis is in line with the finding of both SO and OS word order in sentences with unaccusative psych verbs across languages (Belletti and Rizzi 1988).

Notice that although both classes of psych verbs assign the role of experiencer to the object, the thematic dependency of the arguments is different. The experiencer with a causative psych verb depends on the cause or stimulus argument which is the subject of the sentence. With unaccusative psych verbs it seems to be impossible to indicate the cause or stimulus to the one or the other argument, as the subject is the target of emotion rather than the cause that initiate a change of state. This makes the subject the dependent argument, thus supporting a preference for the OS order.

[9] It has often been claimed that the underlying structures of causative and unaccusative psych verbs are different from each other, as well as from agentive verbs. In the current analysis the configurational approach is applied as a linearization factor based on the surface structure, there is no direct need to integrate possible differences in underlying structure. This, however, does not rule out that these possible differences in underlying structure may influence word order preferences and thus the comprehension process. For a more detailed discussion of the possible differences in underlying structure see den Besten (1989); and for a discussion of possible effects of differences in underlying structure see Lamers (2001).

[10] There are some two place predicates with the indirect object being a recipient experiencing the emotion or sentience of the direct object or derived subject with unaccusative psych verb. Hence "recipients can be construed as experiencers" (Broekhuis, to appear: 13–14).

Hence, with more word order determining factors supporting the OS word order, a preference for a linearization with the object preceding the subject may be expected for unaccusative psych verbs. This corroborates the findings of many German studies, reporting an OS preference for sentences with verbs assigning dative case to the object (Bader 2000; Bornkessel and Schlesewsky 2006; Bornkessel et al. 2003). So far, no such preference is reported for Dutch sentences, but as we will see in Sect. 4, the general preference for SO order over OS order in Dutch is less strong for sentences with an unaccusative psych verb than for sentences with other classes of two predicate verbs.

In sum, there are multiple features that are crucial for identifying the subject and object in sentences with two place predicates. Three of these features (number agreement, case marking, selectional restrictions of the verb in combination with the animacy of the arguments) may offer the possibility to unambiguously distinguish the subject and object. However, even in languages with a relative rich case marking system there are many ambiguous sentences. To resolve the puzzle which argument is the subject or the object in these sentences, other mechanisms than clear ambiguity resolution have to come into play. I argued that word order might be a strong cue for getting the arguments right. Following Primus (1998), I analysed the linearization patterns for four different Dutch verb classes with two arguments by deducing three word order determining factors, each of which relates to a preference rule. These factors are configurational structure, preserving dominance relations in animacy, and thematic dependency.

According to this analysis pure transitive verbs and subject-experiencer verbs have the strongest SO-ordering preference. A weaker but still clear preference holds also for causative psych verbs since all but one determining factor lead to this word order. For unaccusative psych verbs two of the three factors support the OS word order, making the SO order the less preferred one. Notoriously, across languages both word orders are used in sentences with unaccusative psych verbs.

3 Ease of Comprehensibility Rating

Under the assumption that a structure with an unmarked or preferred order is easier to comprehend than less preferred or marked structures, it should be possible to apply the outlined multi-factorial approach to explain differences in the difficulty to comprehend sentences with different types of verbs and different word orders. In this section I will present an ease of comprehensibility rating study of which the results will be analysed according the multi-factorial approach of Sect. 2. Before presenting the study, I will first formulate the predictions of this approach.

In the rating study, native speakers of Dutch were asked to rate Dutch embedded clauses in which an animate and an inanimate NP were combined with three different groups of verbs. The first group of verbs consisted of clear transitive and subject-experiencer verbs. They will be labeled agentive verbs. All verbs in this group select an animate subject that is assigned either the role of agent or experiencer. The

Table 2 Examples of sentences used in ease of comprehensibility rating using three different verb groups

NPs	Verb	Sel. Restr.
	Agentive / Subject-Experiencer verbs	Animate subject
an-in	Dat de toerist de stad bezocht …	SO
in-an	Dat de stad de toerist bezocht …	OS
	That the tourist the city visited …	
	Causative psych verbs	Animate object
in-an	Dat de stad de toerist verwonderde …	SO
an-in	Dat de toerist de stad verwonderde …	OS
	That the city the tourist amazed …	
	Unaccusative psych verbs	Animate object
in-an	Dat de stad de toerist beviel …	SO
an-in	Dat de toerist de stad beviel …	OS
	That the city the tourist pleased …	

second group was formed by causative psych verbs. The third group consisted of unaccusative psych verbs. An overview of the verbs and some example sentences are given in Table 2.

According to the multi-factorial approach it may be expected that for sentences with agentive verbs or subject-experiencer verbs the preferred linearization is SO. With all three factors (configurational ordering, animacy dominancy and thematic dependency scale) supporting the same linearization, it may be expected that structures with the OS will be more difficult to comprehend, resulting in a lower rating (for the description of the procedure, see below). For causative psych verbs the preference for the SO order may be expected to be less robust as only two out of the three factors support the SO structure as being the preferred structure. With one factor (i.e., animacy dominancy) supporting the OS structure it may be expected that the OS structure with causative psych verbs will be easier to comprehend than OS structures with agentive verbs. With two (i.e., animacy dominancy, thematic role dependency) out of the three factors supporting the OS word order in sentences with unaccusative psych verbs, it can be expected that the SO structures with this type of verb are more difficult to comprehend than SO structures with the other types of verbs. As can be seen in Table 1, the only sentences that are supported by all three factors are the SO structures with agentive verbs. It may therefore be expected that these structures will be easiest to comprehend, resulting in the highest rating. Moreover, the sentences with unaccusative psych verbs with an OS order can be expected to be easier to comprehend than the OS structures with the other types of verbs, with OS structures with agentive verbs being the most difficult ones.

3.1 Subjects

Forty-five native speakers of Dutch (18–28 years old; 32 female subjects) participated in the rating study. They were paid for their participation (6 euros).

3.2 Material

Dutch embedded clauses with a local structural ambiguity and three different groups of verbs were used. The clauses were formed by combining an animate and an inanimate NP with a verb from each verb group. Presenting the NPs in different word orders (animate-inanimate, inanimate-animate) combined with a verb of each verb group resulted in six conditions. Each verb was combined with six different NP pairs. A pretest was performed to make sure that NP pairs in combinations with the verbs formed equally plausible sentences. In each verb group there were 24 verbs (24 sets of 6 × 6 sentences). The total of 864 sentences were divided over three lists in such a way that all NPs and verbs occurred equally often on each list as well as all conditions were equally divided over lists. The sentences on each list were presented in pseudo-randomized order. To prevent an order effect the pages with approximately 20 sentences were pseudo-randomly mixed. Care was taken that repetitions were kept as far apart as possible. On each list 20 filler sentences were added that were difficult or impossible to comprehend. These filler sentences served as a control to check whether subjects paid attention in rating the sentences.

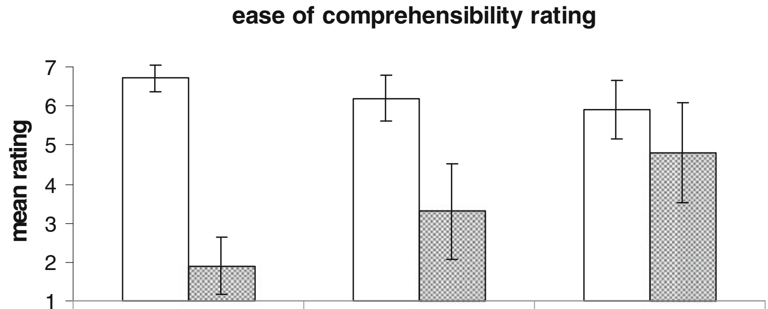
3.3 Procedure

Participants were asked to rate SO and OS embedded clauses on the *ease of comprehensibility* on a scale form 1–7 (1 = very difficult to comprehend, 7 = easy to comprehend). A difference in rating is taken as an indication for a difference in the comprehension process. An instruction presenting some examples that were easy to comprehend with an explanation for a high rating and some examples that were more difficult to understand, as well as an example that was impossible to understand with an appropriate rating and explanation at the beginning of a list, ensured that the participants knew what was meant with *ease of comprehensibility.*

3.4 Results

All subjects rated all filler sentences as extremely difficult to understand (with a rating or 1 or 2), indicating that they understood the instruction and filled out the form seriously.

Figure 1 shows the mean ratings for experimental SO and OS embedded clauses with the three types of verbs. An important observation, similar to the results of an earlier study of Lamers (2001), was a higher rating for SO structures in comparison to OS structures for all three types of verbs, with the highest ratings for SO structures with agentive/subject-experiencer verbs, followed by causative psych verbs and unaccusative psych verbs. Remarkably, for OS structures relatively high ratings were found for unaccusative psych verb structures. OS structures with agentive/



	agentive	causative	unaccusative
□ SO	6,7	6,2	5,9
▨ OS	1,9	3,3	4,8

Fig. 1 Mean ratings of SO and OS embedded clauses with an agentive/subject-experiencer verbs, causative psych verb or an unaccusative psych verb (vertical bars present the standard deviation)

subject-experiencer verbs were rated as most difficult to understand, followed by SO structures with causative psych verbs.

The data were statistically evaluated using mean ratings computed for each condition per subject for the subject analyses, and per item for the item analyses. Two sets of overall repeated measures of analysis of variance (ANOVA)[11] were performed. The first set addresses the syntactic word order with Syntactic word order (SO, OS) and Verb type (agentive/subject-experience, causative psych, unaccusative psych verbs) as the within factors. To address the effects of animacy order a set of analysis was performed with Animacy word order (animate-inanimate, inanimate-animate) and Verb type (agentive/subject-experience, causative psych, unaccusative psych verbs) as the within-subject factors. In both sets of analyses the between subject factor was List, whereas the between item factor was Item group. Since these between factors were not significant nor were there significant interactions including these factors, they were eliminated in the analyses reported in this chapter. The analyses addressing syntactic word order showed significant main effects of Syntactic word order ($F1(1,44)=533.232$, $p<.057$; $F2(1,143)=3774.204$, $p<0.000$) and Verb type ($F1(2,43)=69.539$; $p<.000$; $F2(2,142)=276.239$, $p<0.000$), as well as a significant interaction between these factors ($F1(2,43)=210.210$, $p<0.000$; $F2(2,142)=583.281$, $p<.000$). Also the analysis to address the animacy word order showed marginally significant main effects of Animacy ($F1(1, 44)=3.820$, $p<.057$; $F2(1,143)=22.482$, $p<.000$) and Verb type ($F1(2,43)=69.539$; $p<.000$; $F2(2,142)=27.239$, $p<.000$), as well as a significant interaction ($F1(2,43)=735.729$; $p<.000$; $F2(2,142)=3098.588$, $p<.000$). To follow up on this interaction pairwise

[11]The Huynh-Feldt epsilon correction was used, when evaluating effects with more than one degree of freedom in the numerator to adjust for sphericity violations. The original degrees of freedom and the corrected p-values are reported.

comparisons were performed.[12] Paired *T*-test showed that all conditions differed from each other with T(44) values in between 40.5 and 3.3 ($p < .003$).

Based on the results, it can be concluded that both verb type and word order influence the ease of comprehensibility, with an overall preference for SO over OS order. SO sentences with clear transitive verbs or subject-experiencer verbs were easiest to comprehend. They were followed by SO embedded clauses with causative psych verb. SO clauses with unaccusative psych verbs were rated as being most difficult to comprehend. Thus, although the one factor that supports the SO linearization for sentences with an unaccusative psych verb was outnumbered by the two factors supporting the OS linearization, it turns out that the SO order, as for the other types of verbs, is easier to understand than the OS sentences. OS structures with unaccusative psych verbs were rated as being easiest to comprehend in comparison to the other sentences with the OS order. As predicted, the OS structures with agentive verbs were rated as being most difficult. This ordering in ease of comprehensibility is illustrated in (13).

(13) Comprehensibility ordering:

SO.Ag./Subject-Exp. < SO.Caus. < SO.Unacc. < OS.Unacc. < OS.Caus. < OS.Ag./Subject-Exp.

In the following section, I will further discuss how these results relate to the predictions of the multi-factorial approach.

4 A Multi-factorial Explanation for Differences in Ease of Comprehensibility

To comprehend the Dutch embedded clauses used in the ease of comprehensibility study presented in Sect. 3, it is crucial to distinguish the subject from the object as it resolves the local structural ambiguity. In their model of Incremental Optimization of Interpretation, de Hoop and Lamers (2006) and Lamers and de Hoop (2005) defined five violable constraints that play a role in distinguishing the subject from the object in transitive relations. Following the principles of Optimality Theory (Hendriks and de Hoop 2001) according to which constraints may only be violated to fulfil a higher ranked constraint, the five potentially conflicting constraints were ranked.[13] Among others, a word-by-word (or constituent-by-constituent) comparison between patterns of constraint violations and on-line effects during the comprehension of Dutch transitive sentences with a local structural ambiguity were made

[12] Because of multiple comparisons the level of significant was corrected with level of significance with a T(44) larger than 3.109 and a p-value smaller than .003.

[13] For language processing the optimal interpretation is derived from the hearer's point of view with the direction of optimization from form to meaning.

(c.f., Lamers 2005a, b).[14] Being able to map the constraint violation patterns of different forms onto the on-line results, it was concluded that the five violable constraints provide sufficient information to distinguish the subject and the object in a transitive relation. Moreover, based on these results it can be argued that the way de Hoop and Lamers (2006) defined the constraints, a violation of a constraint reflects some sort of difficulty in language comprehension. Hence, with the right factors being represented as constraints, it should be possible to link differences in ease of comprehensibility to differences in constraint violation patterns. However, so far the model of Incremental Optimization of Interpretation, has only been applied to explain the distinguishability of subjects and objects either in clear transitive relationships, or without taking into account verbs specific characteristics. The definitions of the five constraints used to distinguish the subject from object and their ranking are given below:

(14) Distinguishability constraints (de Hoop and Lamers 2006):

a. AGREEMENT: the verb agrees with the subject
b. CASE: the subject is in the nominative case, the object is in the accusative case
c. SELECTION: fit the selectional restrictions of the verb (animacy)
d. PRECEDENCE: the subject (linearly) precedes the object
e. PROMINENCE: the subject outranks the object in prominence (animacy)

(15) Proposed German/Dutch ranking of the DISTINGUISHABILITY constraints (de Hoop and Lamers 2006):

[AGREEMENT, CASE] ≫ SELECTION ≫ PRECEDENCE ≫ PROMINENCE

Notice that none of the constraints in (14) seem to relate to possible effects of thematic dependency on word order preferences and thus on comprehension difficulties. All other word order defining factors and sources of disambiguating information discussed above are represented by the constraints defined by de Hoop and Lamers (2006).

The three sources of disambiguating information, i.e., number agreement, case and selectional restrictions, are clearly related to the three highest ranked constraints. As was pointed out above, all sentences used in the ease of comprehensibility study had a subject that agreed with the verb, thus fulfilling AGREEMENT. Since in Dutch full noun phrases have no overt case marking CASE does not play a role. Although different groups of verbs had different selectional restrictions, with an animate and an inanimate argument in each sentence and only a restriction on the animacy of one of the arguments, all sentences fulfilled SELECTION.

The first constraint that relates to the linearization is PRECEDENCE, which is fulfilled if the subject precedes the object. Hence all OS structures violate this constraint. This constraint clearly relates to the configurational linearization following the syntactic function hierarchy. With OS structures deviating from the

[14] The time insensitive character of the data obtained in the ease of comprehensibility study in which the participants rated complete sentences, makes the incremental application irrelevant for the current discussion (see de Hoop and Lamers (2006) and Lamers and de Hoop (2005) for more details on the incremental application of the model).

basic word order, and hence probably being more complex and less frequent, it may be expected that structure complexity is also reflected in the ease of comprehensibility rating with lower ratings for OS structures in comparison to SO structures in which PRECEDENCE is satisfied. The other constraint that is concerned with the linearization of the arguments is PROMINENCE. As defined by de Hoop and Lamers (2006) it combines the hierarchical ranking of animacy with syntactic function. It brings together the subject-first preference and the animate-first preference. If PROMINENCE is violated one of these two preferences is not fulfilled. Such a structure is marked in comparison to a structure in which this constraint is satisfied. Processing such a structure will be more costly than an unmarked structure fulfilling both preferences, and hence, will complicate the comprehension process. However, in the experiment there is only one structure that fulfil both these preferences. These are SO sentences with agentive verbs. As it turns out, these sentences were rated as being the easiest to comprehend. However, the way this constraint is defined lacks the ability to differentiate sentences with OS structures with different animacy word orders, as it combines syntactic and animacy word order. This makes the constraint insensitive to influences that are solely based on animacy word order. These structures, however, do differ in ease of comprehensibility (i.e., OS structures with agentive verbs and causative psych verbs). I will therefore propose to adapt this constraint in such a way that it better reflects the influence of animacy dominancy on word order preferences.

As pointed out above, none of the constraints used by de Hoop and Lamers (2006) captures the influence of differences in thematic roles and their dependency. As discussed in Sect. 2, thematic dependency as a word order defining factor seems to be necessary to capture the difference between the two classes of psych verbs. For causative psych verbs linearization follows the SO ordering with the experiencer being the target of sentience/emotion, which depends on the cause argument which is the subject of the sentence. For unaccusative psych verbs the target of sentience is the subject argument which depends on the experiencer object argument. Following the assumption that a structure is marked and thus harder to process if the order of the arguments deviates from the ordering along a scale of prominence, structures in which the dependent argument precedes the argument it depends on, are marked. This results in the following constraint:

(16) THEMATIC DEPENDENCY:

Avoid a word order in which the dependent argument (i.e., target of sentience) precedes the argument it depends on

As can be seen in Table 3, for SO structures with agentive (including subject-experiencer verbs), THEMATIC DEPENDENCY is satisfied because the dependent object argument follows the subject argument. For SO causative psych verbs this constraints is also fulfilled, since it is the object that is the dependent argument. For SO sentences with unaccusative psych verbs this constraint is violated, because it is the initial subject argument that is the dependent argument. The violation of THEMATIC DEPENDENCY may be hold responsible for the slightly but significantly lower rating of these sentences.

Table 3 Constraint violation patterns for SO and SO structures with three different groups of verbs ranked according ease of comprehensibility based on the results of the rating study

	SO. Ag Sbj.-Exp.	SO.Caus.	SO.Unacc.	OS. Unacc	OS.Caus.	OS. Ag Sbj.-Exp.
Rating	6,7	6,2	5,9	4,8	3,3	1,9
SELECTION	✓	✓	✓	✓	✓	✓
PRECEDENCE *Subject-first*	✓	✓	✓	*	*	*
THEMATIC DEPENDENCY	✓	✓	*	✓	*	*
PROMINENCE (adapted) *Animate-first*	✓	*	*	✓	✓	*

OS sentences with unaccusative psych verbs satisfy THEMATIC DEPENDENCY, but as we have seen, PRECEDENCE is violated, resulting in a lower rating than the SO sentences. Finding a lower rating for OS sentences with unaccusative psych verbs than for SO sentences with unaccusative psych verbs indicates that a violation of PRECEDENCE has a larger impact on the ease of comprehensibility than a violation of the thematic dependency constraint. This indicates that PRECEDENCE should be ranked higher than THEMATIC DEPENDENCY.

OS sentences with causative psych verbs, as well as with agentive verbs, not only violate PRECEDENCE but also THEMATIC DEPENDENCY. This violation of both constraints explains why the rating of these sentences is lower than of the OS unaccusative psych verb sentences in which thematic dependency is satisfied. It, however, does not explain why there is a significant difference between the OS sentences with the causative psych verbs and the group of agentive and subject-experiencer verbs. By relativizing the definition of PROMINENCE to word order, such that it mainly reflects the animate-first preference, these two forms can be distinguished.

(17) PROMINENCE:

the argument highest in prominence (animacy) precedes the argument that is lower in prominence (animacy)

OS sentences with a verb selecting an animate subject violate PROMINENCE, whereas OS sentences with verbs selecting an animate object satisfy this constraint. As a result, we can explain the observed difference.

5 Conclusion and Future Directions

In this chapter, I have argued that linearization of arguments in sentences with different types of verbs is a multi-factorial phenomenon. More specifically, I have shown that with four violable constraints it is possible to explain differences in ease of comprehensibility between Dutch SO and OS embedded clauses with different types of verbs and an animate an inanimate argument. The four constraints reflect disambiguating information such as selectional restrictions, as well as word order defining factors including ordering along the syntactic function hierarchy, animacy dominancy and thematic dependency. It goes beyond the previous explanations addressing differences in the comprehension of sentences with a local structural ambiguity (e.g., the model of Incremental Optimization of Interpretation) as it includes a factor that specifically addresses the difference in thematic role assignment by the verbs in combination with the dependency between the arguments.

Under the assumption that differences in comprehension reflect differences in word order preferences, the findings support the proposal of Primus (1999) that the word order of arguments is a multi-factorial phenomenon. To test the multi-factorial approach I have evaluated the results of an ease of comprehensibility rating study in Dutch including sentences with different word orders and different types of verbs. I started off by using the set of violable constraints that was defined by de Hoop and Lamers (2006). As it turned out, for a full explanation of the data constraints had to be defined in such a way that they reflect each of the different prominence hierarchies represented in the multi-factorial approach separately. Besides the constraint that was called SELECTION and relates to fulfilling the selectional restrictions of the verb, which is necessary for the disambiguation of the sentences, there were three other constraints: PRECEDENCE which relates to the linearization according to the prominence in syntactic function; PROMINENCE tapping on the linearization according the animacy dominancy; and THEMATIC DEPENDENCY, reflecting the ordering according their proto-role properties as well as their thematic dependency.

The proposal presented in this chapter is not the only approach that integrates different prominence dimensions to explain differences comprehension of structures with different argument realizations. Recently, Bornkessel-Schlesewsky and Schlesewsky (2009) have argued for a prominence based perspective in their extended Argument Dependency Model. The prominence perspective and the way it is applied in the model show similarities, but also some differences with the multi-factorial approach presented in this chapter. For instance, the constraints used in the present chapter were ranked. Under the assumption that a higher ranked constraint is more important and might therefore be of more influence on the comprehension process, the ranking may reflect some sort of quantitative difference between the constraints, and thus between the different prominence dimensions. So far, Bornkessel-Schlesewsky and Schlesewsky do not provide a specific explanation of mechanisms that rank or weigh the constraints. The extended Argument Dependency Model is a neurotypological framework which is suitable to accommodate both the identification of neurological structure involved in the comprehension processes of argument structure of languages of the world, as well as the time course of these processes. However, Lamers and de Hoop have repeatedly shown that their model of Incremental Optimization of Interpretation can be applied incrementally to successfully identify, distinguish and explain different comprehension processes in different languages (de Hoop and Lamers 2006; Lamers and de Hoop 2005; Lamers et al. submitted). With some small adaptations to accommodate the constraints to refer to the different factors that play a role in argument linearization (i.e., the elaboration of including a constraint referring to the thematic dependency, and changing the definition of PROMINENCE), it should be possible to evaluate the differences in comprehension of sentences with different types of verbs on a word-by-word basis, thus addressing each critical time point in real-time processing.

To conclude, I hope to have shown that the multi-factorial approach in which different prominence dimensions are represented, as well as other word order defining factors, such as disambiguating information, provides suitable means to gain more insight in argument linearization and the comprehension of argument structure.

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Case Inversion in Georgian: Syntactic Properties and Sentence Processing

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1 Preliminaries

That the human sentence processing mechanism makes use of all available cues for grammatical function assignment and structure building in incremental sentence processing is a very natural assumption that has been confirmed in a number of experimental studies. MacWhinney et al. (1984) were among the first showing this by demonstrating that overt case marking, morphological agreement information and syntactic position are used to different degrees in different languages in a sentence interpretation experiment.

Early online-studies concerned with the effect of explicit morphological marking used morphological information that is (relatively) unambiguous in nature. For example, Krems (1984) found increased reading times for German sentences beginning with an NP unambiguously marked for the accusative case that almost always marks direct objects only (as compared to sentences beginning with a nominative noun phrase), a result later confirmed by Hemforth (1993) and Fanselow

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et al. (1999a), see also Felser et al. (2003), Fiebach et al. (2002) for related ERP-based results.

Unambiguous case marking need not, however, indicate the grammatical function and/or structural position of the NP bearing it in an unambiguous way. While subjects are marked with the nominative case and indirect (second) objects with the dative case in a language like German, the correlation is not a biunique one, since nominative and dative NPs occur in the position of direct (first) objects, too – the former do so in passive and unaccusative contexts, the latter do so when they instantiate idiosyncratic case frames of a number of verbs such as *helfen* 'help'. The question arises whether (and if so, how) explicit morphological information that is syntactically ambiguous is used in online sentence processing.

Recent results of Bornkessel et al. (2002, 2003) suggest that such information is put to use and in a way much reminiscent of ambiguous structural information: morphological cases are linked to interpretation preferences that can be expressed in various ways, either as inviting hypotheses concerning the relative thematic position of the NP arguments (such that nominative NPs are preferentially interpreted as the highest argument of a predicate) as in the proposal of Bornkessel et al., or as preferences for the location of the NPs in the structural representation of the clause; for instance, datives trigger a default placement into the indirect object position (the specifier of VP in certain recent syntactic models, see, e.g., Chomsky 2005), while nominatives are preferentially located in the subject position (the specifier of vP in such models).

As suggested by the findings of Bates et al. (1982), languages seem to make use of morphologically explicit but syntactically ambiguous case information to different degrees. Röhm et al. (2007) present electrophysiological evidence for the claim that morphological case plays a very minor role in the online processing of Icelandic, a language with rigid constituent order and a rich morphological case system showing very little correspondence between case and grammatical function. This property contrasts with the apparently strong impact of the morphological case in German, in which there is at least a set of implicative relations between the case and grammatical function (if subject then nominative, if indirect object then dative, if accusative then direct object).[1] In addition, German differs from Icelandic in being a language with flexible constituent order, i.e. deviations from the basic order are possible under particular configurations of semantic and pragmatic conditions.

In the present paper, we will consider the influence of explicit case marking on sentence processing in Georgian. Georgian may help us to disentangle the reasons for the different treatment of case in German and Icelandic. Just like German, Georgian is a flexible word order language. Thus, if the availability of scrambling is the factor that differentiates German from Icelandic with respect to the role of case in online processing, Georgian and German should behave alike in the latter domain as well. On the other hand, there is no overwhelming correspondence between the explicit case and grammatical function in Georgian. The case affix labeled as 'dative' in Georgian grammar appears with direct and indirect objects, as well as with struc-

[1] Exceptions to these generalizations (e.g., verbs with two accusative objects, verbs with genitive and accusative) are lexically conditioned.

tural subjects. Nominative case affixes appear with subjects and direct objects. Ergative affixes occur with actor phrases in the aorist tense. The crucial point from the viewpoint of sentence processing is whether there is a uni-directional case-to-argument association, i.e., if the processing of the inflectional properties of the arguments allows for unambiguous inferences concerning their syntactic function (if case *C*, then function *F*), independently of any additional information (such as lexical information or the inflectional properties of the verb). In turn, the ergative is the only case linked to grammatical function (if ergative, then subject). Given that the ergative is a peripheral case (it shows up with the aorist only) and that indirect objects are a rare category, one can argue that Georgian is closer to Icelandic than to German with respect to the grammatical interpretation of case, which may trigger parallels in case of processing if that aspect of the morphology-syntax correspondence is relevant.

In order to assess the role of explicit case information in the processing of Georgian, we carried out two reaction time experiments (see Sect. 3). In particular, we examined the role of case inversion that is exemplified in (1). Depending on the inflectional properties of the verb (conjugation class and tense), arguments in Georgian show two different case-marking patterns (among others): in the direct pattern, which is illustrated in (1a), the nominative marked constituent bears the θ-role of an actor and the undergoer constituent bears an oblique case, namely the dative; in the inverse pattern, which is illustrated in (1b), the actor constituent bears the dative case, while the nominative argument is the undergoer.

(1) a. *ǯarisk'ac-i monadire-s da-č'r-i-s.*
soldier-NOM hunter-DAT PR(FUT)-cut-THM-S.3.SG
'The soldier will wound the hunter.'

b. *ǯarisk'ac-s monadire*
soldier-DAT hunter(NOM)
da-u-č'r-i-a.
PR(PFV)-(INV.S.3)PV-cut-PRF-INV.O.3(INV.S.SG)
'The soldier has wounded the hunter.'

The structure of the article is as follows. Section 2 outlines the Georgian case system with particular emphasis on the morphological and syntactic phenomena that contribute to our understanding of case inversion. Based on the conclusions of this grammatical account, Sect. 3 presents an experimental study on the processing of Georgian sentences with the case-marking patterns illustrated in (1).

2 Grammatical Facts on Case Inversion

2.1 The Case System of Georgian

In interaction with aspectual/modal categories, Georgian verb (conjugation) classes license three different case-marking patterns, which are presented in Table 1 (see Harris 1981:1, Blevins 2005). The roles indicated in this table should be understood

Table 1 Proto-roles and case-marking patterns

Case-marking pattern	Actor	Undergoer	Goal
A	Ergative	Nominative	Dative
B	Nominative	Dative	Dative
C	Dative	Nominative	(Postpositional)

as abstractions out of the θ-roles ('proto-roles' in the sense of Dowty 1991). An 'actor' stands for the highest participant involved in the event, who may be an agent or an experiencer depending on the event at issue; the 'goal' encompasses recipients and beneficiaries; the 'undergoer' is the participant that is affected or effected through the event or the (non-agentive) stimulus of an experiential event.

The case affix labeled 'dative' is the product of case syncretism between accusative and dative (this affix is labeled 'dative' following the Georgian grammatical tradition, see Tschenkéli 1958; Harris 1981; Hewitt 1995 among others). Synchronically, this affix shows mixed properties as will be exemplified below: when it is licensed by thematic properties, it is used for the marking of goals and non-volitional actors, which is a function reminiscent of the dative in Indo-European languages; when it is structurally licensed, it marks the lower argument, hence having the properties of an accusative. The case affix labeled 'ergative' (also called 'narrative' in Georgian grammar; see Harris 1990, 1993; Hewitt 1987) marks actors.

The case-marked arguments are cross-referenced on the verb through person affixes. In patterns A and B, two sets of affixes are used for the cross-reference of the actor, undergoer and goal constituents.[2] In pattern C, the nominative argument corresponds to the affix set that marks actors in the other patterns and the dative argument to the affix set that marks goal constituents in the other patterns, whereby the postpositional goal is not cross-referenced at all, which shows that it has adjunct status.

Case-marking patterns are determined by the verb (conjugation) class in interaction with its tense/aspect/mood properties. Following the Georgian grammatical tradition, inflectional categories are classified into three series (or 'screeves'): *Series I*: present (indicative/subjunctive), future (indicative/subjunctive), imperfect, conditional; *Series II*: aorist indicative, optative; and *Series III*: present perfect, pluperfect. Georgian verbs are divided into four conjugation classes that – in interaction with the series – determine different case-marking patterns for the clausal arguments as presented in Table 2. Class membership is not fully predict-

[2] The sets of affixes display many instances of overlap, in particular whenever two argument markers compete for a single available slot. Without proceeding into details, the resolution of these conflicts is determined by the interaction of morphotactic constraints and constraints derived by the person and argument hierarchies (see detailed account in Anderson 1984).

Table 2 Case marking in classes and series (see Harris 1981:2, 118)

	Series I	Series II	Series III
Classes 1&3	B	A	C
Class 2	B	B	B
Class 4	C	C	C

able by the semantic properties of the verb (see Aronson 1989) but some rough correlations with syntactic/semantic properties are identifiable (see Harris 1981:228 ff.): class 1 mainly contains active transitive verbs and a large class of derived causatives; class 2 contains unaccusatives, analytic passives that are formed with the class 2 verb *ikneba*, as well as synthetic passives with change of state semantics; class 3 contains unergative verbs and class 4 mainly contains verbs with a non-volitional actor.

The following examples illustrate the facts about case marking. Example (2) illustrates the case patterns of a class 1 verb. The present form (series I) in (2a) licenses case-marking pattern B, the aorist form (series II) in (2b) licenses pattern A and the perfect form (series III) in (2c) licenses pattern C.

(2) a. Class 1, pattern B
dato *nino-s* *c'ign-s* *a-čuk-eb-s.*
Dato(NOM) Nino-DAT book-DAT (IO.3)PV-donate-FUT-THM-S.3.SG
'Dato will give a book to Nino (as a present).'

b. Class 1, pattern A
dato-m *nino-s* *c'ign-i* *a-čuk-a.*
Dato-ERG Nino-DAT book-NOM (IO.3)PV-donate-AOR.S.3.SG
'Dato gave a book to Nino (as a present).'

c. Class 1, pattern C
dato-s *nino-s-tvis* *c'ign-i*
Dato-DAT Nino-GEN-for book-NOM
u-čuk-eb-i-a.
(INV.S.3)PV-donate-THM-PRF-INV.O.3(INV.S.SG)
'(Apparently) Dato has given a book to Nino (as a present).'

Two classes of verbs deviate from the basic pattern illustrated in (2), as shown in (3). These verbs license an invariable case-marking pattern that is not influenced by the tense properties of the verb. Examples (3a–b) illustrate the syntactic behavior of a class 2 verb that licenses pattern B and a class 4 verb that licenses pattern C.

(3) a. Class 2, pattern B
dato *nino-s* *elodeba/daeloda/dalodebia*
Dato-NOM Nino-DAT (IO.3)wait(S.3.SG) (present/aorist/perfect)
'Dato waits/waited/has waited for Nino.'

b. Class 4, pattern C
dato-s *nino* *sʒuls/sʒulda/*
Dato-DAT Nino(NOM) (INV.S.3)hate(INV.O.3/INV.S.SG) (present/past)
sʒulebia.
(SINV.3)hate(OINV.3/SINV.3.SG) (perfect)
'Dato hates/hated/has hated Nino.'

Turning back to the question whether Georgian displays uni-directional case-to-argument associations, the data presented in this section show that nominative and dative affixes are mapped to different arguments, which imply that they are only probabilistic predictors for argument structure. The only Georgian case that is uni-directionally associated with a particular θ-role is the ergative.

2.2 Inherent vs. Structural Cases

In line with recent accounts of Georgian case marking (Joppen-Hellwig 2001; Blevins 2005), we assume two distinct layers of case licensing, a non-structural and a structural one. The non-structural layer encompasses cases that are either determined by the role properties of the argument (inherent case), or are idiosyncratically stipulated by particular verbal heads through lexical specification (lexical case) (see Chomsky 1981; Fanselow 2000, 2002; Stiebels 2000: 46–55; Butt and King 2005; Woolford 2006: 111, among others). The structural layer applies to the set of eligible arguments that do not receive case through a lexical or thematic rule. At this layer, case is licensed in a hierarchical manner, such that the highest eligible argument receives the highest available case (following the hierarchy nominative > accusative > dative) (see Wunderlich 1997; Stiebels 2000). Depending on the theoretical framework, the argument hierarchy is either determined by the embeddedness in the syntactic configuration or by the hierarchy of theta roles (see a comparison of the alternative accounts in Fanselow 2000).

Our basic assumptions concerning the Georgian case marking system are given in Table 3 (based on previous accounts in Joppen-Hellwig 2001; Blevins 2005). Non-structural cases are specified either through lexical specification of the verbal head (this holds for dative$_{\lambda}$ in the B_3 pattern) or through the thematic properties of the arguments (see dative$_{\theta}$ in all other cases). The case marking of the remaining arguments is subject to structural licensing (marked as *s* in Table 3). Structural licensing takes place in a hierarchical manner, such that the highest case (nominative > dative) marks the highest eligible argument (actor > undergoer). The crucial difference of Table 3 with respect to the account of case inversion is that it distinguishes between a subclass of case-marking pattern B that involves a structurally marked dative undergoer (B_1) and another subclass of the same case-marking pattern that involves a non-structurally marked dative under-

Table 3 Layers of case licensing[a]

Case-marking pattern	Actor	Undergoer	Goal
A_1 (class 1, series II)	Ergative_θ	s_H	Dative_θ
A_2 (class 3, series II)	Ergative_θ	–	Dative_θ
B_1 (class 1, series I)	s_H	s_L	Dative_θ
B_2 (class 3, series I)	s_H	–	Dative_θ
B_3 (class 2)	s_H	Dative_λ	$(\text{Postpositional})_\theta$
C_1 (class 1/3, series III)	Dative_θ	s_H	$(\text{Postpositional})_\theta$
C_2 (class 4)	Dative_θ	s_H	–

[a] x_θ inherent case; x_λ lexical case; s_H structural case, higher in the argument hierarchy; s_L structural case, lower in the argument hierarchy

goer (B_2). Furthermore, Table 3 contains some additional information about the classes of verbs that do not occur with all three arguments, which is abstracted away in Table 1.

Evidence for the assumptions in Table 3 comes from three types of phenomena that are discussed in the following sections: (a) thematic relatedness of the non-structural cases (see Sect. 2.3), (b) eligibility for A-movement (see Sect. 2.4) and (c) stratal uniqueness effects (see Sect. 2.5). A further diagnostic for the non-structural case is the occurrence of case preservation effects under A-movement: an argument with a non-structural case does not change case properties when it undergoes such operations as passivization or raising (see Yip et al. 1987: 225; Woolford 2006: 118). Previous literature on Georgian shows that case preservation effects cannot be diagnosticized in this language, since passivization is either not possible or involves a change of verb class and raising constructions are formed on the basis of non-finite verb forms (see Harris 1981: 156–167).

2.3 *Thematic Relatedness*

Cases that are licensed by a thematic rule are restricted to a particular range of thematic relations to the verbal head. This is quite straightforward for the marking of goal (recipient and beneficiary) arguments in patterns A and $B_{1/2}$. That the licensing condition goal → dative_θ fails to apply for pattern C_1 is an effect of stratal uniqueness that is discussed in Sect. 2.5.

The case affix labeled ‘ergative’ is thematically related to the actor role, a fact that is extensively discussed by Harris (1990). Licensing the ergative affix in series II depends on the thematic properties of the argument: it marks actors of either transitive (class 1) or unergative (class 3) verbs but not undergoers of either transitive (class 1) or unaccusative (class 2) verbs. The thematic relatedness of the ergative affix in Georgian suggests that it is not a structural case.

The dative$_{\theta}$ in pattern C occurs with two types of arguments. First, it marks actors of class 4 verbs that share in common that they do not exercise volitional control on the event (in most part, these arguments are experiencers). Evidence for the non-volitionality of these arguments is provided through distributional diagnostics: the occurrence of an adverb that requires the volitional involvement of the actor is not acceptable with class 4 verbs, see (4).

(4) Class 4, pattern C$_2$

#dato-s	*nino*	*ganzrax*	*s-ʒul-s.*
Dato-DAT	Nino(NOM)	purpose	INV.S.3-hate-INV.O.3(INV.S.SG)

'Dato hates Nino on purpose.'

Furthermore, the dative$_{\theta}$ in pattern C marks actors of transitive verbs in series III (perfect tense). The perfect in Georgian involves stative aspect and has epistemic properties: the speaker asserts that he has not direct evidence that the conveyed proposition took place. These aspectual/modal properties do not exclude volitional actors, as shown through the grammaticality of example (5) that involves a Class 1 verb in the perfect tense and an adverb asserting the volitional involvement of the actor constituent. However, native speaker intuitions suggest that utterances in the perfect tense involve an assertion about the truth value of a particular proposition letting the volitional or non-volitional involvement of the speaker unspecified (see Harris 1981; Asatiani and Ivanishvili 2007 for further discussion). Some indirect distributional evidence comes from the interaction with negation. Negative facts in the past are encoded in the perfect, while positive facts are encoded in the aorist (see Joppen-Hellwig 2001: 142).

(5) Class 1, series III, pattern C$_1$

dato-s	*nino-s-tvis*	*c'ign-i*	*ganzrax*
Dato-DAT	Nino-GEN-for	book-NOM	purpose

u-čuk-eb-i-a.
(INV.S.3)PV-donate-THM-PRF-INV.O.3(INV.S.SG)
'(Apparently) Dato has given Nino a book (as a present) on purpose.'

The dative$_{\lambda}$ in pattern B$_3$ is a lexical case, i.e., it is lexically determined by the verbal head. Thematically, these arguments are undergoers, which is in line with the view that case licensing by the verbal head can only apply within the VP proper (see Fanselow 2000; Woolford 2006). That the undergoer-dative in pattern B$_3$ (class 2 verbs) is licensed differently than the undergoer-dative in pattern B$_1$ (class 1 and 3 verbs) is supported by evidence from stratal uniqueness effects that are discussed in Sect. 2.5.

2.4 A-movement

The data discussed in the following reveal a contrast with respect to the eligibility of particular arguments for A-movement of the passive type. This contrast gives empirical support to the distinction between two subclasses of verbs that occur with the case marking pattern B: class 1 verbs and class 2 verbs. Passivization of Class 1 verbs (case-marking pattern B_1) is illustrated in (6). The undergoer-dative in (6a) is not preserved under A-movement (passivization) in (6b), which supports the view that case marking is structurally licensed in this class: the highest argument in the configuration receives the nominative case (see also Tuite 1987).

(6) Class 1, series I, pattern B_1

a. *nino* *vano-s* *č'r-i-s.*
Nino(NOM) Vano-DAT wound-THM-S.3.SG
'Nino wounds Vano.'

b. *vano* *i-č'r-eb-a* *(nino-s* *mier).*
Vano(NOM) PASS-wound-THM-S.3.SG Nino-GEN by
'Vano is wounded (by Nino).'

Class 2 verbs (case-marking pattern B_2) do not allow for A-movement of the passive type, as illustrated in (7). The difference between the two verb classes relates to the fact that the higher ar gument of class 2 verbs does not have agentive properties (see also discussion of similar facts from Icelandic in Yip et al. 1987: 225). A large subset of the verbs in this class consists in deponentia.

(7) Class 2, pattern B_3

a. *nino* *vano-s* *st'umr-ob-s/*
Nino(NOM) Vano-DAT (IO.3)visit-THM-S.3.SG
e-čxub-eb-a.
(IO.3)PASS-fight-THM-S.3.SG
'Nino is visiting/fighting with Vano.'

b. **vano* *nino-s* *mier* *i-st'umr-eb-a/*
Vano(NOM) Nino-GEN by PASS-visit-THM-S.3.SG
i-čxub-eb-a.
PASS-fight-THM-S.3.SG
(intended) 'Vano is visited/fighted by Nino'.

These data support the view that the case-marking pattern B subsumes two superficially identical but qualitatively different subtypes: subtype B_1 involves a higher argument with agentive properties and a lower argument that is structurally marked for the dative case; subtype B_3 involves a higher argument without agentive properties and a lower argument that is marked for the dative case through the lexical specification of the verb.

2.5 *Stratal Uniqueness*

Stratal uniqueness requires that the case-to-argument correspondences at each layer of case licensing are biunique, i.e., that case affixes within each layer are unambiguously associated with one and the same argument (see Perlmutter and Postal 1986:

Table 4 Case licensing of causative verbs

		Causer	Actor/causee	Undergoer	Goal
A_1	Basic		Ergative_θ	s_H	Dative_θ
	Causative	Ergative_θ	Dative_θ	s_H	$\text{(Postpositional)}_\theta$
B_1	Basic		s_H	s_L	Dative_θ
	Causative	s_H	Dative_θ	s_L	$\text{(Postpositional)}_\theta$
C_1	Basic		Dative_θ	s_H	$\text{(Postpositional)}_\theta$
	Causative	Dative_θ	$\text{(Postpositional)}_\theta$	s_H	$\text{(Postpositional)}_\theta$

92, Stiebels 2000: 64, Blevins 2005). The fact that the same case affix may occur on two different arguments in certain patterns (see dative affix on the undergoer and goals in pattern B) but cannot occur on two different arguments in other patterns (see dative affix on actors but not on goals in pattern C) reveals that case licensing of the latter arguments – but not of the former – takes place within the same licensing layer. Following the assumptions in Table 3, double occurrence of the dative affix is not banned when the undergoer dative is structurally licensed and the goal dative is thematically licensed, as in pattern B_1 but is excluded when both arguments bear a non-structural case, as in pattern C_1.

Previous accounts that subsume class 1 and class 2 verbs under the same case-marking pattern (see pattern B in Table 1) do not mention the fact that the addition of a dative goal is only possible for class 1 and 3 verbs (see Table 3). A goal constituent with class 2 is not encoded through the dative case but is headed by a postposition, as exemplified in (8a–b).

(8) Class 2, pattern B_3

a. *nino* *vano-s* *šesaxeb* *dato-s*
Nino(NOM) Vano-GEN about Dato-DAT
e-lap'arak'-eb-a.
(IO.3)PASS-speak-THM-S.3.SG
'Nino is speaking with Dato about Vano.'

b. **nino* *vano-s* *dato-s* *e-lap'arak'-eb-a.*
Nino(NOM) Vano-DAT Dato-DAT (IO.3)PASS-speak-THM-S.3.SG

Further evidence for stratal uniqueness is provided by causative verbs, which are class 1 verbs independently of the conjugation class of the base verb (see Harris 1981:132).[3] The facts from class 1 verbs in the three case-marking patterns are presented in (9).

[3] Hence, causativization can be only used as a diagnostic for the case properties that depend on inflection within class 1.

(9) a. Class 1, series I, pattern B_1

soso	*dato-s*	*nino-s-tvis*	*c'ign-s*
Soso(NOM)	Dato-DAT	Nino-GEN-for	book-DAT

a-čuk-eb-in-eb-s.
(IO.3)PV-donate-THM-CAUS-THM-S.3.SG
'Soso makes Dato give Nino a book (as a present).'

b. Class 1, series II, pattern A_1

soso-m	*dato-s*	*nino-s-tvis*	*c'ign-i*
Soso-ERG	Dato-DAT	Nino-GEN-for	book-NOM

a-čuk-eb-in-a.
(IO.3)PV-donate-THM-CAUS-AOR.S.3.SG
'Soso made Dato give Nino a book (as a present).'

c. Class 1, series III, pattern C_1

soso-s	*dato-s-tvis*	*nino-s-tvis*	*mi-sa-cem-ad*
Soso-DAT	Dato-GEN-for	Nino-GEN-for	PR-PTC-give-ADV

c'ign-i
book-NOM
u-čuk-eb-in-eb-i-a.
(INV.S.3)PV-donate-THM-CAUS-THM-PRF-INV.O.3(INV.S.SG)
'(Apparently) Soso has made Dato give Nino a book (as a present).'

Table 4 summarizes the case-marking patterns presented in (9a-c) in comparison to the basic patterns of Table 3. The causee argument is marked by an inherent dative in patterns A_1 and B_1, hence it excludes the use of the dative for the goal constituent in both patterns and it does not conflict with the structural dative marking of undergoers in pattern B_1. In pattern C_1, the inherent dative of the causer does not allow for a second inherent dative for the causee, which is rendered through a PP instead.

2.6 Summary

This section has shown that there are two distinct and ordered layers of the licensing case: the first layer is non-structural and determines the case according to case-marking information in the subcategorization frame of the verb. In the second layer, case marking is structural, i.e., it is determined by the position of the argument in the syntactic configuration. The two layers are ordered, since structural case marking applies to those arguments that do not already bear a non-structural case.

The crucial point of the account sketched in the previous sections is that the contrast between the direct and inverse patterns is not the result of a symmetric mutual exchange of the case marking of the arguments. Direct case marking arises when both actor and undergoer receive case properties from the structural configuration, whereas inverse case marking arises when the actor is not eligible for structural case marking. This view implies that the dative affix has a twofold contribution to the case system: in the direct case marking of class 1 verbs, the dative of the direct object is the morphological exponent of the lower structural case (hence it functionally corresponds to the accusative); the dative affix of inverse actors or indirect objects is a non-structural case.

It has to be noted that there is *no syntactic evidence that case marking affects argument asymmetries*. The facts from word order (Skopeteas and Fanselow 2009, 2010), from control predicates and from binding properties (see Harris 1981; Asatiani 1982; Amiridze 2005, 2006; McGinnis 1997, 2004) provide evidence for argument asymmetries that suggest a hierarchical syntactic structure, such that actor > undergoer. In all these phenomena, whenever evidence for a syntactic asymmetry is available, it holds that $\{NP_{NOM} > NP_{DAT}\}$ in the direct case-marking pattern and $\{NP_{DAT} > NP_{NOM}\}$ in the inverse case-marking pattern, which amounts to saying that {actor > undergoer} holds across case-marking patterns, or simply that case marking does not interact with argument asymmetries.

3 Syntactic Processing of Case

3.1 Preliminaries

The aim of this section is to formulate the observations in Sect. 2 in terms of optimality theoretical constraints in order to derive predictions concerning the processing of Georgian sentences. We subsume the licensing conditions for inherent and lexical cases under a common constraint that prevents deviations from the specifications carried by the verbal head. This constraint applies on pairs of the form {role → case} that correspond to the non-structural cases licensed by the verbal head (either lexically or through its inflectional properties). The relevant pairs for the marking of actor and undergoer are two: {actor → dative$_{\theta}$ (class 4 verbs, perfect series of class 1 verbs), undergoer → dative$_{\lambda}$ (class 2 verbs)}. The constraint on the selectional properties is formulated in (10) and is not violable in Georgian.

(10) Constraint I: SELECTION
Do not violate specifications of the predicate concerning non-structural case licensing.

Structural case marking is strictly determined by locality, i.e., the highest eligible (non-structurally case marked) argument receives the highest case. This condition is formulated in terms of a violable constraint that ranges over two ordered sets: the set of arguments {external, internal} and the set of morphological cases {nominative, dative} and bans disharmonic alignments between these hierarchies.

(11) Constraint II: LOCALITY
Do not mark the highest argument with the non-highest eligible structural case.

Word order is a probabilistic cue for grammatical functions in Georgian. Actors precede undergoers in the canonical word order but deviations from this order are possible – though contextually restricted (see in particular Harris 1981; Apridonidze 1986; Asatiani 2007, 2008; Skopeteas et al. 2009; Skopeteas and Fanselow 2009, 2010). Notably, undergoer constituents may scramble over actor constituents, when the former but not the latter are discourse-anaphoric. In view of these facts, we assume that the default interpretation of an {argument, argument} chain will be {actor, undergoer}. These facts are straightforwardly captured by a violable constraint that bans deviations from the canonical word order (in the sense of Grimshaw 1997).

(12) Constraint III: STAY
Do not move.

The constraints above apply in strict order (see ranking in (13)). The constraint SELECTION is not violable, i.e., violations of the selectional properties of the verbal head lead to non-grammatical expressions. Structural case licensing has the status of an elsewhere condition, i.e., it applies on the subset of arguments that do not bear a non-structural case. This asymmetry is captured through the constraint ranking: SELECTION dominates LOCALITY. Word order is dominated by the case licensing constraints, since scrambling object constituents over subject constituents is always possible – and indeed frequently attested. .

(13) SELECTION >>LOCALITY >>STAY

Optimality theoretical constraints refer to the choice of an optimal candidate among a set of possible structures, hence they straightforwardly apply on language production. In the context of our investigation, these constraints are used in order to account for data from language processing, which requires the above constraints to be part of the hearer's model. The underlying assumption is that *the hearer assumes that the speaker observes the constraints and their ranking*.

3.2 Incremental Optimization

In sentence comprehension, the hearer incrementally develops assumptions about clause structure that are derived by the constraint interaction in (13) and these assumptions are subject to revision during the incremental parsing of the utterance (see Fanselow et al. 1999b and the model of incremental optimization in De Hoop and Lamers 2006). At the time point <t_1> of the utterance in (14), the speaker has processed the case and word order properties of two lexical NPs (i.e., NP_{NOM} NP_{DAT}). His/her assumptions about clause structure at this time point are determined by LOCALITY and STAY. Both constraints suggest that the nominative and first NP is the actor constituent (see Tableau 1). At the time point <t_2>, the speaker has processed the verb. The verb belongs to class 1/series I, i.e., it does not license any inherent case and SELECTION is vacuously satisfied. Hence, the optimal interpretation in <t_1> is identical to the optimal interpretation in <t_2>.

Tableau 1 ACT → nom&first, V: class 1, series I; see (14)

NP_{NOM} NP_{DAT}…	…V			
<t_1>	<t_2>	Selection	Locality	Stay
☞ ACT → nom&first	☞ ACT → nom&first			
ACT → dat&non-first	ACT → dat&non-first		*	*

(14) Class 1, series I, pattern B_1
ǯarisk'ac-i *monadire-s* *da-č'r-i-s.*
soldier-NOM hunter-DAT <t_1> 'will wound' <t_2>
'The soldier will wound the hunter.'

Though superficially identical, the situation with class 2 verbs is slightly different (see (15)). Verbs of this class are lexically specified for a dative undergoer, hence the input at <t_2> involves the information that the undergoer bears dative$_\lambda$. By consequence, Selection applies at <t_2>, reinforcing the assumption already made by Locality and Stay at <t_1>.

(15) Class 2, pattern B_3
ǯarisk'ac-i *monadire-s* *e-lod-eb-a.*
soldier-NOM hunter-DAT <t_1> 'waits' <t_2>
'The soldier waits for the hunter.'

In sentence (16), the NP_{DAT} NP_{NOM} order creates a conflicting situation at <t_1>: Locality predicts that the actor is the nominative argument, while Stay makes the opposite prediction. The conflict at <t_1> is resolved by the constraint ranking in favor of the former prediction and this option is confirmed at <t_2>, since the class 1 series I verbal head does not license any inherent argument and Selection is vacuously satisfied.

(16) Class 1, series I, pattern B_1
monadire-s *ǯarisk'ac-i* *da-č'r-i-s.*
hunter-DAT soldier-NOM <t_1> 'will wound' <t_2>
'The soldier will wound the hunter.'

Selection applies with a class 2 verb (see (17) and Tableau 4). Incremental optimization proceeds in the same way as for class 1 series I verbs (compare Tableaux 3 and 4) but the verb that is processed at <t_2> is lexically specified for a dative$_\lambda$ undergoer. The outcome of the application of Selection reinforces the interpretation that results from the ranking of Locality and Stay at <t_1>.

(17) Class 2, pattern B_3
monadire-s *ǯarisk'ac-i* *e-lod-eb-a.*
hunter-DAT soldier-NOM <t_1> 'waits' <t_2>
'The soldier waits for the hunter.'

Tableau 2 ACT → nom&first, V: class 2; see (15)

NP_{NOM} NP_{DAT}…	…V {UND → dat}			
$<t_1>$	$<t_2>$	SELECTION	LOCALITY	STAY
☞ ACT → nom&first	☞ ACT → nom&first			
ACT → dat&non-first	ACT → dat&non-first	*	*	*

Tableau 3 ACT → nom&non-first, V: class 1, series I; see (16)

NP_{DAT} NP_{NOM}…	…V			
$<t_1>$	$<t_2>$	SELECTION	LOCALITY	STAY
☞ ACT → nom&non-first	☞ ACT → nom&non-first			*
ACT → dat&first	ACT → dat&first		*	

Tableau 4 ACT → nom&non-first, V: class 2; see (17)

NP_{DAT} NP_{NOM}…	…V{UND → dat}			
$<t_1>$	$<t_2>$	SELECTION	LOCALITY	STAY
☞ ACT → nom&non-first	☞ ACT → nom&non-first			*
ACT → dat&first	ACT → dat&first	*	*	

Sentences (18)–(19) present sentences in which the verb licenses a dative$_\theta$ actor. Up to $<t_1>$, the hearer has processed the same case and order information as in sentences (16)–(17) and is confronted with the same conflict between LOCALITY and STAY, which suggests a nominative actor. Processing the selectional properties of the verbal head in $<t_2>$ involves a revision of the assumed argument structure, since the class 1, series III verb in (18) and the class 4 verb in (19) license a dative$_\theta$ actor. This revision is presented in Tableau 5: the optimal candidate at $<t_1>$ differs from the optimal candidate at $<t_2>$.

(18) Class 1, series III, pattern C_1
monadire-s *ǯarisk'ac-i* *da-u-č'r-i-a.*
hunter-DAT soldier-NOM $<t_1>$ 'has wound' $<t_2>$
'The hunter has wound the soldier.'

(19) Class 4, pattern C_2
monadire-s *ǯarisk'ac-i* *s-ʒul-s.*
hunter-DAT soldier-NOM $<t_1>$ 'hates' $<t_2>$
'The hunter hates the soldier.'

Finally, sentences (20)–(21) illustrate the revision of a stronger initial assumption about the thematic properties of the processed NPs. Both LOCALITY and STAY suggest that NP_{NOM} is an actor. However, the verb processed at $<t_2>$ licenses a dative$_\theta$ actor (see Tableau 6).

Tableau 5 ACT → dat&first, V: class 1, series III or class 4; see (18)–(19)

NP_{DAT} NP_{NOM}…	…V{ACT → dat}	SELECTION	LOCALITY	STAY
<t_1>	<t_2>			
☞ ACT → nom&non-first	ACT → nom&non-first	*		*
ACT → dat&first	☞ ACT → dat&first		*	

Tableau 6 ACT → dat&non-first, V: class 1 (III) or class 4; see (20)–(21)

NP_{NOM} NP_{DAT}…	…V{ACT → dat}	SELECTION	LOCALITY	STAY
<t_1>	<t_2>			
☞ ACT → nom&first	ACT → nom&first	*		
ACT → dat&non-first	☞ ACT → dat&non-first		*	*

(20) Class 1, series III, pattern C_1

ǯarisk'ac-i	*monadire-s*		*da-u-č'r-i-a.*	
soldier-NOM	hunter-DAT	<t_1>	'has wound'	<t_2>

'The hunter has wound the soldier.'

(21) Class 4, pattern C_2

ǯarisk'ac-i	*monadire-s*		*s-ʒul-s.*	
soldier-NOM	hunter-DAT	<t_1>	'hates'	<t_2>

'The hunter hates the soldier.'

The constraint interactions presented so far differ in the following respects:

- some sentences involve at <t_2> a revision of the hearer expectations at <t_1> (see Tableaux 5 and 6),
- the hearer's expectations at <t_1> involve two different degrees of "strength" depending on the constraint interactions that motivate them. A 'strong' assumption at <t_1> is motivated by converging evidence from both LOCALITY and STAY (see Tableaux 1, 2 and 6). A 'weak' assumption at <t_1> is motivated by LOCALITY but involves conflicting evidence from the lower ranked constraint STAY (see Tableaux 3, 4 and 5). In the latter cases, LOCALITY suggests that the dative argument is an undergoer but STAY suggests that it is an actor. It is only due to the ranking of LOCALITY over STAY that the former expectation is stronger at <t_1>.

Combining these differences results in a scale that reflects the extent to which the optimal candidate in <t_2> is expected at <t_1> (see Table 5). The order in Table 5 implies that thematic revision at <t_2> is expected to have the stronger impact on processing difficulty. Whenever thematic revision is involved, it will be easier to process when the expectation at <t_1> is weak. If no revision is involved, then the strength of the expectations at <t_1> will increase the ease of processing. The aim of our empirical study is to examine whether the asymmetries in Table 5 have a discernible effect on the processing time.

Table 5 Predictions

(Predicted) ease of processing		Strength of assumption at <t_1>	Thematic revision at <t_2>	Tableau
NP_{NOM} NP_{DAT}…	V	Strong	No	1
	V{UND→dat}	Strong	No	2
< NP_{DAT} NP_{NOM}…	V	Weak	No	3
	V{UND→dat}	Weak	No	4
< NP_{DAT} NP_{NOM}…	V{ACT→dat}	Weak	Yes	5
< NP_{NOM} NP_{DAT}…	V{ACT→dat}	Strong	Yes	6

Note, furthermore, that a further distinction is possible among the Tableaux that does not involve thematic revision at <t_2>: in case of class 1 verbs (Tableaux 1 and 3), SELECTION is vacuously satisfied, while in case of class 2 verbs SELECTION reinforces the hearer's expectations. This asymmetry allows for further predictions concerning the strength of the reinforcement of hearer's expectations. However, we will not be able to consider this asymmetry in our study, since the experimental design does not involve minimal pairs for the contrast between class 1 and class 2 verbs.

3.3 Method

Our study consists in two independent experiments that were performed within the same experimental sessions, as explained below. The first experiment examines the contrast between series I and series III in class 1 verbs and the second experiment examines the contrast between class 2 and class 4 verbs, see experimental conditions in (22)–(23). Each experiment contains two factors, 'case' {actor→nominative, actor→dative} and 'order' {actor→first, actor→non-first}, which are crossed, hence rendering 4 experimental conditions.

(22) Experiment I: series' contrast
 (a) actor → nominative and first (class 1, series I); see (14)
 (b) actor → nominative and non-first (class 1, series I); see (16)
 (c) actor → dative and first (class 1, series III); see (18)
 (d) actor → dative and non-first (class 1, series III); see (20)

(23) Experiment II: classes' contrast
 (a) actor → nominative and first (class 2); see (15)
 (b) actor → nominative and non-first (class 2); see (17)
 (c) actor → dative and first (class 4); see (19)
 (d) actor → dative and non-first (class 4); see (21)

The task was implemented in a DMDX presentation. Native speakers were shown a nominative and a dative NP on the screen (either in the nominative-first or in the dative-first order) and an empty slot at the place of the missing verb. After 5 s., the verb appeared in the clause final slot. The speakers were instructed to judge whether this sentence is “right” or “false” in Georgian by pressing the corresponding keys (left SHIFT = right, right SHIFT = false) as soon as they could. Timing started when the verb appeared on the screen (time window: 10 s).

For each experiment, 16 items were created in a factorial design rendering four data points per participant for each experimental condition. Each item contained two NPs with animate referents, which were used in all four conditions. For the first experiment, each experimental item contained a class 1 verb that was used in two different inflectional forms, namely future (series I) and perfect (series III). For the second experiment, we used verbs that lexically license a case-marking pattern: 8 items contained class 2 verbs (direct case marking) and 8 items contained class 4 verbs (inverse case marking). The complete list of verbs is given in the Appendix.

The 16 items of both experiments were distributed to four different versions of the DMDX presentations, so that every participant saw each item once. Each presentation contained four trials per experimental condition for each experiment (total: 4 trials × 4 conditions × 2 experiments = 32 trials). Additionally, 96 fillers were used that were identical in the four presentations. 32 fillers were well formed sentences with very different clause structures (intransitives, passives, verbs with adjuncts, etc.). The remaining 64 fillers displayed several violations of the selectional properties of the verbs. The 32 target sentences and the 96 fillers were pseudo-randomized for each participant. In sum, 32 participants (18 female, 14 male, age range 19-25, average: 21.9) took part in the experiment (Tbilisi, September 2005).

The choice of verbs was based on the appendix of verb classes in Harris (1981). The examined conditions are necessarily based on different inflectional forms of the same verb (Experiment I) or on different verbs (Experiment II). In order to estimate the influence of item-specific properties to the result, we performed a lexical decision experiment. The verb forms used in experiments I and II were distributed in two DMDX presentations (in order to avoid lexical repetition of the class 1 verbs in two different inflectional forms), pseudo-randomized together with a further 72 filler elements. 10 participants took part in this experiment (7 female, 3 male, age range 20–25, average: 21.7), who were different from the participants of the main experiments I and II. The resulting data set contains five measurements of the reaction time for each verb form used in either experiment.

3.4 Results

Experiments I and II resulted in a data set of 16 (target sentences) × 32 (participants) = 512 reaction time measurements each. Some measurements were classified as non-valid either because the participant judged the stimulus as ‘false’ or because the participant did not give any judgment within the time window (46 measurements in Experiment I and 19 measurements in Experiment II). After excluding this data, we computed the z-transformation of the gathered RTs per participant and excluded

Table 6 Means of RTs, logarithmized measurements and residuals in Experiment I

	First → ACT			Non-first → ACT		
	ms	log(rt)	Residuals	ms	log(rt)	Residuals
Nom → ACT (series I)	2171	7.60	–.055	2319	7.66	.007
Dat → ACT (series III)	2558	7.75	.011	2632	7.80	.064

1 measurement in Experiment I and 11 measurements in Experiment II that strongly deviated from the participant's means ($z > \pm 2.5$). The measurements presented below are calculated on the remaining valid RTs (Experiment I: 512 – 46 – 1 = 465 valid RTs; Experiment II: 512 – 19 – 11 = 482 valid RTs).[4]

The obtained reaction times were positively skewed (experiment I, $g_1 = .9$, SE = .1; experiment II, $g_1 = 1.2$, SE = .1); in order to meet the normality requirements of parametric tests, a logarithmic transformation (based on the natural logarithm) was applied on the primary data. The analyses reported in the following are calculated on the log transformed data. A repeated-measures analysis of variance was carried out on the logarithmized data of both experiments (at an α level of .05). This analysis revealed a significant main effect of case marking ($F_{1,31} = 23.28$, $p < .001$)[5], a significant main effect of word order ($F_{1,31} = 8.13$, $p < .01$), a significant main effect of experiment, i.e., of the factor lexical vs. inflectional licensing of case marking ($F_{1,31} = 57.26$, $p < .001$), a significant interaction between these three factors ($F_{1,31} = 4.55$, $p < .05$) and no significant effects for the interactions among the pairwise crossed factors. The crucial finding of this analysis is the significant threefold interaction 'licensing × case × order'. In order to assess the sources of this interaction, we performed analyses of variance for each experiment separately, which are reported in the following sections.

3.4.1 Inflectional Case Licensing (Series I vs. Series III)

Experiment I examines the contrast between future (series I) and perfect (series III) of class 1 verbs. Actors and undergoers of future tense class 1 verbs are structurally case-marked, while actors of perfect tense verbs bear a non-structural dative$_\theta$ (see Table 5). The obtained means of the RTs, the means of the logarithmized measurements, as well as the means of the residuals (see below) are given in Table 6.

As may be observed in Fig. 1, the preference for nominative actors has a strong impact on reaction times. Descriptively, we observe an additional effect of the word order. A repeated-measures ANOVA on the logarithmized data at an α level of .05 revealed a significant main effect of case marking ($F_{1,31} = 18.27$, $p < .001$); the effect of the word order as well as the interaction did not reach significance.

[4] The 77 missing values were distributed in the obtained data of 26 speakers, such that at least one valid reaction time was available for every speaker in every condition in both experiments.

[5] Following a proposal by Raaijmakers et al. (1999), we only report the subject analysis (averaging over items), since item variability is experimentally controlled.

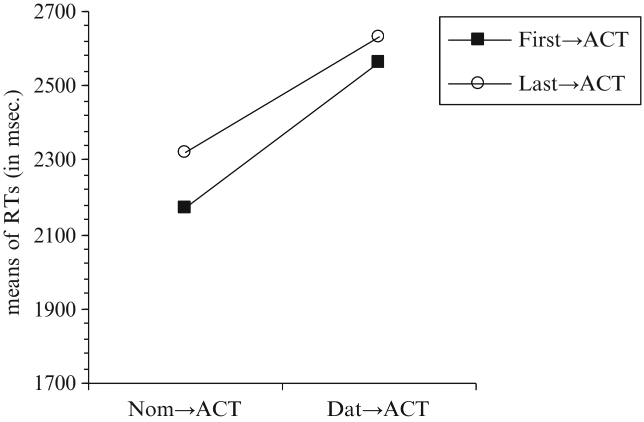

Fig. 1 Reaction times in Experiment I

On the basis of the results from the lexical decision test, we calculated the means of reaction times for each verb form. The natural logarithm of each mean was inserted to a linear regression analysis as a predictor for the logarithmized reaction times obtained by the conditions involving the corresponding verb form. This analysis gave a highly significant regression coefficient ($t = 3.74$, $p < .001$), which indicates that the processing cost of the individual verb forms has a significant impact on sentence processing. In order to eliminate this impact, we carried out an evaluation of the residuals (see means per experimental condition in Table 6), assuming that these values give an estimate for the actual effect of the investigated factors independently of the processing cost of the individual verb forms. A repeated-measures ANOVA at an α level of .05 revealed a significant main effect of case marking ($F_{1,31} = 4.52$, $p < .05$) but neither a significant effect of order nor of the interaction between the two factors. This result confirms the significant main effect of case marking in the analysis of the reaction times and shows that this effect is independent from item-specific differences.

3.4.2 Lexical Case Licensing (Class 2 vs. Class 4)

Experiment II examines the contrast between class 2 and class 4 verbs. Class 2 verbs license a dative$_{\lambda}$ undergoer, while class 4 verbs license a dative$_{\theta}$ actor (see Table 5). The means of the obtained RTs and the corresponding logarithmized values are given in Table 7. RTs in experiment II were overall lower than the RTs of experiment I (see discussion below).

Figure 2 indicates an ordinal interaction pattern for experiment II. A repeated-measures ANOVA, carried out on the logarithmized data at an α level of .05, revealed a significant main effect of case ($F_{1,31} = 9.73$, $p < .01$), a significant main effect of order ($F_{1,31} = 8.67$, $p < .01$) and a significant interaction between the two factors ($F_{1,31} = 9.44$, $p < .01$).

Table 7 Means of RTs, logarithmized measurements and residuals in Experiment II

	First → ACT			Non-first → ACT		
	ms	log(rt)	Residuals	ms	log(rt)	Residuals
Nom → ACT (class 2)	1822	7.43	–.071	1857	7.46	–.062
Dat → ACT (class 4)	1870	7.46	–.003	2264	7.65	.171

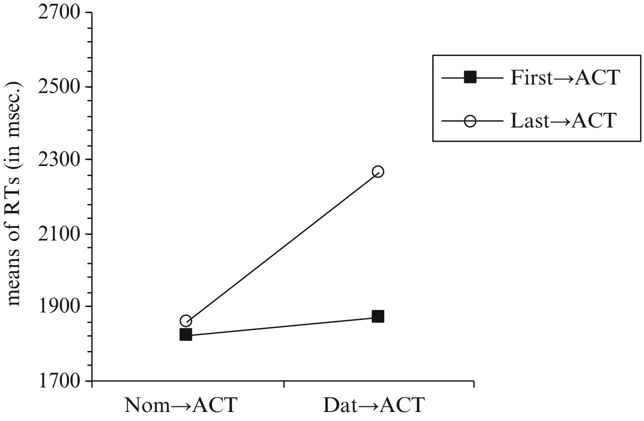

Fig. 2 Reaction times in experiment II

Paired sample (2-tailed) t-tests revealed significant differences for all comparisons with the 'Dat & Non-first → ACT' condition and only those (for a cumulative type I error below .05 the criterion of significance for six comparisons after the Bonferroni correction is .008).

(24)	(a)	Nom & First	$<_{rt}$	Dat & Non-first	($t_{31}=3.81$, $p<.001$)
	(b)	Nom & Non-first	$<_{rt}$	Dat & Non-first	($t_{31}=4.19$, $p<.001$)
	(c)	Dat & First	$<_{rt}$	Dat & Non-first	($t_{31}=3.50$, $p<.001$)

For the calculation of the effect of the individual verb forms on the obtained RTs we used the procedure described in Sect. 3.4.1. A linear regression analysis on the RTs of the individual verbs (in the lexical decision text) and the corresponding RTs in experiment II revealed a significant regression coefficient ($t=2.92$, $p<.01$). On the basis of a regression analysis carried out separately for every participant, we computed the means of the residuals in Table 7. A repeated-measures ANOVA at an α level of .05 revealed a significant main effect of case ($F_{1,31}=30.03$, $p<.001$), a significant main effect of order ($F_{1,31}=9.47$, $p<.01$) and a significant interaction effect ($F_{1,31}=9.72$, $p<.01$). Paired t-tests (2-tailed) computed on the means of residuals gave the same significant differences with the logarithmized data (see (24)), as shown in (25) (significance level .008 after Bonferroni correction for six comparisons). We conclude that only the condition of a non-first dative actor involves a significantly higher processing cost.

Table 8 Summary of predictions and results

Predictions		Results (Exp. I)	Results (Exp. II)
$NP_{NOM}\ NP_{DAT}\ldots$	V({UND → dat})	α_{I}	α_{II}
$< NP_{DAT}\ NP_{NOM}\ldots$	V({UND → dat})	α_{I}	α_{II}
$< NP_{DAT}\ NP_{NOM}\ldots$	V{ACT → dat}	$\alpha_{I} + \beta_{I}$	α_{II}
$< NP_{NOM}\ NP_{DAT}\ldots$	V{ACT → dat}	$\alpha_{I} + \beta_{I}$	$\alpha_{II} + \beta_{II}$

(25) (a) Nom & First $<_{rt}$ Dat & Non-first ($t_{31} = 5.59$, $p < .001$)
(b) Nom & Non-first $<_{rt}$ Dat & Non-first ($t_{31} = 5.88$, $p < .001$)
(c) Dat & First $<_{rt}$ Dat & Non-first ($t_{31} = 3.57$, $p < .001$)

The computed residuals allow us to inspect the means' difference between the reaction times in the two experiments. Descriptively, we may observe that the overall means of the residuals does not substantially differ in experiment I (means: .006; C.I.: ±.03) and experiment II (means: .008; C.I.: ±.03), $t_{31} = .37$, $p < .8$. An analysis of variance on the overall set of residuals (licensing × case × order) revealed that the main effect of (inflectional vs. lexical) licensing is not significant, which indicates that the difference we observe in the reaction times is eliminated if we take into account the differences in the processing cost of the verbs. We may speculate that a portion of this difference comes from the fact that the verbs of experiment I were complex inflectional forms (future or perfect), while the verbs of experiment II were presented in the present tense, which is morphologically unmarked but lexical differences may play a role as well.

3.5 Discussion

Table 8 compares the results reported in Sect. 3.4 with the predictions in Table 5. Experiment I yielded a significant main effect of case that implies two levels of processing cost: level α_{I} for the conditions with a nominative actor and level $\alpha_{I} + \beta_{I}$ for the conditions with a dative actor. Since the main effect of order was not significant, the related means' differences are not taken into account. In experiment II, only the order {NP_{NOM} NP_{DAT}} with a dative actor differed significantly from all other experimental conditions; hence, we assume a level of processing cost α_{II} for the three conditions that involved shorter reaction times and a higher level $\alpha_{II} + \beta_{II}$ for the condition with a non-first dative actor. The resulting levels are in line with the predicted hierarchy in Table 5.

Both experiments show that word order does not have a significant impact in the conditions that involve a nominative actor. This is in line with the view that these conditions do not involve a revision of the assumed thematic properties of the processed NPs (see Table 5), which follows from the assumption that structural case information (LOCALITY) outranks word order (STAY).

The most important empirical finding is the significant threefold interaction 'licensing × case × order'. On the basis of the separate analyses of the experiments, we conclude that this effect results from the fact that the interaction 'case × order' depends on case licensing. Inflectional case licensing (Experiment I), did not yield a 'case × order' effect, since reaction times increase whenever the verb licenses a dative actor. Lexical case licensing (Experiment II), yielded a significant 'case × order' interaction. The crucial difference lies in the condition of initial dative actors (see Table 8). This configuration is sanctioned when the hearer parses a verb that lexically licenses the dative actor.

We hypothesize that the empirical difference relates to the distinction between lexically and inflectionally licensed dative actors. It has been observed for German that a reanalysis towards a dative-first word order involves less processing effort than a reanalysis towards an accusative-first word order, since only the latter involves a reanalysis of the constituent structure (see revision of behavioral studies and qualitative neuro-physiological correlates in Bornkessel et al. 2004; Bornkessel and Schlesewsky 2006). In this view, it is not surprising that the thematic reanalysis of initial dative arguments as experiencers with class 4 verbs yields low processing cost. However, this explanation seems to be contradicted by the finding in the perfect tense of class 1 verbs. According to the observation in German, we may hypothesize that the processing of initial datives involves a reanalysis of the constituent structure with perfect tense verbs but not with experiencer verbs.

Dative actors of class 4 verbs are thematically determined by their relation to the lexical semantics of the verb. With class 1 verbs, dative actors in the perfect and nominative actors in the present denote the same range of thematic relations with the verb and mark both the external argument. Their case properties reflect the impact of the modal properties of the perfect to the relevance of the actor's involvement to the event (following assumptions in the literature summarized in Sect. 2.3). We may thus speculate that the revision of the thematic properties of the morphological case with this verb group is associated with a reanalysis of the assumed constituent structure. Further research is required in order to test the implications of this claim and its compatibility with non-structural case licensing.

4 Conclusions

The aim of this article is to account on the morphological and syntactic properties of case inversion in Georgian and to examine their implications for syntactic processing. We have shown that the complex case-marking patterns in Georgian arise through two layers of case licensing, non-structural and structural. Evidence for this distinction comes from the thematic relatedness of case affixes and from stratal uniqueness effects. The crucial point is that the morphological dative shows mixed properties arising from the syncretism of a structural case (accusative) and an inherent case (dative). As a structural case, the dative affix marks the lower structurally case marked argument. As a non-structural case, the dative affix marks non-volitional actors of class 4 verbs, goal arguments of class 1 verbs, actor arguments of class 1 verbs in the perfect tense and is lexically licensed as a marker of the undergoer argument of class 2 verbs.

Furthermore, we presented the findings of two experiments on incremental processing of sentences with two case arguments that are thematically ambiguous. The results of these experiments provided evidence that case marking is a more reliable cue than word order in processing thematically ambiguous expressions in Georgian. Scrambling the undergoer over the actor constituent of verbs with a nominative actor does not result in additional processing effort. Furthermore, the experimental findings suggest a difference between lexical and inflectional licensing of dative actors, since the revision of the thematic properties of lexically licensed datives is associated with low processing effort.

As stated in the introduction, Georgian sentence processing presents an interesting puzzle, since this language displays flexible word order (such as German) and no uni-directional case-to-argument associations (such as Icelandic). The experimental findings suggest that case information is indeed more used as a cue for assumptions about argument structure in this language. In the absence of a verbal head speakers build their assumptions according to the default rules of structural case marking and less according to word order. This finding is in line with the observation that in languages with rich morphological systems case marking is a particularly strong cue for the interpretation of the thematic properties of the arguments (see Bornkessel-Schlesewsky and Schlesewsky 2009: 159).

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5 Appendix

5.1 Class 1 (Experiment I)

dač'ris 'he/she will wound him/her'; *dabans* 'he/she will wash him/her'; *dak'argavs* 'he/she will loose him/her'; *irčevs* 'he/she chooses him/her'; *aγmertebs* 'he/she admires him/her'; *k'lavs* 'he/she kills him/her'; *xedavs* 'he/she sees him/her'; *at'arebs* 'he/she carries him/her'; *malavs* 'he/she hides him/her'; *daγlis* 'he/she makes him/her tired'; *acek'vebs* 'he/she causes him/her to dance'; *avarǯišebs* 'he/she makes him/her to exercise'; *amγerebs* 'he/she makes him/her to sing'; *atamašebs* 'he/she causes him/her to play'; *amušavebs* 'he/she makes him/her to work'; *amepebs* 'he/she puts him/her on the throne'.

5.2 Class 2 (Experiment II)

elodeba ‘he/she waits him/her’; *šeepereba* ‘he/she suits him/her’; *šeesabameba* ‘he/she fits him/her’; *šeesat’q’viseba* ‘he/she corresponds him/her’; *etamašeba* ‘he/she plays with him/her’; *elap’arak’eba* ‘he/she speaks with him/her’; *ečxubeba* ‘he/she fights/quarrels him/her’.

5.3 Class 4 (Experiment II)

st’umrobs ‘he/she visits him/her’; *uq’vars* ‘he/she loves him/her’; *sʒuls* ‘he/she hates him/her’; *mosc’ons* ‘he/she likes him/her’; *avic’q’deba* ‘he/she forgets him/her’; *axsovs* ‘he/she remembers him/her’; *enat’reba* ‘he/she misses him/her’; *sč’irdeba* ‘he/she needs him/her’; *aint’eresebs*[6] ‘he/she interests/wonders him/her’.

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[6] The verbs *sč’irdeba, avic’q’deba*, *enat’reba* and *aint’eresebs* share some morphological properties with class 2/class 1 verbs, however they both have an inversive argument structure, hence they have to be considered together with the class 4 verbs.

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The Impact of Case and Prosody on the Availability of Argument Structures

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1 Introduction

There is an ongoing debate in psycholinguistics on which information is used for initial structure building in sentence comprehension. The lexicalist view highlights the role of the verb (MacDonald et al. 1994). According to this view, the referents of nominal constituents are evaluated against thematic constraints imposed by the verb (Ferretti et al. 2001; McRae et al. 1998). Moreover, structural decisions are assumed to hinge on lexical information. Faced with a verb that displays alternative subcategorization frames the sentence processor adopts an analysis that is concordant with the most frequent usage of that verb (Jurafsky 1996). In contrast, the "syntax first" view of sentence comprehension holds that structural principles instead of verb-specific information guide initial analyses (Frazier 1987; Friederici 1995). Structures with the verb in the final position are seen as a test case of the lexicalist view. Consequently, the finding that structural commitments are made before the sentence-final verb has been processed is interpreted in favour of non-lexicalist models (Bader and Lasser 1994).

In the last decade, the predictive capacity of the sentence processing system has become the focus of interest. It is claimed that sentence processing not only proceeds incrementally but that upcoming materials are predicted to enhance their integration. A crucial role in this process is attributed to the verb, again, as it provides information about selectional restrictions and subcategorized constituents (Altmann and Kamide 1999; Crocker and Brants 2000). Alternative accounts compute the probability of conflicting continuations on the basis of distributional information associated with phrases and lexical entities (Hale 2006; Levy 2008). Within these accounts, which are rather close to the lexicalist

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approach, the specific status of structures with the subcategorizing verb in the final position is acknowledged (Gibson 1998; Levy 2008) but it is not yet fully understood how prediction might work without reliance on verb-specific information. Current proposals tend to rely on argument-specific information, considering case and/or the number of given arguments as equivalents of subcategorization information, being thereby compatible with a syntax-first approach as well (German: Friederici and Frisch 2000; Konieczny and Döring 2003; Scheepers et al. 1999, in prepration; Japanese: Kamide et al. 2003; Nakatani and Gibson 2008). We pursue this path here, looking at the predictive power of case in German single and double object structures.

As one looks at structural expectations in single and double object structures, word order preferences come into play. For example, a relative ease associated with the processing of structures with the dative preceding the accusative as compared to structures with an inverse word order has been attested (e.g., Pappert et al. 2007; Rösler et al. 1998). This finding might be interpreted as a case effect. However, there is evidence from the processing of single object structures that indicates that thematic roles rather than case are relevant for word order preferences (Frisch and Schlesewsky 2001; Bornkessel and Schlesewsky 2006). Moreover, there is no straightforward translation of word order preferences into argument number preferences. Completion data reveal an interaction of case and animacy with the available number of objects. Generally, single object structures are more frequently produced than double object structures. Only when both the subject and the (first) dative object refer to an animate entity do double object structures outnumber single object structures (Pappert et al. 2008; cf. Scheepers and Corley 2000, for animate referents). Arguably, these off-line data give an estimate of on-line resources for argument structure availability in prediction (cf. Lapata et al. 2001).

Besides case as an argument-specific cue, we consider prosody as a structure-specific cue. It has been shown that structural decisions in German are influenced by prosodic information, namely by prosodic boundary marking that resolves an attachment ambiguity (Lingel et al. 2006) and by a contrastive accent that resolves a syntactic function ambiguity (Weber et al. 2006). There is also indirect evidence from the processing of verb-final sentences in German that more subtle prosodic information like the declination of the prosodic contour towards the end of the sentence helps to predict a preverbal gap (Muckel 2002). More direct evidence is reported for English, where prosodic information in a given sentence fragment is used to estimate the original sentence's length (Grosjean 1983; Grosjean and Hirt 1996). Since single and double object structures differ in length, prosody might qualify as a predictor in German verb-final sentences as well.

Hence, the purpose of the current study is twofold. First, we want to investigate the effect of case on on-line sentence completions. Controlling for animacy as an intervening factor, we predict that case influences argument structure availability so that accusative as the first object favours single object structures and dative favours double object structures. Second, we want to explore the impact of prosody on the availability of argument structures. We expect prosodic information to modulate differences in argument structure availability due to case. To test these predictions, we conducted two experiments, a cross-modal sentence completion experiment (Experiment 1) and a cross-modal naming experiment (Experiment 2).

2 Experiment 1

With Experiment 1, we wanted to investigate the availability of argument structures as a function of case as an argument-specific cue and of prosody as a structure-specific cue. We decided to present sentence fragments for cross-modal completion. This procedure resembles the previously adopted paper and pencil completion procedure (Pappert et al. 2008). In both tasks, sentence fragments that include a case variation are presented for completion where completions are assumed to serve as an indicator of argument structure availability. However, cross-modal completions differ from questionnaire completions in two important details. First, completions are elicited online such that reaction times serve as an indicator of incremental processing. Second, sentence fragments are presented acoustically such that a prosodic manipulation can be included. The cross-modal completion paradigm used in Experiment 1 is a variant of the cross-modal naming paradigm adopted in Experiment 2. The latter paradigm was originally developed to reveal effects of syntactic appropriateness (Tyler and Marslen-Wilson 1977) but it was already shown to be sensitive to prosodic appropriateness as well (Marslen-Wilson et al. 1992; Warren et al. 1995). During cross-modal completion, subjects are not simply asked to read a sentence continuation aloud (i.e., to name it) but to insert a determiner with appropriate case marking.

2.1 Method

2.1.1 Subjects

Twenty-eight native speakers of German participated in the experiment. They were recruited via flyers at the University of Leipzig. Most of them were students of various disciplines. Six of them were male, 22 were female. Their mean age was 23.3 years, ranging from 19 to 38 years. They were naive with respect to the purpose of the study and were paid for their participation.

2.1.2 Materials

Experimental items were 36 single and double object sentences with an auxiliary in the second position and a verb in the final position. The auxiliary was neutral with respect to the verb type of the subcategorizing verb. The first position in the sentence was occupied by the subject. Case marking of the first or single object (henceforth: first object) was varied (dative vs. accusative) as well as the number of objects (single or double object structure). Subject and object nouns were masculine so they underwent unambiguous case marking. All determiners were definite and all noun referents were animate. The nouns' length in syllables was controlled: Subject nouns were two syllables long, first object compound nouns were four syllables long and second object nouns were three to four syllables long. Single object verbs were chosen to begin with a /d/ or a /t/ in order to minimize coarticulatory information at the offset of the first object. As there are few ditransitive verbs in German that occur with three animate referents, 18 verbs were chosen that were all presented twice.

Sentences were spoken by an informed female speaker and recorded on hard disk (mono, 16 bit, 44 kHz), using a Neumann TLM 103 microphone and an M-Audio MOBILEpre USB preamplifier. Fragments were generated by truncating experimental sentences at the offset of the first object noun. Examples are given in (1)–(4), where continuations that were cut-off are put in square brackets.

(1) *Der Doktor* *wird* *den Krankenpfleger* *[duzen.]*
the.NOM doctor will the.ACC male nurse [address informally]
'The doctor will address the male nurse informally.'

(2) *Der Doktor* *wird* *den Krankenpfleger* *[dem Rollstuhlfahrer zeigen.]*
the.NOM doctor will the.ACC male nurse [the.DAT wheelchair user point out to]
'The doctor will point out the male nurse to the wheelchair user.'

(3) *Der Doktor* *wird* *dem Krankenpfleger* *[danken.]*
the.NOM doctor will the.DAT male nurse [thank]
'The doctor will thank the male nurse.'

(4) *Der Doktor* *wird* *dem Krankenpfleger* *[den Rollstuhlfahrer zeigen.]*
the.NOM doctor will the.DAT male nurse [the.ACC wheelchair user point out to]
'The doctor will point out the wheelchair user to the male nurse.'

Prosodic analyses of the sentence fragments were performed. The durations of the constituents (subject, auxiliary, and first object) as well as those of pauses (between subject and auxiliary and between auxiliary and first object) were computed. As all pauses but one were zero, Table 1 reports the mean durations and standard deviations of the constituents only.

Analyses of variance on the factors Case of the first object (accusative vs. dative) and Length of the original sentence (single vs. double object) were performed. They revealed differences in the duration of the subject: There was no significant effect of Case ($F(1, 35) = 3.52$ ($MSe = 1912.03$), $p = .069$) but a significant main effect of Length (F (1, 35) $= 6.37$ ($MSe = 1911.39$), $p < .05$) with shorter subject durations in the single object as compared to the double object conditions and a significant interaction of the factors Case and Length (F (1, 35) $= 5.54$ ($MSe = 1218.99$), $p < .05$). A post hoc Scheffé test (critical difference $= 16.7$, $p < .05$) showed that the duration of the subject was shorter in the condition with accusative Case and single object Length than in all other conditions. There were no differences of duration of the auxiliary and the first object between the conditions (all $p > .1$).

Table 1 Mean durations (standard deviations) of the fragments' constituents in ms per Case of the first object and Length of the original sentence

Case	Length	Subject	Auxiliary	First object
Accusative	Single object	478 (55)	167 (25)	835 (76)
Accusative	Double object	510 (73)	174 (27)	837 (88)
Dative	Single object	505 (74)	182 (21)	842 (85)
Dative	Double object	510 (73)	183 (28)	848 (65)

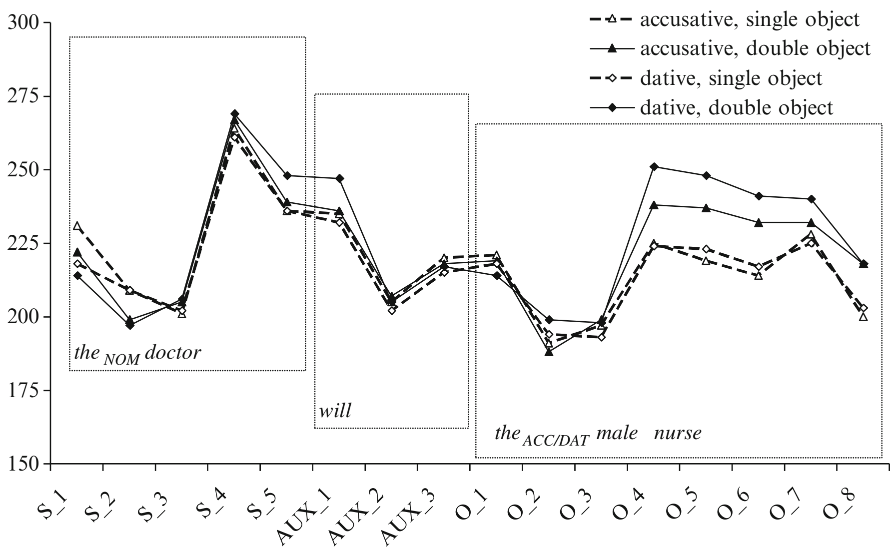

Fig. 1 Mean F0 values in Hz for each predefined moment (see text for details) within the subject (S), the auxiliary (AUX) and the first object (O) per Case of the first object and Length of the original sentence

Moreover, the tonal realization of the constituents was analyzed using Praat (http://www.praat.org). Discrete F0 values were obtained at predefined moments per item. There were five moments within the subject (onset, offset and three equidistant points in-between), three moments within the auxiliary (onset, offset and one point in the middle) and eight moments within the first object (onset, offset and six equidistant points in-between). If the relevant portion was voiceless, the F0 value of the next voiced moment to the right (or, respectively, to the left for offsets) was gained. If there was no voiced moment until the next predefined time point, a missing value was submitted to the analyses. Moreover, F0 values above 500 Hz were treated as missing values. Figure 1 depicts mean F0 values per condition.

F0 values were submitted to separate analyses of variance for each predefined moment.

Table 2 reveals those main effects that yielded significance.

Only one interaction reached significance. At the onset of the auxiliary (AUX_1), a significant interaction of Case and Length was attested (F (1, 35) = 4.96

Table 2 Differences in F0-values at predefined moments (see text) that were significant (p < .05) according to analyses of variance with the factors Case and Length of the original sentence (*DAT/ACC* first object marked for dative/accusative; *SglO/DbO* single/double object structure)

	S_5	AUX_1	AUX_3	O_1	O_4	O_5	O_6	O_7	O_8
Case	DAT > ACC		ACC > DAT	ACC > DAT	DAT > ACC				
Length	DbO > SglO	DbO > SglO			DbO > SglO	DbO > SglO	DbO > SglO	DbO > SglO	DbO > SglO

(*MSe* = 311.70), $p < .05$). A post hoc Scheffé test (critical difference = 8.5, $p < .05$) revealed that the F0 values at the onset of the auxiliary were higher in the condition with dative Case and double object Length than in all other conditions.

To summarize, prosodic analyses of single and double object structures revealed heterogeneous effects of Case and a clear effect of Length with higher F0 values for the double object sentences as compared to the single object sentences. These differences were already found as early as on the subject but they were of increased size on the first object.

Targets for continuations in the cross-modal completion task consisted of the original second object nouns and ditransitive verbs, e.g., *Rollstuhlfahrer zeigen*. To produce a grammatical continuation of the heard sentence fragment, subjects had to insert a determiner with appropriate case marking. Double object fragments (cf. (2) and (4)) are referred to as prosodically congruent with the target completion whereas single object fragments (cf. (1) and (3)) are considered as prosodically incongruent.

In addition, there were 36 filler fragments cut out of single object sentences (cf. (5)) that had to be completed by a monotransitive verb, e.g., *ankleben*.

(5) *Der Schuster* *wird* *die Sohle* *[ankleben.]*
the.NOM shoemaker will the.ACC sole [fix]
'The shoemaker will fix the sole.'

Eighteen of the filler fragments included an accusative object; the other 18 fragments included a dative object. The filler items served to obscure the task, such that participants were not prepared to produce a second object and a ditransitive verb after all fragments.

The experimental items were distributed over four lists according to a Latin Square design, the filler items were added and two pseudo-randomisations were generated for each list. Moreover, there were eight training items, four double object sentences and four single object sentences that were cut off after the first object. Half of them had the first object marked for accusative; the other half had the first object marked for dative.

2.1.3 Procedure

Experiments were run in a sound-attenuated chamber using the experimental software ERTS (http://www.berisoft.de/). Subjects sat on a chair, with a computer screen on the table in front of them. They wore a head set (Vivanco VSR 67). Sentence fragments were presented via earphones; articulation latencies were measured via the microphone connected to a voice key. The utterances of the subjects were recorded.

Prior to the experiment, subjects were instructed to listen to the sentence fragments and to produce an immediate continuation by using the words presented on the screen and by inserting a definite determiner in the accusative or dative case where appropriate. The experiment was preceded by training trials that served to acquaint the subjects with the task and to adjust the sensitivity of the voice key.

Trials followed a fixed scheme. Right after an intertrial pause of 500 ms, a fixation star was displayed for 400 ms in the central position on the screen and, with a latency of 50 ms, a sentence fragment was presented acoustically. Immediately at the offset of the sentence fragment, a target for completion was presented in the centre of the screen (font size 18 pt) that disappeared after a response or, at the latest, after 1,500 ms. The maximal response latency was set to 3,000 ms. The experimenter coded the response immediately on the keyboard as to whether it was correct or erroneous with respect to case, or whether there was a false alarm by the voice key. Moreover, he marked uncertainties that were checked after the session by reference to the recording of the subjects' utterances. Subjects received a signal when they exceeded the reaction time limit.

The experiment was run in three blocks with the opportunity to have a very short break in-between and lasted approximately 15 min.

2.2 Results

Trials were discarded because of voice key problems, disfluencies, or clicks by the subject (14% of the trials). Table 3 shows the case error rates for the remaining trials.

Analyses of variance revealed a significant main effect of Case (F_1 (1, 27) = 61.93 (MSe = 1058.75), $p < .001$; F_2 (1, 35) = 166.21 (MSe = 466.37), $p < .001$) with higher error rates in the accusative as compared to the dative conditions. Moreover, there was a main effect of Length that was significant in the subject analysis only (F_1 (1, 27) = 4.51 (MSe = 90.65), $p < .05$; F_2 (1, 35) = 2.27 (MSe = 208.56), $p = .141$), indicating higher error rates in the double object conditions (i.e., the prosodically congruent conditions) as compared to the single object conditions (i.e., the prosodically incongruent conditions). Finally, there was no significant interaction (F_1 (1, 27) = 1.21 (MSe = 128.96), $p = .282$; F_2 (1, 35) < 1).

Table 4 reports mean articulation latencies per condition after exclusion of erroneous trials.

As there were too many missing values in the accusative conditions, analyses of variance could not be computed. Instead T-tests were computed on the dative conditions only. There was no significant effect of Length (t_1 (23) = – 1.310 (MSe = 22.931), $p = .203$; t_2 (35) < 1).

Table 3 Mean error rates (%) and standard deviations per condition in Experiment 1

Case	Length	Prosody	Error rate	Standard deviation	N
Accusative	Single object	Incongruent	44	50	243
Accusative	Double object	Congruent	47	50	242
Dative	Single object	Incongruent	05	22	248
Dative	Double object	Congruent	06	23	244

Table 4 Mean reaction times (ms) and standard deviations per condition in Experiment 1

Case	Length	Prosody	RT	Standard deviation	N
Accusative	Single object	Incongruent	984	307	107
Accusative	Double object	Congruent	972	277	88
Dative	Single object	Incongruent	912	270	202
Dative	Double object	Congruent	930	269	199

2.3 Discussion

Case had a strong impact on subjects' performance. About half of the sentence fragments with an accusative object were erroneously completed by another accusative object. This finding questions the function of the filler fragments. Single object fillers were presented to balance the proportion of single and double object structures to be produced and to hinder subjects from preparing the production of a second object in all trials. Observed reaction time differences would have been attributed to differential argument structure availability.

However, in consideration of the huge amount of case errors, we suggest that the word order preference was so strong that subjects reanalysed an accusative as a dative when they were asked to produce a second object. As a consequence, the Case effect found in Experiment 1 is not easily attributed to differences in argument structure availability but could also reflect a linearization preference.

Moreover, error rates are slightly higher in the prosodically congruent (double object) than in the incongruent (single object) conditions. One plausible explanation holds that the double object intonation favours a misinterpretation of a given accusative as a dative but such a pattern should rather be reflected by an interaction of the factors. Finally, the sparse reaction time data do not allow us to confirm or to deny a possible impact of prosody on argument structure availability.

3 Experiment 2

As the production of a case-marked determiner turned out to be error-prone, we decided to run a second experiment with an easier task. Experiment 2 included the same manipulations as Experiment 1 but subjects did not complete sentence fragments by insertion of a case-appropriate determiner. They completed sentence fragments by naming a case-congruent verb. By sticking to the method originally described by Tyler and Marslen-Wilson (1977), we expected fewer erroneous responses and therefore more reaction time data to enter the analysis.

The immense syntactic processing load associated with the task in Experiment 1 might furthermore have masked a prosodic effect. Consequently, we hoped to shed more light on the impact of prosody on argument structure availability in Experiment 2 given that previous cross-modal naming studies revealed prosodic effects on sentence processing (Marslen-Wilson et al. 1992; Warren et al. 1995). We predicted a modulation of the availability of argument structures due to case by prosodic information. As target structures were now single object structures, we predicted an advantage of accusative fragments over dative fragments as well as an advantage of single object prosody over double object prosody.

3.1 Method

3.1.1 Subjects

Twenty-four native speakers of German participated in Experiment 2. The recruitment procedure was the same as in Experiment 1. All participants were students of the University of Leipzig. Six of them were male, 18 were female. Their mean age was 23.2 years, ranging from 18 to 35 years. They were paid for their participation and none of them had participated in Experiment 1.

3.1.2 Materials

Thirty-two out of the 36 sentence fragments from Experiment 1 were presented acoustically. This reduction of materials was necessary because there were fewer single object verbs. As in Experiment 1, sentence fragments differed with respect to Case of the first object, i. e., dative vs. accusative, and with respect to Length, i. e., the original sentences were single vs. double object structures.

Targets were single object verbs, subcategorizing either a dative or an accusative object, e. g., *duzen* (‘to address informally’) or *danken* (‘to thank’). Verbs were matched for length in syllables. Moreover, the lemma frequencies according to the Celex database did not differ significantly between the Case conditions. There were 16 dative and 16 accusative verbs, that is, two items “shared” one verb. However, as items were distributed over lists, each subject had to produce each verb only once.

As targets were single object verbs, the single object conditions are considered prosodically congruent whereas the double object conditions are referred to as prosodically incongruent.

In addition to the experimental items, there were 36 double object filler sentences with a dative or accusative first object. These sentences were cut off at the offset of the first object noun (cf. (6)).

Table 5 Mean reaction times (ms) and standard deviations per condition in Experiment 2

Case	Length	Prosody	RT	Standard deviation	N
Accusative	Single object	Congruent	585	121	177
Accusative	Double object	Incongruent	587	123	175
Dative	Single object	Congruent	613	105	176
Dative	Double object	Incongruent	624	115	173

(6) *Der Feinschmecker wird den Lachs [der Gemüsesuppe vorziehen.]*
the.NOM gourmet will the.ACC salmon [the.DAT vegetable soup prefer]
'The gourmet will prefer the salmon to the vegetable soup.'

Targets were the original second object nouns plus verb, e.g., *Gemüsesuppe vorziehen*. Experimental items were distributed over four lists such that each subject heard each sentence fragment once and performed on an equal number of items per condition. Across subjects, each item appeared an equal number of times in each condition. Fillers were added to the lists and two pseudo-randomisations were generated. Training items were the same as in Experiment 1.

3.1.3 Procedure

The technical equipment and procedure were the same as in Experiment 1, except that subjects had to name experimental targets and to complete filler fragments by insertion of an appropriate determiner. The procedure for the experimental items was therefore more similar to that described by Marslen-Wilson et al. (1992) and Warren et al. (1995).

There were two experimental blocks with short pauses in-between. The whole experiment lasted approximately 15 min.

3.2 Results

Trials were discarded because of voice key problems and disfluencies or clicks by the subjects (5% of the trials). As subjects did not have to produce case-marked determiners in the experimental trials, there were no case errors.

Articulation latencies served as a dependent variable. Outliers were eliminated per subject and condition. After elimination of all values that differed from subjects' means by two standard deviations the results summarized in Table **5** were obtained.

Analyses of variance were performed on the reaction times. There was a significant main effect of Case ($F_1(1, 23) = 15.62$ ($MSe = 1583.65$), $p < .01$; $F_2(1, 31) = 8.73$ ($MSe = 3929.81$), $p < .01$) with longer articulation latencies in the dative as compared to the accusative conditions. Length did not have an effect (F_1 (1, 23) = 1.09 (MSe = 1321.02), p = .308; F_2 (1, 31) < 1) and there was no significant interaction of the factors Case and Length (F_1 (1, 23) < 1; F_2 (1, 31) < 1).

3.3 Discussion

Case had an impact on reaction times with longer reaction times in the dative conditions as compared to the accusative conditions. As verb length and lexical frequency were controlled for, the found differences are attributed to the manipulation of case. Unlike in Experiment 1, the case effect found in Experiment 2 is not subject to word order preferences. We conclude that the availability of single object structures varies as a function of case. This finding is in line with off-line completion data that reveal a single object preference after an accusative and a double object preference after a dative, as long as all given referents are animate (Scheepers and Corley 2000; Pappert et al. 2008).

However, even though previous studies showed that the cross-modal naming paradigm is suitable for revealing prosodic effects (Marslen-Wilson et al. 1992; Warren et al. 1995) and even though the task applied in Experiment 2 presumably induced less syntactic processing load than that used in Experiment 1, there was again no evidence that naming latencies were dependent on the original sentences' length (i.e., their prosodic characteristics).

4 General Discussion

Most lexicalist theories of incremental as well as predictive sentence comprehension attribute a central function to the verb (MacDonald et al. 1994; Jurafsky 1996; but see Gibson 1998; Levy 2008). Data from the processing of verb-final sentences that indicate an immediate integration of upcoming constituents have been interpreted as a challenge for lexicalist theories (Bader and Lasser 1994). However, studies that report evidence of the prediction of arguments before the subcategorizing verb are rare (Konieczny and Döring 2003; Scheepers et al., in prep.; Kamide et al. 2003; Nakatani and Gibson 2008). Experiments 1 and 2 add to the evidence by showing that prediction is feasible in verb-final structures. Both experiments identify case as an important factor for argument structure availability. The found case effect is attributable to word order preferences in Experiment 1 but not in Experiment 2. We suggest that longer articulation latencies for dative as compared to accusative verbs might arise from differences in both verb token and structural frequencies. That is, German verbs that subcategorize a single accusative object outnumber verbs that subcategorize a single dative object (Pappert et al. 2005). Moreover, under the given animacy restrictions, single object structures are more frequent after an accusative and double object structures are more frequent after a dative (own corpus data, report in preparation).

However, we do not assume that case alone triggers production and predictions. As already indicated, experiments that target incremental interpretation (Bornkessel and Schlesewsky 2006; Frisch and Schlesewsky 2001) and off-line completion (Pappert et al. 2008; cf. Scheepers and Corley 2000) reveal an interaction of case and animacy. We suggest that this interaction is relevant for argument structure availability as well. More specifically, we propose that the sentence processor relies on case and animacy information to project a typical thematic relation and to predict, where required, missing arguments (Pappert et al. 2008). Such a view is compatible with both a strict syntax-first view (Frazier 1987; Friederici 1995) as well as with a lexicalist view of sentence processing (MacDonald et al. 1994).

Finally, we must conclude that despite the fact that phonetic analyses revealed reliable prosodic cues to sentence length, there was no evidence that these cues were helpful during cross-modal completion or during cross-modal naming. We are reluctant to interpret this null effect. However, it might be taken into account that we were dealing with differences in declination, which are subtle prosodic differences. Prosodic effects found in the cross-modal naming paradigm (Marslen-Wilson et al. 1992; Warren et al. 1995) arose because of more perceptible prosodic differences due to boundary marking. However, assumedly subtle prosodic differences were found to produce reliable effects on prediction in the gating paradigm (Grosjean and Hirt 1996). We suggest that these different outcomes are due to the fact that the cross-modal paradigms target immediate responses whereas the gating paradigm elicits responses that are rather off-line. Certainly, further research is needed to ascertain the effects of prosodic cues on structural predictions.

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Case Matching and Conflicting Bindings Interference

Pavel Logačev and Shravan Vasishth

1 Introduction

The process of comprehending a sentence, just like any other cognitive process, requires us to use our memory. As we incrementally parse a sentence, linguistic objects have to be stored in working memory (WM) for later usage. Storage and recall, however, are usually not perfect – they are subject to a number of limitations imposed by principles of WM as well as the structure of objects encoded therein (e.g. Anderson and Paulson 1978; Lewis 1996; Miller and Chomsky 1963; Oberauer and Kliegl 2006). However, the observable effects of these limitations, can help reveal the internal structure of the representations used in parsing. One well-attested constraint on memory is similarity-based interference (SBI), that is increased difficulty in distinguishing between two objects in WM due to their similarity. One of the adverse effects of SBI is worse performance in understanding sentences containing similar noun phrases (NPs) as compared to dissimilar ones. In this paper, similarity will be operationalized as a match along some dimension, such as definiteness, animacy, etc., which may or may not be linguistic in nature. Since it is not restricted to the linguistic domain (e.g. Anderson and Paulson 1978) we assume that SBI is a general principle of memory, rather than something specific to language.

In this paper we will propose the idea that a specific storage and retrieval mechanism in memory is responsible for SBI (and importantly, the opposite of SBI in some cases). We will argue that the content-addressability of human WM requires objects in WM to represented as a set of *bindings* between this objects' features – and that this architecture of memory gives rise to a phenomenon known as case matching (or case attraction). In Experiments 1a-c we will provide experimental evidence favoring

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this account over the explanations proposed so far (e.g. Bader and Meng 1999; Fanselow et al. 1999; Schlesewsky 1996). Based on the results of Experiment 2, we will argue that case matching is in fact driven by abstract case and not by factors that case may be confounded with. We will furthermore explore the implications of this analysis for the representation of morphological case ambiguities and argue that ambiguous NPs must be represented by several distinct objects in WM.

Our work is set within the cue-based parsing framework (Lewis 1996; Lewis and Vasishth 2005; Lewis et al. 2006; Van Dyke and Lewis 2003; Vasishth et al. 2008; Vasishth and Lewis 2006; Vasishth 2008), which puts particular emphasis on the notion of *retrieval*. During the parsing process, every head (e.g. a verb) has to be *integrated* with its dependents (e.g. subject and/or object). This leads to the interesting situation that in head-final constructions the dependent has to first be retrieved from memory before integration can take place; this scenario is interesting because if multiple potential candidates for integration are present in memory, a choice has to be made during the retrieval process. The role of interference can only be investigated when several alternative candidates for retrieval exist. In the cue-based parsing framework, every object stored as a *chunk* (i.e. an object in WM). The probability and latency of retrieval of a dependent will depend on, among other factors, its *activation*. Activation in turn, depends on the number of times the object has been retrieved in the past and the amount of time that has passed since (time-based *decay*).

Since the model assumes a content-addressable memory (e.g. McElree 2000), retrieval is mediated by certain *cues*, which identify the linguistic object to be retrieved. These cues are derived from our syntactic, semantic or world knowledge, such as number (if the verb bears number agreement), case of the dependent, animacy, – and other factors determining the grammaticality or even typicality of usage of a dependent with the current head. The match between these cues and the target item is another significant determinant of the probability and latency of a successful retrieval operation.

In the following section we will present an overview of well-established phenomena involving retrieval interference, and the theoretical proposals in the literature that address the empirical evidence for retrieval interference.

2 Similarity-Based Interference

Similarity-based interference – interference due to a match of objects along some dimension – plays an important role in sentence comprehension. When readers encounter words or phrases similar to preceding ones, they often have difficulty in processing them. Gordon et al. (2001) demonstrated that subject- and object-clefts like (1a) and (1b) respectively are processed faster when the noun phrases (NPs) are of different types. Sentences with two proper names as well as those with two definite NPs were processed slower than mixed conditions. Comprehension accuracy was also lower for the similar conditions compared to the dissimilar ones. Both effects were more pronounced in object clefts.

(1) a. It was *the barber/John* that saw *the lawyer/Bill* in the parking lot.
b. It was *the barber/John* that *the lawyer/Bill* saw in the parking lot.

In subsequent work, Gordon et al. (2002) asked participants to memorize a list of three common nouns or three proper names before reading sentences as in (1). Both the NPs in the sentence were either definite descriptions or proper names. Reading times as well as error rates on recall of the memorized list were significantly higher in the matched conditions, suggesting that interference effects can be caused by an external memory load – and therefore arise as a consequence of general memory constraints. Similar effects can be found for animacy (Suckow et al. 2005) and case marking. Regarding case marking, Babyonyshev and Gibson (1999) collected complexity ratings for double-embedded Japanese sentences in which two of the grammatical subjects were always marked with the nominative case marker *–ga* while a third one was either marked with *–ga* or with the topic marker *–wa*. Although both options are grammatical in Japanese, participants found the sentences with two nominative markers and one topic marker easier to understand than sentences with three nominative markers. Babyonyshev and Gibson interpreted this result as evidence for lower structural prediction cost (because more verb-phrases are predicted for three nominative NPs than for two nominative- and one topic-marked NP). However, the results can also be interpreted as evidence for lower interference cost: the three nominative-marked NPs could cause more interference than two nominative- and one topic-marked NP.

Assuming such an interpretation of the Babyonyshev and Gibson results, it is not clear whether interference is due to phonological or more abstract properties of the case markers. Fedorenko et al. (2004) addressed this issue by making use of different inflection paradigms for feminine and masculine nouns in Russian. In a self-paced reading experiment, they investigated how case marking and abstract case (i.e. case without explicit morphological marking) affect *retrieval interference*.[1]

Fedorenko et al. (2004) varied case markers and abstract case independently from each other. While in both, (2a) and (2c), *the violinist* and *the pianist* bear the same morphological case marker *-u*, their abstract case matches only in (2a) (both NPs are accusative), because in (2a) the verbs *respect* and *anger* both assign accusative case to their objects. In (2c), however, the verb *call* in (2c) assigns dative case and thus abstract case does not match. In (2b) and (2d) the morphological marking of the two NPs differs, but it is only in (2d) that the abstract case differs as well. The authors found significantly higher reading times at the verb *angered* in condition (2a), but no significant differences between the other conditions. They conclude that case interference does not stem from identical morphological case marking or matching abstract case alone. Rather, both need to match for case interference to arise.[2]

[1] Retrieval interference occurs during a retrieval operation, e.g. while processing the head, but it is dependent on the relation between the target item and competitors.

[2] There is one caveat to this experiment, however. In (2a) and (2d) the nouns involved match in gender, which is not so in (2b) and (2d). So the data do not exclude an interpretation in which gender and abstract case conspire to cause interference if both match, while the case marker does not have any effect at all.

(2) a. *[[Uvažavšuju skripačk**u**] pianistk**u**] razozlil …*
Respecting violinist FEM.ACC pianist.FEM.ACC angered
'angered the pianist, who respected the violinist'

b. *[[Uvažavšuju skripač**a**] pianistk**u**] razozlil …*
Respecting violinist.MASC.ACC pianist.FEM.ACC angered
'angered the pianist, who respected the violinist'

c. *[[Pozvonivšuju skripač**u**] pianistk**u**] razozlil …*
having.called violinist.MASC.DAT pianist.FEM.ACC angered
'angered the pianist, who had called the violinist'

d. *[[Pozvonivšuju skripačk**e**] pianistk**u**] razozlil …*
having.called violinist.FEM.DAT pianist.FEM.ACC angered
'angered the pianist, who had called the violinist'

… *dirižer iz izvestnoj konservatorii*
conductor.NOM from famous conservatory

… *posle generalnoj repetitsii.*
after final rehearsal

'After the final rehearsal, the conductor from a famous conservatory angered the pianist, who respected/had called the violinist.'

Other evidence suggests that interference arises due to *retrieval cues* that drive integration processes. In a self-paced reading study, Van Dyke and McElree (2006) presented object clefts like (3) with and without a preceding memory load (Load and No-Load). In the Load conditions, participants had to memorize a list of three proper nouns before reading the sentence. Critically, all nouns were potential objects of *fixed* in (3b), but not of *sailed* in (3a). In the Load conditions they found a significant slowdown in (3b) as compared to (3a), but not in the No-Load conditions. Consistent with the idea of retrieval interference, the slowdown occurred at the verbs *fixed* and *sailed* respectively.

(3) a. It was the boat that the guy who lived by the sea *sailed* in two sunny days.
b. It was the boat that the guy who lived by the sea *fixed* in two sunny days.

On these grounds Van Dyke and McElree argue that similarity-based interference (SBI) arises as a consequence of cue-based retrieval operations needed for retrieving dependent NPs from WM in order to combine them with the verb. When the clefted object is retrieved at the verb *fixed* or *sailed* in (3), one of the cues will be its 'fixabiliy' or 'sailability'. They claim that the better the cues match the object *boat* in memory, the higher its probability of being retrieved. But in addition, the better the cues match the competitors from the memory list, the higher their retrieval probability. Higher retrieval probability for the competitors means lower retrieval probability for the target. Thus, the stronger the competitors for *boat,* the less likely it is to be retrieved. Since the items in the memory list are more plausible objects for *fixed* than for *sailed*, they share more of the targets features required by the retrieval cues in (3b). Thus, *cue-overload* makes them stronger competitors for *boat* in (3b) than in (3a) – and the probability of retrieving a wrong item is higher for *fixed*. Hence the slowdown in (3b) given a memory load.

How can the Van Dyke and McElree interference model explain the Gordon et al and Fedorenko et al results? It seems that it cannot. Consider Gordon and colleagues' findings again. The influence of NP type in (1) (repeated in (4)) cannot be mediated by a cue-overload: verbs do not in general subcategorize for the type of referential expression of their arguments. But even if they did in this case – a **match** in referential properties of two NPs seems to be impossible to subcategorize for, because a match does not help in identifying a single object, it is rather a relation between two objects. Therefore, it appears that the Van Dyke and McElree model cannot explain why Gordon and colleagues find interference effects due to the referential types of NPs.

(4) a. It was *the barber/John* that saw *the lawyer/Bill* in the parking lot.
    b. It was *the barber/John* that *the lawyer/Bill* saw in the parking lot.

The Van Dyke and McElree model cannot explain Fedorenko and colleagues' findings either: while abstract case in (2) is a very probable candidate for a retrieval cue, the surface form of the case marking seems an unlikely one. Since the effect in (3) does not appear to be reducible to a non-cue-based mechanism, it follows that we are dealing with two distinct kinds of interference.

Moreover, in contrast to Van Dyke and McElree's claims concerning cue-based SBI, recent work (Logacev and Vasishth in preparation) has demonstrated that non-cue-driven SBI does not rise monotonically with increasing similarity. In an eye tracking study, we presented stimuli such as (5), consisting of a matrix clause with an intervening relative clause. We manipulated both subjects (i.e. *painter* and *sculptor* in (5a)) along two different dimensions: gender and noun type. Gender is overtly marked in German and it could be masculine (*Maler*) or feminine (*Malerin*) in this experiment. For noun type we chose occupations such as *painter, sculptor, policeman, etc.* and nationalities. We were interested in the effect of match and mismatch along one or both these dimensions. In (5) this manipulation is illustrated for the first subject noun phrase. In (5b) both subjects match only in noun type, in (5c) only in gender, in (5a) in both, and in (5d) in none of these features. Importantly, noun type and gender match are variables that cannot be subcategorized for, and therefore any interference effect during retrieval must be non-cue-driven.

(5) a.	*Die Malerin*	*hat*	*die Snacks,*	*die*	*die Bildhauerin*	…
	the painter.FEM	AUX	the snacks,	which	the sculptor.FEM	
b.	*Der Maler*	*hat*	*die Snacks,*	*die*	*die Bildhauerin*	…
	the painter.MASC	AUX	the snacks,	which	the sculptor.FEM	
c.	*Die Kroatin*	*hat*	*die Snacks,*	*die*	*die Bildhauerin*	…
	the croatian.FEM	AUX	the snacks,	which	the sculptor.FEM	
d.	*Der Kroate*	*hat*	*die Snacks,*	*die*	*die Bildhauerin*	…
	the croatian.MASC	AUX	the snacks,	which	the sculptor.FEM	

…	*neulich*	*mitbrachte*	*nur*	*widerwillig*	*serviert.*
	recently	brought	only	reluctantly	served

'The painter/Croatian only reluctantly served the snacks that the sculptor bought recently.'

Conditions with one matching feature, i.e. (5b,c), were read more slowly at the embedded verb *mitbrachte* than the maximally mismatching condition (5d) and the maximally matching (5a). This means that a match in gender has an adverse effect on processing, but only if the noun type does not match. If the noun type does match, a gender match *facilitates* processing, contrary to the predictions of all current SBI theories. In other words, a noun type match facilitates a gender match, and a noun type mismatch facilitates a gender mismatch during retrieval.

This surprising finding is not limited to language processing. Hommel (1998) showed participants two visual objects (S1 and S2) on a computer screen with a 500 ms interval in-between. These were varied in shape and color. For instance, there could be a red 'O' and a green 'X'. Both objects were varied with respect to color, shape and location on the screen. After the second stimulus (S2) was presented, participants had to respond to its shape by pressing a corresponding button (e.g. right for 'X', left for 'O'). Interestingly, the reaction time for this decision was affected by the relationship between the two objects. Reaction time was slower if the shape (respectively color) of S1 was identical in S2, while the colors (respectively shapes) of S1 and S2 were different; but if both shape and color were identical, reaction time was faster. The same type of interaction was present between shape and location repetition as well. (This effect appears to be very reliable, see also Hommel and Colzato 2004; Colzato et al. 2006).

Hommel explains these effects by assuming a particular structure of so-called object files, which are created for every perceived object. To form such an object file, features such as shape, color and location are linked to each other by pairwise bindings. When an object is processed it is encoded in memory and its shape will be bound to its color and also to its location, thereby forming an object file, i.e. the object's representation.

We will define a binding B_1 as *conflicting* with another binding B_2 if one feature is common to both bindings, and B_1 links this feature to another feature F_1, while B_2 links it to F_2, and F_1 and F_2 are distinct.[3] Hommel assumes that conflicting bindings are the source of interference effects. For example, if only one feature of stimulus object S1 is present in S2, conflicting bindings will incur higher processing costs. While for a green object 'X', the color feature *green* will be bound to the shape feature *X*, the same color feature would have to be bound to another shape feature for a green 'O'. These bindings would conflict, and therefore interfere. They would not interfere if the two objects presented were a green 'O' and a red 'X'. In this case the objects would not share any (experimentally relevant) features, and thus no feature would be involved in two conflicting bindings. This sort of encoding seems not to be domain-specific (e.g. Hommel 1998).

Our explanation for the surprising interaction in (5) runs along the same lines. We assume that linguistic objects consist of features linked to each other by pairwise

[3] We will furthermore assume throughout this paper, that B_1 and B_2 will conflict only if F_1 and F_2 are of the same type, e.g. case, gender, etc. This is only for expository reasons. Untyped bindings make the same predictions.

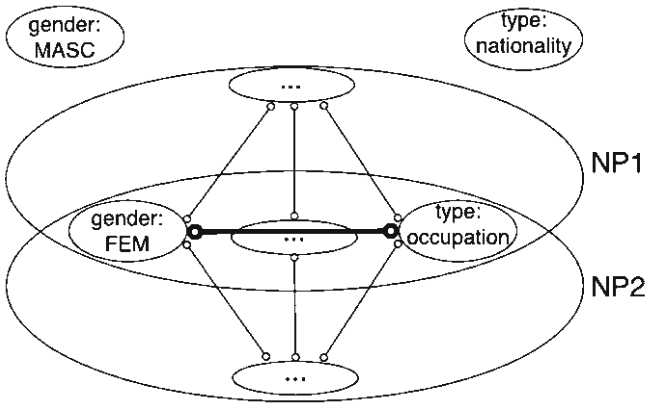

Fig. 1 Example (5a), gender and noun type match. *Bold line*: non-conflicting binding

bindings, just like in object files. Every object is represented by the totality of its bindings, i.e. links between its features. The source of interference in retrieval are not just the features shared by other objects, it is rather the conflicting bindings which are part of those objects.

Let us revisit the findings in (5) in light of this architecture. Figure 1 schematically depicts the bindings involved in representing the NPs in (5a). We focus only on features related to noun type and gender. The representation of [*the sculptor*$_{FEM}$], marked as NP1 in the figure, involves bindings between the feature bundle associated with occupations and the feature (or feature bundle) associated with feminine gender. [*the painter*$_{FEM}$], marked as NP2, involves the very same bindings. Since they are identical, there is no conflict present. In Fig. 2, on the other hand, [*the painter*$_{MASC}$] has a binding between occupation and masculine gender. Since both sets of bindings involve occupation, but link it to different genders, they are conflicting in (5b). This conflict leads to processing difficulty. The explanation for the reverse effect in (5c,d), i.e. facilitated processing of a gender mismatch if the noun type is different, is that in (5c) (Fig. 3) the same gender is bound to nationality and occupations, while in (5d) (Fig. 4) each noun type is associated with a different gender, so there is no conflict in (5d).

Overall, there seems to be evidence for two mechanisms known under the name SBI, cue-based (Van Dyke and colleagues) and non-cue-based (Gordon and colleagues and Fedorenko and colleagues). Since the latter stems from conflicting bindings interfering during retrieval and exhibits a slightly different pattern than SBI in the sense of Van Dyke and McElree (2006), *conflicting bindings retrieval interference* (CBRI) might be a more appropriate term for non-cue-based interference. This kind of interference probably reflects difficulty in activating (i.e. retrieving) an item in content-addressable memory.

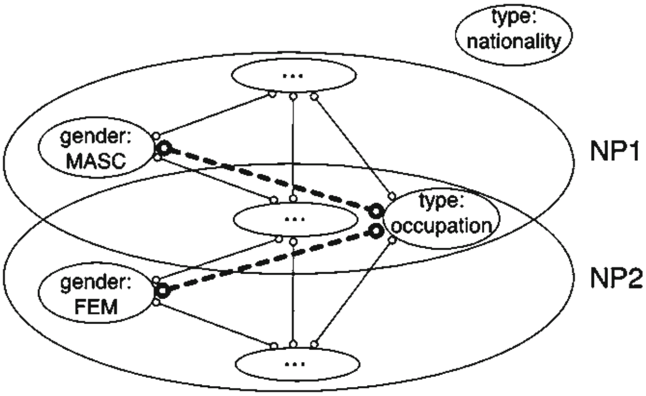

Fig. 2 Example (5b), gender mismatch. *Bold dashed lines*: conflicting bindings

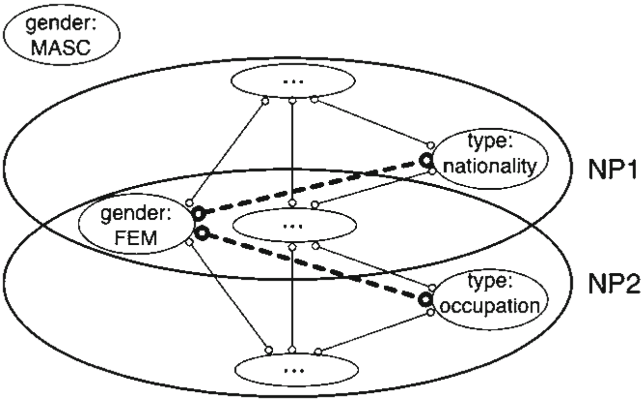

Fig. 3 Example (5c), noun type mismatch. *Bold dashed lines*: conflicting bindings

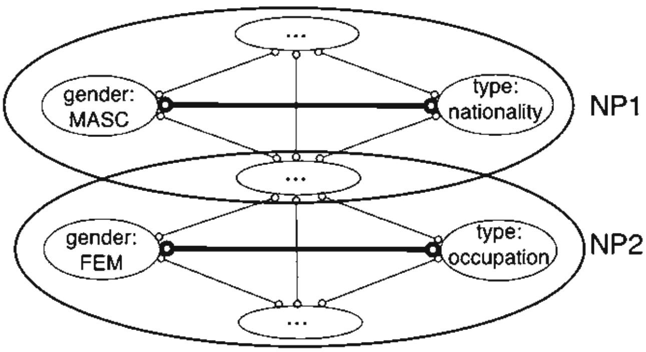

Fig. 4 Example (5d), gender and noun type mismatch. *Bold lines*: non-conflicting bindings

But how can CBRI account for Gordon et al.'s and Fedorenko et al.'s results? Let us assume, for the sake of simplicity, that the strength of interference depends on the sum of conflicting bindings involved in the representation of the target item and its competitor and that both objects have the same number of features. Most of the time, when an object is retrieved there will be some conflicting bindings. The observed slowdown in processing is due to a relative difference in the number of such bindings between two conditions. If in one condition there are more conflicting bindings than in another, an interference effect arises. Since all features are linked to each other by pair-wise bindings, the feature bundle manipulated in the experiment will be linked to all other features in the object. Thus, if both objects match in this feature, all its links to other matching features will be non-conflicting, while all its links to mismatching features will conflict. If it mismatches, the opposite is true: each link to a matching feature will be a conflicting one, whereas each link to a mismatching feature will be non-conflicting.[4]

The amount of additional interference caused by an additional matching feature will depend on the difference between mismatching and matching features excluding the ones subject to the experimental manipulation, i.e. the amount of dissimilarity not affected by the experimental manipulation. If there are more mismatching features than matching ones, an increase in similarity will turn more non-conflicting bindings into conflicting ones than vice versa. The net effect will be an increase in the number of conflicts, yielding interference. If, however, there are more matching features than mismatching ones, interference will decrease.

Roughly speaking, interference occurs whenever the similarity of two dissimilar objects is increased.[5]

The critical manipulation in the Gordon et al. experiment in (1) was the noun phase type. It is not implausible to assume that the similarity of the noun phrases used, excluding features affected by the experimental manipulation, is not very

[4] More formally, if two objects have n and all features belonging to an object are bound to each other every feature will be bound to $(n-1)$ others. Since bindings are bidirectional, both objects will consist of $((n-1)+(n-2)+\ldots+2+1)$ bindings each. If they match in k features, each object will contain $k*(n-k)$ conflicts, because only bindings from matching to mismatching features are conflicting, and every object contains k of the former and $(n-k)$ of the latter. If we increase similarity by making q more features match, the number of conflicts will be $(k+q)*(n-(k+q))$. An interference effect due to additional similarity corresponds to $k*(n-k)<(k+q)*n-((k+q))$. One can easily show that this is the case iff k < n/2. Thus one can formally demonstrate that for low levels of similarity, CBRI predicts an interference effect if the objects are made more similar, while for high levels of similarity it predicts the opposite.

[5] Admittedly, the exact differences between the numbers of matching and mismatching features for any two objects may appear to be a free parameter in the CBRI theory. They are, however, not completely unconstrained. Although precise quantitative predictions of CBRI rely on the objects' similarity at least on an interval scale, we can still derive qualitative predictions from similarity rankings on an ordinal scale, available from uncontroversial intuitions and possibly similarity rating studies.

high, given that the nouns were not necessarily related and referred to completely distinct discourse referents. Additionally, the effect was most pronounced in objects clefts, in which one NP was a subject and the other one was the object.

As for the Fedorenko et al. experiment (example (2)), the manipulation was somewhat more complex. Three features of the noun phrase were manipulated: the case marker, the abstract case, and the gender of the first noun phrase. Although the last feature was not an experimental factor, it had to be changed to switch the inflectional class and thus dissociate case marking from abstract case. The only condition suffering interference was (2a) in which the target and the competitor shared all three of them. Again, the two nouns had distinct discourse referents, and while the first one was the patient or theme of the participle (first verb), the second one was its agent.

Under the assumption that in both experiments the number of mismatching noun phrase features outweighed the number of matching ones, CBRI predicts an interference effect, thereby accounting for non-cue-based interference.

Critically, however, if the noun phrases involved exceed a certain level of similarity, we should observe the reverse effect. An increase in similarity should not slow down, but rather speed up processing. It is this property of CBRI, which makes it able to account for a phenomenon called *case matching*, which we discuss in the next section.

3 Case Matching

Case attraction, first discussed by Bader (1996), also known as case matching can be roughly characterized as the facilitation of sentences in which two coreferent NPs bear the same case. It was demonstrated in self-paced reading (Schlesewsky 1996; Fanselow et al. 1999) and speeded acceptability judgment tasks (e.g. Bader and Meng 1999).

For example, the noun *Opernsängerinnen* in (6) is locally ambiguous with respect to case. Morphologically, it can be nominative, accusative or dative, but the presence of the nominative NP *der Tenor* excludes the nominative reading. *Opernsängerinnen* is disambiguated by the verb *begrüßen*, which requires an accusative object. But disambiguation takes place only after the adjunct clause (in bold), which contains the pronoun coreferent with *Opernsängerinnen*. In (6a) it is the accusative pronoun *sie* and in (6b) the dative pronoun *ihnen*. Schlesewsky (1996; cf. also Fanselow et al. 1999) demonstrated that disambiguation of *Opernsängerinnen* towards accusative case is harder if the coreferent dative pronoun *ihnen* (6b) (rather than the accusative pronoun *sie,* (*6a*)) intervenes between *Opernsängerinnen* and the verb *begrüßen*. In a self-paced reading task this was reflected in higher reading times at the disambiguating region (*begrüßen sollte*). Thus, sentences like (6a) with an accusative pronoun were easier to process than (6b). For disambiguation towards dative, the reverse was true – a dative pronoun facilitated processing. Apparently, processing is easier if the case of the pronoun matches that of its antecedent.

(6) *Der Tenor* *behauptet,* *dass* *man* *Opernsängerinnen,* …
The tenor.NOM claims that one opera singers.ACC

a. *obwohl* *man* *sie* *erkennt,* *begrüßen* *sollte* …
although one them.ACC recognizes greet should

b. *obwohl* *man* *ihnen* *misstraut,* *begrüßen* *sollte* …
although one them.DAT mistrusts greet should

'The tenor claims that one should greet opera singers, although one recognizes/mistrusts them.'

The same effect held true for sentences such as (7), involving a restrictive relative clause instead of a parenthetic insertion.

(7) *Der Tenor* *behauptet,* *dass* *man* *Opernsängerinnen,* …
The tenor.NOM claims that one opera singerss.ACC

a. *die* *man* *erkennt,* *begrüßen* *sollte* …
who.ACC one recognizes greet should

b. *denen* *man* *misstraut,* *begrüßen* *sollte* …
who.DAT one mistrusts greet should

'The tenor claims that one should greet opera singers, who one recognizes/mistrusts.'

This phenomenon seems quite unexpected, given the reverse pattern in the findings of Babyonyshev and Gibson (1999) and Fedorenko et al. (2004). In their experiments, identical case marking did not facilitate but rather hindered processing. And thus it appears that coreference between the two NPs involved is a necessary precondition for case matching. And in fact, Fanselow et al. (1999) present evidence that this effect disappears if *sie/ihnen* is replaced by a second- or first person pronoun, thereby excluding coreference.

All interpretations of the case-matching effect involve the assumption that the unambiguous pronoun somehow affects the representation of the ambiguous NP such that it ends up having the same case as the pronoun before it is reanalyzed. According to Schlesewsky (1996), case matching is caused by the parser's tendency to unify as many features of coreferent NPs as possible, which serves as a disambiguation strategy; let us refer to this as the unification account. Fanselow et al. (1999) explain it by means of a grammatically motivated OT-constraint AGRCASE, which requires coreferent NPs to agree in case. Thus of the two readings of *Opernsängerinnen* the parser will adopt the one conforming to AGRCASE, leading to reanalysis effects at *begrüßen* in (6b) and (7b).

Bader and Meng (1999; cf. also Bader et al. 2000; Bayer et al. 2001) on the other hand relate case matching to number attraction. In their account, the head noun of an NP which does not bear a marked case may attract the case feature of a relative pronoun that it c-commands. According to them, both nominative and accusative are unmarked cases in German, while dative is marked. Critically, the attractor noun does not need to be ambiguous in order to attract a marked case feature – bearing an unmarked case is sufficient (Bader and Meng 1999). In fact, ambiguous NPs in German are always compatible with unmarked case. Thus, under Bader and colleagues' view, case matching is expected to occur only in certain syntactic configurations in which an antecedent compatible with unmarked case precedes and c-commands a (relative) pronoun bearing a syntactically marked case.

Critically, if percolation occurs only in an upward direction, attraction of marked case does not predict case matching to occur in the configuration in (8) and (9). In (8), *[die Frau]*, which is assigned accusative case by the verb *überrascht*, serves as an antecedent for the next word, the locally ambiguous relative pronoun *die*. The relative pronoun's syntactic function is disambiguated only at the auxiliary *hat/ haben* via number agreement. When the auxiliary is the singular-marked *hat* (in (8a)) the relative pronoun is disambiguated as the nominative subject; when the auxiliary is the plural-marked *haben* (in (8b)), the relative pronoun is disambiguated as the accusative object (the subject is now *[die Männer]*).

(8)	*Der Soldat*	*überrascht*	*die Frau,*	…
	The soldier.NOM	surprises	the woman.ACC	

a.	*die*	*glücklicherweise*	*die Männer*	*besucht*	*hat,*	…
	who.NOM/ACC	luckily	the men.ACC/NOM	visited	AUX.SG	
b.	*die*	*glücklicherweise*	*die Männer*	*besucht*	*haben,*	…
	who.ACC/NOM	luckily	the men.NOM/ACC	visited	AUX.PL	

'The soldier surprises the woman who, luckily, has visited the men./
The soldier surprises the woman who, luckily, the men have visited.'

(9)	*Das*	*ist*	*die Frau,*	…
	this	is	the woman.NOM	

a.	*die*	*glücklicherweise*	*die Männer*	*besucht*	*hat,*	…
	who.NOM/ACC	luckily	the men.ACC/NOM	visited	AUX.SG	
b.	*die*	*glücklicherweise*	*die Männer*	*besucht*	*haben,*	…
	who.ACC/NOM	luckily	the men.NOM/ACC	visited	AUX.PL	

'That's the woman who, luckily, has visited the men./
That's the woman who, luckily, the men have visited.'

Example (9) differs only in the case assigned to *[die Frau]*; here the copula assigns nominative case. The relative clauses are identical to the ones in (8). In (9), there should be no attraction of marked case, as assumed by Bader and colleagues'. That is because dative case is not involved in this construction and thus no marked case can be attracted.

However, Schlesewsky (1996, also reported in Fanselow et al. 1999) showed that the processing time for the auxiliary depends on the case match between the relative pronoun and its antecedent. If it does match, like in (8b) and (9a), processing is easier than in the non-matching counterpart. Thus the disambiguating auxiliary was read more slowly in (8a) than in (8b), while (9a) was read faster than (9b). In other words, the case marking percolates downwards from *die Frau* to the relative pronoun *die*, which is incompatible with the Bader et al. account because (a) no marked case is involved and (b) attraction only supposed to happen in upward direction, but here *[die Frau]* c-commands the relative pronoun that it biases. It follows that case matching does not depend on any particular linearization of pronoun and antecedent, which favors the unification account over case attraction.

4 Case Matching and Conflicting Bindings

But how does case matching relate to conflicting bindings? Let us recall the effect of CBRI: Similarities of dissimilar objects and dissimilarities of similar objects have an adverse effect on the retrieval latency. Coreferent NPs can be considered very similar by virtue of sharing the same discourse referent. Obviously, they may differ in syntactic and lexical properties (as they do in (6–9)), but they are as close to identity as possible for two different objects. Therefore the slowdown in processing due to mismatching case is not unexpected, given that dissimilarities of similar objects make retrieval harder.

If CBRI is the mechanism underlying case matching, we would expect the same effect even without coreference as long as we allow for enough similarity between the NPs. Importantly, Fanselow et al. (1999) as well as Schlesewsky (1996) would not predict such an effect, since both accounts rely on an anaphoric relationship between the NPs involved.

To test the opposing predictions of CBRI and the unification account, we conducted experiments 1a and 1b. We used a partitive construction referring to a proper subset of its antecedent. We used stimuli like (10) which contained a case ambiguous conjunctive NP *Leo and Tim (=NP1)* followed by a concessive clause (*, obwohl …,*) containing the partitive construction *one of them (=NP2)*. In a factorial design the case of NP1 was crossed with the case of NP2, and the case of the former was not resolved until the second verb (*grüßen*, which assigns dative case to its object*;* and *glauben,* which assigns accusative case). If CBRI is the explanation for case matching, then (10c) should be harder to process than (10a) and (10b) harder than (10d). The processing difficulty should occur at the second verb, because it is here that the ambiguous NP is disambiguated/retrieved.

Additionally, this design allowed us to directly contrast the predictions from CBRI with predictions of coreference-based accounts. Although the partitive construction *einen/einem von ihnen* varied in case, it always contained the pronoun *ihnen*, bearing dative case. Thus, if case matching phenomena are driven by coreference, we would expect the ambiguous NP to be biased towards dative in all conditions. This should lead to a processing difficulty if the ambiguity is resolved to accusative – thereby making conditions (10a,c) harder to process than (10b,d).

(10)	*Dass*	*er*	*[Leo und Tim]$_i$,*	*obwohl*	*er*	…
	that	he	Leo and Tim.ACC/DAT	although	he	

(a)	…	*[einen*	*[von*	*ihnen$_i$]]*	*verabscheut,*	*grüßen*	*sollte*	…
		one.ACC	of	them.DAT	despises	greet [_ ACC]	should	
(b)	…	*[einen*	*[von*	*ihnen$_i$]]*	*verabscheut,*	*glauben*	*sollte*	…
		one.ACC	of	them.DAT	despises	believe [_ DAT]	should	
(c)	…	*[einem*	*[von*	*ihnen$_i$]]*	*misstraut,*	*grüßen*	*sollte*	…
		one.DAT	of	them.DAT	mistrusts	greet [_ ACC]	should	
(d)	…	*[einem*	*[von*	*ihnen$_i$]]*	*misstraut,*	*glauben*	*sollte*	…
		one.DAT	of	them.DAT	mistrusts	greet [_ DAT]	should	

…	*glaubt*	*Sebastian*	*nicht.*
	think	Sebastian	not

'Sebastian does not think, that he should greet/believe Tim and Leo, although he despises/mistrusts one of them.'

Importantly, CBRI's predictions rely on the assumption that the memory representation of morphologically ambiguous NPs consists of several distinct objects (*chunks*) and disambiguation involves retrieving the correct one. In principle, the parser could apply some sort of heuristic in order to tentatively resolve an ambiguity (cf. e.g. Bader et al. 2000; Hopf et al. 2003 inter alia). In this case the ambiguous NP would be represented by one chunk, which should suffer CBRI from a pronoun of a different case. Consequently, there should be a main effect of the first verb's (V1) case, but no case matching effect. Another possibility is to represent an ambiguous NP by means of one chunk with an underspecified case feature – but again no case matching effect is to be expected, because since it is always the same chunk being retrieved, it should always suffer the same amount of interference, independent of the case it is finally disambiguated towards. So the CBRI account is not compatible with a single-chunk representation of ambiguous NPs, it requires case ambiguities to be represented by several chunks corresponding to their respective possibilities for disambiguation. Thus, evidence in favor of similarity as the driving force behind case matching would also constitute evidence in favor of a parallel representation of (some) ambiguities.

To recapitulate, a CBRI-based account of case matching predicts processing difficulty when the case of the ambiguous NP turns out to bear a different case than the partitive construction. Hence (10b,c) should be read more slowly than (10a,d). Accounts based on coreference, on the other hand, predict a slowdown when the ambiguous NP is resolved towards accusative, since the coreferent pronoun, which is part of the partitive construction is marked as dative. In this case (10a,c) should be read slower than (10d,b).

In order to test these predictions we conducted an eye-tracking experiment as well as an additional self-paced reading experiment and a plausibility rating study.[6]

4.1 Experiment 1a (Eye-Tracking)

4.1.1 Participants

Fifty-six undergraduate students from University of Potsdam participated in exchange for course credit or a payment of 7€.

4.1.2 Procedure

Both filler and target materials were presented as whole texts on a single line. Participants were seated 55 cm from a 17 in. color monitor with 1024 × 768 pixel resolution. They were asked to sit comfortably in front of an IView-X eye-tracker (SensoMotoric Instruments) running at 240 Hz sampling rate, 0.025° tracking resolution, <0.5° gaze position accuracy. They were asked to place their head in a frame and to position their chin on a chin-rest for stability. Viewing was binocular, but only the participant's right eye was tracked. Participants were asked to avoid large head movements throughout the experiment. The presentation of the materials and the recording of responses was controlled by two PCs running proprietary software. Each participant was randomly assigned one of four pseudo-randomized sentence lists.

At the start of the experiment the experimenter performed a standard calibration procedure, which involved participants looking at a grid of 13 fixation targets in random succession in order to validate their gazes. Calibration and validation were repeated after every 10–15 trials throughout the experiment, or if the experimenter noticed that measurement accuracy was poor (e.g., after large head movements or a change in the participant's posture). Participants had the opportunity to take a break if they felt tired.

[6] The self-paced reading method was used to ensure comparability of our results with the results obtained by Schlesewsky (1996) and Fanselow et al. (1999). The plausibility rating study on the other hand, served to exclude potential systematic differences in plausibility caused by the fact that the proposition of the sentence was not constant across conditions.

Each trial was structured in the following way: First, a fixation target in the same position as the first character of the text display was presented; a fixation on this target triggered the presentation of the sentence. This ensured that participants always started reading in the leftmost character position. Each sentence was presented in one line. Participants were instructed to read the sentence at a normal pace and to click a mouse button after finishing the sentence. To ensure that sentences were read for comprehension this was followed by a simple comprehension question, which the participant answered with 'yes' or 'no' by clicking one of two boxes on the screen. Responding to the question triggered the presentation of the next trial. A complete session took about 45 min to complete.

4.1.3 Stimuli

The stimuli consisted of 16 sets of items such as (10). The four conditions resulting from crossing the factors *V1 case* (case assigned by the first verb to the partitive construction) and *V2 case* (case assigned by the second verb to the ambiguous NP) were divided into four pseudo-randomized lists using a latin-square design. They were intermixed with 70 fillers and 32 sentences from another, unrelated, experiment. The questions were targeted at either the matrix or embedded verb, or at the matrix or embedded clause object. In the latter case they focused on whether the proposition applies to one or both individuals.[7]

4.1.4 Results

Before we turn to the analyses of experimental data, we would like to present an overview of the eye tracking measures we used, together with their definition and the interpretation we attribute to them (cf. Table 1).

We analyzed first-pass reading time (FPRT), regression-path duration (RPD), total-fixation time (TFT) and regression probability (RP) at the region comprising the disambiguating verb (*grüßen/glauben* in (8)) and the auxiliary.[8] Additionally, we made use of regressive refixation probability (RRP_{verb+}) and regressive re-reading time (RRT_{verb+}) at the locally ambiguous NP and the partitive construction after disambiguation, i.e. subsequent to a fixation on the disambiguating verb or anything to the right of it. We did not exclude data from trials followed by a wrong response because interference may lead to different levels of accuracy. If online effects and accuracy are interdependent then considering only correct responses may distort the

[7] These questions were meant to direct the participants' attention to the fact that the embedded clause object was a partitive construction and not a pronoun.

[8] If the verb was preceded by an adverb (in two items), it was included in the region too. One item lacked an auxiliary, and so the region consisted of the verb only.

Table 1 Definitions of eye-tracking measures and their interpretations

Symbol	Measure	Definition	Hypothesized cognitive process
FPRT	First-pass reading time, gaze duration	The sum of all fixations in a region during first pass	Text integration (Inhoff 1984) but cf. (Rayner and Pollatsek 1987)
RP	Regression probability	Likelihood of jumping back to a previous word during the first pass	Resolution of temporary ambiguity (Frazier and Rayner 1982; Clifton et al. 2003)
RPD	Regression path duration	The sum of all fixations from the first fixation on the region of interest up to, but excluding, the first fixation downstream from the region of interest	Integration difficulty (Clifton et al. 2007, 349)
TFT	Total fixation time	Sum of all fixation durations of a word	General comprehension difficulty
RRP_{W+}	Regressive refixation probability	Likelihood of jumping back to a preceding word after reading word W or anything further downstream	Processing difficulty associated with a word, caused by W
RRT_{W+}	Regressive re-reading time	Time spent reading a preceding word after a regression from word W or anything further downstream	Re-processing difficulty associated with a word, caused by W

data instead of removing noise. The dependent measures were computed with the R package *em* (Logačev and Vasishth 2006). All reading times were log-transformed before analysis. Reading times recorded as zero were excluded.

A mixed-effects model (Bates and Sarkar 2007; Gelman and Hill 2007) was fit with participants and items as crossed random factors, and V1 case and V2 case as fixed factors. No significant effects were found at the ambiguous NP an the partitive construction, although there was a marginally significant effect of V1 in regressive re-reading time on the partitive construction ($t=1.82$) due to longer re-reading times on dative partitive constructions. Additionally, there was a marginally significant interaction between V1 case and V2 case in regressive refixation probability ($t=1.64$) due to more regressions to the partitive construction if V1 case did not match V2 case. At the disambiguating verb region we found a significant interaction in regression-path duration ($t=-2.00$) and regression probability ($t=2.11$); both due to longer reading times respectively more regressions if V1 case did not match V2 case (i.e. in conditions (10c,d)). There was no main effect at the disambiguating region ($|t|<1.5$). There were no significant effects in comprehension accuracy (Tables 2–6).

Discussion will be postponed until after Experiment 1c.

Table 2 Eye-tracking measures at the ambiguous NP and the partitive construction, SE in brackets

Condition measure	(10a)	(10b)	(10c)	(10d)
Ambiguous NP				
RRP_{verb+}	.37 (.03)	.37 (.03)	.35 (.03)	.33 (.03)
RRT_{verb+}	194 (27)	202 (19)	247 (29)	230 (27)
Partitive construction				
RRP_{verb+}	.34 (.03)	.39 (.03)	.39 (.03)	.36 (.03)
RRT_{verb+}	241 (27)	266 (31)	355 (42)	287 (39)

Table 3 T-values for the ambiguous NP and the partitive construction

Factor measure	V1 case	V2 case	V1 case × V2 case
Ambiguous NP			
RRP_{verb+}	t=−0.52	t=0.13	t=−0.55
RRT_{verb+}	t=0.22	t=0.28	t=0.17
Partitive construction			
RRP_{verb+}	t=1.42	t=1.42	t=−1.64
RRT_{verb+}	t=1.82	t=0.59	t=0.22

Table 4 Eye-tracking measures at the disambiguating region, SE in brackets

Condition measure	(10a)	(10b)	(10c)	(10d)
FPRT	149 (9)	152 (8)	153 (11)	147 (9)
RPD	169 (10)	185 (11)	188 (14)	175 (12)
TFT	224 (14)	232 (13)	227 (15)	228 (16)
RP	.08 (.02)	.12 (.02)	.11 (.02)	.07 (.02)

Table 5 T-values for the disambiguating region

Factor measure	V1 case	V2 case	V1 case × V2 case
FPRT	t=0.65	t=1.14	t=−1.30
RPD	t=0.83	t=1.38	t=−2.0*
TFT	t=−0.45	t=0.49	t=−0.54
RP	t=1.07	t=1.28	t=−2.11*

*statistical significance at alpha=0.05

Table 6 Comprehension questions accuracy, SE in brackets

Condition	(10a)	(10b)	(10c)	(10d)
Accuracy	0.71 (.03)	0.67 (.03)	0.68 (.03)	0.69 (.03)

4.2 Experiment 1b (Self-Paced Reading)

4.2.1 Participants

Forty-eight undergraduate students from University of Potsdam participated in exchange for course credit or a payment of 5€.

Table 7 Reading times after the disambiguating region, SE in brackets

Condition position	(10a)	(10b)	(10c)	(10d)
V2	619 (25)	591 (20)	589 (26)	606 (24)
V2+1	625 (35)	663 (34)	652 (33)	613 (30)
V2+2	498 (16)	505 (17)	515 (16)	481 (15)
V2+3	446 (13)	457 (16)	433 (11)	442 (11)
V2+1 and V2+2	1124 (42)	1168 (40)	1167 (39)	1094 (37)

Table 8 T-values for the disambiguating region

Condition position	V1 case	V2 case	V1 case × V2 case
V2	t=–0.87	t=0.28	t=1.37
V2+1	t=–0.57	t=–0.25	t=–1.56
V2+2	t=–0.29	t=–1.49	t=–1.68
V2+3	t=–0.88	t=0.74	t=0.30
V2+1 and V2+2	t=–0.51	t=–0.78	t=–2.38*

*statistical significance at alpha=0.05

4.2.2 Stimuli

The stimuli were almost identical to the ones in Experiment 1a, but adapted to match in the number of words at and before the critical region. They were divided into four lists using a Latin-square design, intermixed with 70 fillers and 32 sentences from another, unrelated, experiment. The lists were randomized for every participant.

4.2.3 Procedure

The task was self-paced non-cumulative word-by-word reading. Presentation and recording was done with the Linger software package, version 2.94 by Doug Rohde running on an iMac G4. At the beginning of a trial the whole sentence appeared, masked by dashes. Participants pressed the space bar to reveal the next word. As the next word appeared, the current one was masked by dashes again. The time between key-presses was recorded as the reading time for the word. To ensure reading comprehension, each sentence was followed by a question – which participants had to answer with ‘yes’ or ‘no’ by pressing the corresponding button on the keyboard.

4.2.4 Results

A mixed-effects model (Bates and Sarkar 2007; Gelman and Hill 2007) was fit with participants and items as crossed random factors and revealed no significant effects at the disambiguating region (|t|s < 1.5). Visual inspection of the data suggested a case matching effect at the two words following the verb. Analysis of the reading time on these two words revealed a significant interaction (t=–2.38) due to mismatching conditions (10b,c) being read more slowly. There were no main effects (|t|s < 1). There were no significant effects in comprehension accuracy (Tables 7–9).

Discussion will be postponed until after Experiment 1c.

Table 9 Comprehension accuracy, SE in brackets

Condition	(10a)	(10b)	(10a)	(10b)
Accuracy	0.69 (.03)	0.71 (.03)	0.77 (.03)	0.70 (.03)

4.3 Experiment 1c (Plausibility Rating)

To ensure that the effect found in Experiments 1a and 1b was really an on-line effect, i.e. that it was not accidentally caused by degraded plausibility of conditions (10b,c) we conducted an offline plausibility rating study.

4.3.1 Participants

Forty-eight undergraduate students from University of Potsdam participated in exchange for course credit.

4.3.2 Stimuli

The same stimuli as in the self-paced reading experiment were used. Using a latin-square design they were divided into 4 pseudo-randomized lists, intermixed with 70 fillers and 24 sentences from another, unrelated, experiment.

4.3.3 Procedure

Participants worked through a paper questionnaire rating sentences on a 7-point scale, ranging from 1 (completely implausible) to 7 (perfectly plausible).

4.3.4 Results

A mixed-effects model (Bates and Sarkar 2007; Gelman and Hill 2007) was fit with participants and items as crossed random factors and revealed no significant effects whatsoever (Table 10).

4.4 Discussion

In both on-line experiments we found no evidence for coreference as the trigger of case matching effects. If coreference was the trigger, there should have been a processing disadvantage for accusative matrix verbs, i.e. a main effect of V2 case.

Table 10 Embedded verb: means by condition, SE in brackets

V2 case V1 case	Accusative	Dative
Accusative	5.25 (.11)	5.31 (.11)
Dative	5.28 (.10)	5.12 (.11)

There was none. Instead, we found an interaction between V1 case and V2 case, such that mismatching conditions were read more slowly. In Experiment 1a the slowdown occurred due to regressions, while in Experiment 1b it occurred at the two words following the disambiguating verb, suggesting a spill-over effect. These slowdowns match the predictions of the similarity-based CBRI account, which predicts that even partitive constructions can cause case matching effects by virtue of similarity with the antecedent. The results of an off-line plausibility rating study suggest that this effect is not due to degraded plausibility in the mismatching conditions.

Interestingly, neither the probability of regressions to the ambiguous NP, nor the time spent on it given a regression, show any effect of our case manipulation. Under a unification or attraction account this finding is surprising, given that Frazier and Rayner (1982), Meseguer, Carreiras and Clifton (2002), inter alia, have demonstrated that reanalysis triggers more regressions towards the string to be reanalyzed. Thus, on the one hand our data suggests that case matching phenomena do not involve reanalysis, and on the other hand it shows that strict coreference is not a necessary condition for case matching – (strong) similarity seems sufficient. Both findings cannot be explained by unification or attraction theories, favoring an explanation in terms of CBRI.

So it is tempting to conclude that CBRI is the mechanism underlying case matching. If correct, an interesting conclusion from this unified explanation of interference and case matching is that morphological ambiguities must be represented by several chunks, i.e. in parallel. If an ambiguous NP was represented as one single object, the same object would have to be retrieved upon disambiguation – independent of the reading disambiguated towards. Thus, the amount of retrieval interference would always be the same and we would not observe any differences in processing times in (10). CBRI can only explain the findings at hand if a case ambiguous NPs is stored in form of several chunks, each causing a different amount of interference. Since other accounts, however, do not appear to explain the present data, it does seem reasonable to adopt this assumption.

5 Case?

Experiments 1a and 1b have a weak point. As in most other experiments on case matching, varying the case of an NP involved varying the verb, and therefore the proposition of the sentence. Although we tried to keep the meaning of each accusative-dative verb pair as close as possible and although we made sure that there is no detectable difference in plausibility, we cannot rule out a systematic variation in our verbs such that arguments of each verb class share more properties than just the case.

German dative objects of two-place verbs differ from accusative objects not only in syntactic behavior (Fanselow 2000; McFadden 2006), but also in semantic properties. They cover different ranges of possible thematic roles. For example, according to Primus (1999), dative cannot be assigned to objects physically affected by the action denoted, while accusative can. Also, accusative objects tend to have more Proto-Patient properties, while dative objects often have some Proto-Agent properties. Thus, we cannot be certain the possibility that the interference or case matching effect observed in Experiment 1 is really caused by case. Instead, it may be brought about by additional properties, which tend to go with accusative or dative case respectively.

To address this issue and to investigate the influence of case marking while holding the theta-roles and the proposition sufficiently constant, we conducted Experiment 2. Quite similar to the stimuli in (8) and (9), our stimuli consisted of a main clause with a relative clause attached to either the object of an active sentence or the subject of a passive sentence (*die Künstler* in (11) and (12) respectively). Moreover, the relative clause had either subject-object – ((11a) and (12a)) or object-subject order ((11b) and (12b)). It was always attached to the same NP (*"die Künstler"*), which always had the same theta role. Only the antecedent's grammatical function and therefore its case was varied in the main clause. In (11) it was an object in accusative case, whereas in (12) it was the subject, therefore bearing nominative case. Since we used feminine and plural NPs, the case was not overtly marked since both types of NPs have the same morphological marking for nominative and accusative. Abstract case was disambiguated by the first NP in the main clause.

Importantly, the grammatical functions in the relative clause were ambiguous and only resolved at its final word, the auxiliary. The ambiguity was resolved by number agreement, and to this end the arguments differed in number.

(11) *Der Prinz* *respektiert* *die Künstler* …
the prince.NOM respects the artists.ACC

a. *die* *die Königin* *erst* *kürzlich* *getroffen* *haben* …
who.NOM/ACC the queen.ACC/NOM only recently met AUX.PL

b. *die* *die Königin* *erst* *kürzlich* *getroffen* *hat* …
who.ACC/NOM the queen.NOM/ACC only recently met AUX.SG

… *für* *ihr* *herausragendes* *Talent.*
for their outstanding talent

'The prince respects the artists, who the queen only recently visited/who only recently visited the queen, for their outstanding talent.'

(12)	*Vom Prinzen*	*respektiert*	*werden*	*die Künstler*	…
	by the prince	respected	AUX.PASS	the artists.NOM

a.	*die*	*die Königin*	*erst*	*kürzlich*	*getroffen*	*haben*	…
	who.NOM/ACC	the queen.ACC/NOM	only	recently	met	AUX.PL	
b.	*die*	*die Königin*	*erst*	*kürzlich*	*getroffen*	*hat*	…
	who.ACC/NOM	the queen.NOM/ACC	only	recently	met	AUX.SG	

…	*für*	*ihr*	*herausragendes*	*Talent.*
	for	their	outstanding	talent

'The artists, who the queen only recently visited/who only recently visited the queen, are respected by the prince for their outstanding talent.'

If case matching is really case matching proper, we expect an interaction in reading times at the point of disambiguation (*hat/haben*). In contrast to the well-attested preference for subject-object (SO) word order (e.g. Kaan 1997; Kretzschmar, this volume; Lamers 2001, 2005, see also this volume; Mak et al. 2006; Scheepers et al. 2000; Schlesewsky et al. 2000) we expect that SO order is only preferred if the antecedent is nominative while OS order is preferred if it is accusative. Therefore (11b) should be processed faster than (11a) while (12b) should be processed slower than (12a). If, on the other hand, case matching is caused by something which is not case proper, but rather something which may be confounded with it (e.g. affectedness, awareness, control, etc.) we expect there to be no effect of the main clause on the word order preference within the relative clause. There should be an across-the-board SO preference, making (11a) and (12a) easier to process than (11b) and (12b).

To avoid a confound and ensure that a case matching effect is not predicted by structural frequencies, we investigated the TIGER corpus (König and Lezius 2003) in order to determine how the case of a relative pronoun depends on its antecedent's case. We made two searches: one for all NPs headed by proper nouns (cf. Table 6a) and one for a subset consisting only of feminine NPs (Table 6b) to make sure that the results generalize to case-ambiguous NPs. Clearly, independent of the antecedent case relative pronouns tend to be nominative (Tables 11 and 12).

5.1 *Experiment 2*

5.1.1 Participants

Fifty-six undergraduate students from University of Potsdam participated in exchange for course credit or a payment of 7€.

Table 11 TIGER corpus count for the occurrence of all combinations of relative pronoun case and antecedent case (all NPs). Percentages in brackets

Relative pronoun antecedent	Nominative	Accusative	Dative
Nominative	1150 (.90)	99 (.07)	16 (.01)
Accusative	560 (.89)	61 (.09)	7 (.01)
Dative	114 (.90)	7 (.06)	4 (.03)
Genitive	348 (.92)	19 (.05)	10 (.03)

Table 12 TIGER corpus count for the occurrence of all combinations of relative pronoun case and antecedent case (only feminine NPs). Percentages in brackets

Relative pronoun antecedent	Nominative	Accusative	Dative
Nominative	386 (.90)	35 (.08)	3 (.01)
Accusative	218 (.90)	21 (.09)	3 (.01)
Dative	35 (.92)	2 (.05)	1 (.03)
Genitive	123 (.87)	12 (.09)	6 (.04)

5.1.2 Stimuli

Crossing the factors *antecedent case* and *relative pronoun case* resulted in four experimental conditions, which we implemented in 24 sets of items such as (11) and (12). In half the items the antecedent (and therefore relative pronoun) was singular, in the other half it was plural. To allow for disambiguation by number, the other NP in the relative clause differed in number. The items were divided into four pseudo-randomized lists using a Latin-square design and intermixed with 96 sentences from other, unrelated experiments.

5.1.3 Procedure

The procedure was identical to the one in Experiment 1a.

5.1.4 Results

We analyzed first-pass reading time (FPRT), regression-path duration (RPD), total-fixation time (TFT), regression probability (RP), and regressive refixation probability (RRP) at the verb, and the auxiliary. Furthermore we examined regressive refixation probability and regressive re-reading time at the relative pronoun and the RC-internal NP subsequent to disambiguation, i.e. **after** a fixation on the verb (due to possible preview effects of the auxiliary), the auxiliary itself, or

Table 13 Eye-tracking measures at the relative pronoun and the RC-internal NP, SE in brackets

Condition measure	(11a)	(11b)	(12a)	(12b)
Relative pronoun				
RRP_{verb+}	.18 (.02)	.20 (.02)	.18 (.02)	.20 (.02)
RRT_{verb}	283 (32)	344 (27)	304 (23)	338 (32)
RC-internal NP				
RRP_{verb+}	.35 (.03)	.35 (.03)	.34 (.03)	.35 (.03)
RRT_{verb}	621 (38)	766 (59)	708 (56)	694 (48)

Table 14 T-values for the relative pronoun and the RC-internal NP

Factor measure	Antecedent case	Relative pronoun case	Antecedent case × relative pronoun case
Relative pronoun			
RRP_{verb+}	t = −0.17	t = 1.01	t = 0.34
RRT_{verb}	t = −0.81	t = 1.66	t = 0.57
RC-internal NP			
RRP_{verb+}	t = 0.21	t = 0.36	t = 0.07
RRT_{verb}	t = 0.05	t = 0.29	t = −0.67

anything to the right of it (RRP_{verb+} and RRT_{verb+}). We hypothesize that these measures at these regions reflect the degree of processing difficulty that may be caused by mismatching case.

The dependent measures were computed with the R package *em* (Logačev and Vasishth 2006). All reading times were log-transformed before analysis. Reading times recorded as zero were excluded. A mixed-effects model (Bates and Sarkar 2007; Gelman and Hill 2007) was fit with participants and items as crossed random factors. It revealed a marginally significant effect of relative pronoun case in regressive re-reading time (t = 1.66) at the relative pronoun caused by longer reading times for accusative relative pronouns. No significant effects were found for the RC-internal NP.

There was a significant interaction in regression probability at the verb (t = −2.75) and the auxiliary (t = −2.61) due to more regressions when relative pronoun case and antecedent case did not match (i.e. (11a) and (12b)). The same pattern was present in regressive refixation time at the verb (more refixations if relative pronoun case does not match antecedent case, t = −1.96). Furthermore, there was an interaction at the auxiliary in regression path duration (t = −2.48) and (marginally significant) in first-pass reading time (t = −1.79) due to longer reading times if the antecedent case did not match the relative pronoun case. There were no significant effects for comprehension accuracy (Tables 13–17).

Table 15 Eye-tracking measures at the disambiguating region, SE in brackets

Condition measure	(11a)	(11b)	(12a)	(12b)
Verb				
FPRT	116 (5)	124 (6)	116 (5)	123 (6)
RPD	146 (7)	141 (8)	137 (6)	150 (8)
TFT	181 (9)	180 (9)	178 (9)	195 (10)
RP	.15 (.02)	.08 (.02)	.10 (.02)	.13 (.02)
RRP	.40 (.03)	.32 (.03)	.38 (.03)	.39 (.03)
Auxiliary				
FPRT	94 (5)	87 (4)	90 (5)	93 (4)
RPD	139 (11)	117 (10)	120 (9)	132 (11)
TFT	133 (8)	123 (7)	121 (7)	137 (8)
RP	.20 (.02)	.13 (.02)	.14 (.02)	.19 (.02)
RRP	.27 (.03)	.29 (.03)	.24 (.03)	.28 (.03)

Table 16 T-values for the disambiguating region

Factor measure	Antecedent case	Relative pronoun case	Antecedent case × relative pronoun case
Verb			
FPRT	t=−0.21	t=1.24	t=1.01
RPD	t=−0.11	t=0.56	t=−0.49
TFT	t=0.06	t=0.51	t=−0.54
RP	t=0.13	t=−1.11	t=−2.75*
RRP	t=−0.91	t=−1.12	t=−1.96
Auxiliary			
FPRT	t=−1.08	t=0.21	t=−1.79
RPD	t=−0.86	t=0.07	t=−2.48*
TFT	t=−0.47	t=1.47	t=−1.50
RP	t=−0.19	t=−0.29	t=−2.61*
RRP	t=0.83	t=1.11	t=−0.21

*statistical significance at alpha=0.05

Table 17 Comprehension accuracy, SE in brackets

Condition	(11a)	(11b)	(12a)	(12b)
Accuracy	0.75 (.02)	0.73 (.02)	0.73 (.02)	0.69 (.03)

5.2 Discussion

Regression probability at the verb and auxiliary, as well as reading times at the auxiliary that the subject preference for the relative pronoun (i.e. subject-object word order for the RC) does not only become weaker, but even reverses when the relative pronoun's antecedent is accusative. Because the only features manipulated in the main clause were (abstract) case and therefore grammatical function, it appears that they are sufficient to induce case matching effects. Therefore, no additional properties associated with case need to be taken into account for explaining the outcome of Experiment 1. It therefore seems safe to conclude that it is these syntactic factors which underlie case matching phenomena.

Furthermore, the lack of regressions to the ambiguous NPs in the mismatching conditions (11a) and (12b) is quite in line with the results of Experiment 1a, and again suggest that reanalysis is not involved in processing of sentences with mismatching case. Again, this pattern favors a retrieval account such as CBRI over unification or attraction accounts.

6 Conclusion

We began by reviewing two different types of interference theories that have been proposed in the literature: (a) Van Dyke and McElree's interference due to retrieval-cue overlap, and (b) Gordon and colleagues' interference due to match in referential properties. We argued that these two theories address orthogonal phenomena and are unable to provide a unified explanation for the full range of results that fall under the rubric of interference. Further, we showed that none of the existing theories can explain the surprising fact that a match between two noun phrases along two dimensions can facilitate rather than hinder processing (similarity-based facilitation); current theories make the opposite prediction. We proposed an explanation based on an assumption about the nature of memory representations: conflicting bindings. We showed that, under this representational assumption, not only can we explain the published similarity-based interference facts but also the similarity-based facilitation data. In addition, we demonstrated that the conflicting-bindings assumption can also furnish an explanation for case matching phenomena in German.

In particular, in Experiment 1 we showed that strong similarity is sufficient to trigger case matching effects. Coreference is not really necessary. The outcome of Experiment 2 suggests that it is not properties tentatively associated with case (e.g. affectedness, control) but rather (abstract) case proper, which is responsible for case matching. The importance of similarity can be explained in terms of CBRI, a memory mechanism for which there is independent evidence. Under this account, a case ambiguity has to be represented by several chunks in WM, each with a different case feature. Disambiguation involves retrieving the correct one, using the case assigned to the NP as a retrieval cue. This retrieval process is harder if the case feature of the to-be-retrieved chunk does not match the case feature of another, highly similar, NP present in WM (coreferent pronoun or partitive construction in the examples so far). Since every feature of an object is bound to every other one, most of the bindings involving the mismatching case feature will be conflicting. More precisely, it will be the ones binding the case feature to other features shared by both objects. If the case feature, however, matches, they will be identical in both objects. Only the smaller number of bindings between the case feature and features not shared by both objects will be conflicting. Therefore, sentences with two similar NPs bearing same case are easier to process, since retrieving a chunk with a matching case feature will be easier. Two dissimilar NPs, however, will be harder to process if they bear the same case, since it will give rise to retrieval interference at the verb.

In sum, in contrast to SBI, conflicting binding based retrieval interference can explain Fedorenko et al.'s data as well as case matching. Gordon et al.'s explanation based on 'referential properties' can be subsumed under the similarity account as well as under the quite plausible assumption that objects of different types will be associated with different features or feature bundles representing their type, or the attributes associated with their particular type. One important implication is that different readings of case ambiguous NPs must be represented by distinct chunks before disambiguation.

To sum up, we have presented an independently motivated storage and retrieval mechanism based on bindings, which offers a unification of apparently unrelated, or even contradicting phenomena.

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Processing Verb Medial Word Orders in a Verb Final Language

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1 Introduction

One important question in the history of Linguistics is whether language variation is unbounded, or whether there are universal principles that constrain the space for variation (Robins 1967). Joseph Greenberg's *Universals of Language* (1963) and Chomsky's *Syntactic Structures* (1957) constitute landmarks that changed the focus and framework for discussion. Greenberg's work showed there are significant generalizations emerging from various aspects of linguistic variation. Chomsky's approach successfully argued that the goal of linguistics is to find "the fundamental underlying properties of successful grammars. The ultimate outcome of these investigations should be a theory of linguistic structure in which the descriptive devices utilized in particular grammars are presented and studied abstractly, with no specific reference to particular languages" (Chomsky 1957: 11). Since then, it is established that variation across languages is limited to a rather narrow range and human languages are organized following the same basic patterns and mechanisms.

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Greenberg was the founder of modern linguistic typology; the results of his surveys showed that many language features are related and discarded the idea of limitless variation; some decades later, in the eighties, the *Principles and Parameters* model articulated by Chomsky (1981) claimed that those patterns of variation can be derived from a finite set of linguistic parameters. Languages can thus be classified by these structural features, or *parameters*, into a few language types (Baker 2001).

Here, we focus on the implications that arise from variations in the relative basic order of the S(ubject), O(bject) and V(erb) in a sentence. What Greenberg found in his language-survey is that apparently unrelated syntactic properties are strongly correlated: if a language has SOV as its canonical constituent order in declarative sentences, then this language will tend to have postpositions, relative clauses will appear before nouns, adverbs before verbs or adjectives and main verbs before auxiliary verbs. Following Greenberg's implicational universals, the Basque language has been argued to be of the SOV type (de Rijk 1969). In Basque, declarative sentences that initiate a discourse (that is, sentences where all information is new) display SOV order. Following the greenbergian correlations, Basque has postpositions (example 1), in declarative sentences adverbs appear to the left of verbs and adjectives (examples 3 and 4) and auxiliary verbs appear following the main verb (example 5).

(1) *gizon-A-REKIN*
man-DET-with
'WITH THE man'

(2) *[gizon-a ikusi duEN] emakume-a*
man-DET seen has-REL woman-DET
'the woman that saw the man'

(3) *Mikel BERANDU etorri da*
Mikel LATE arrived is
'Mikel arrived LATE'

(4) *Zu-re auto-a OSO polita da*
You-GEN car-DET VERY beautiful is
'Your car is VERY beautiful'

(5) *Mikel-ek Ana ikusi DU*
Mikel-ERG Ana seen HAS
'Mikel HAS seen Ana'

1.1 Word Order

Basque is a free word order language. Constituents can appear in almost any order. In example (6), which is adapted from Ortiz de Urbina (2003: 448), all sentences generated by combining the constituents in all orders (in square brackets) are grammatical:

(6) a. PP-S-IO-O-V *[$_{PP}$Afaldu ondoren] [$_{SUBJ}$Mikel-ek] [$_{IO}$Ana-ri] [$_{OBJ}$gerriko berria] [$_{V+AUX}$oparitu dio]*
[diner after] [Mikel-ERG] [Ana-DAT] [belt new-DET] [given aux]
'After dinner, Mikel has given the new belt to Ana'

b. O-PP-IO-S-V *[$_{OBJ}$Gerriko berria] [$_{PP}$afaldu ondoren] [$_{IO}$Anari] [$_{SUBJ}$Mikelek] [$_{V+AUX}$oparitu dio]*

c. S-O-PP-V-IO *[$_{SUBJ}$Mikelek] [$_{OBJ}$gerriko berria] [$_{PP}$afaldu ondoren] [$_{V+AUX}$oparitu dio] [$_{IO}$Anari]*

d. IO-V-O-PP-S *[$_{IO}$Anari] [$_{V+AUX}$oparitu dio] [$_{OBJ}$gerriko berria] [$_{PP}$afaldu ondoren] [$_{SUBJ}$Mikelek]*

e. …

Based on this constituent-order freedom in the sentence, some linguists (Rebuschi 1987) have argued that sentence structure in Basque is flat and has no hierarchical arrangement (that is, it is non-configurational). However, most authors agree that sentence structure is hierarchical in this language (De Rijk 1969, 2007; Ortiz de Urbina 1989; Laka 1990; Artiagoitia 1995; Fernandez 1998; Elordieta 2001, among many others). In particular, evidence from linguistic theory shows that the Subject constituent is hierarchically higher than the Object constituent. In other words, there is widespread agreement among linguists that (6a) is the underived word order of a sentence and that other word-orders are derived from this one via syntactic movement/displacement of constituents.

1.2 Syntactic Complexity

According to syntactic studies of Basque grammar (De Rijk 1969; Ortiz de Urbina 1989; Laka 1990; Artiagoitia 1995; Fernandez 1998; Elordieta 2001, among others), SOV sentences reflect the canonical word order and all other word orders (OSV, SVO and OVS) are syntactically derived. Assuming this to be the correct analysis of Basque sentence grammar, we hypothesized that SOV would be easiest to process and all other word orders (OSV, SVO and OVS) would show a processing cost due to the extra syntactic operations involved.

As shown in the (somewhat simplified) syntactic representation in Fig. 1, the syntactic structure of the OSV word order can be derived from the canonical SOV by means of displacing the object over the subject.

Recently obtained psycholinguistic and neurolinguistic evidence supports the linguists' claim that Basque language's SOV word order is syntactically simpler than OSV word order (Erdocia et al. 2009): reading times showed that canonical SOV is processed faster than OSV word order by native speakers of this language. In the OSV condition, reading the Subject after the Object required extra processing effort compared with reading the Subject before the Object in the SOV condition.

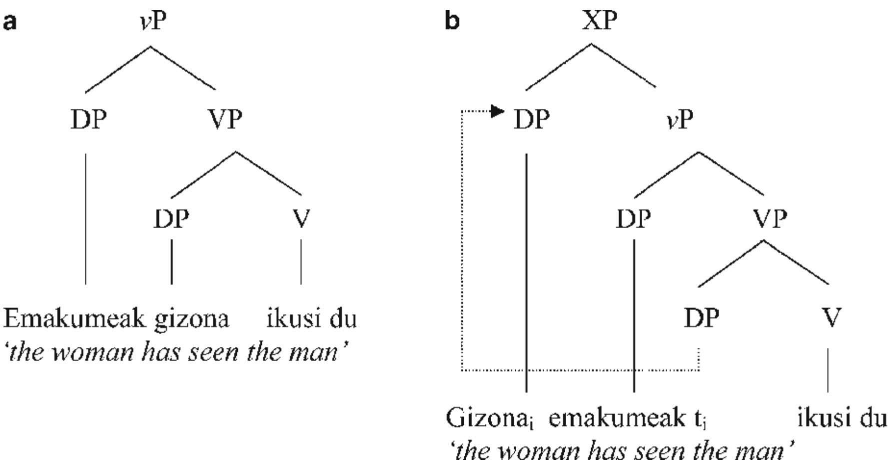

Fig. 1 In these syntactic representations the vP represents the transitive sentence where the Determiner Phrases (DP) are the subject and the object of the verb (V). (**a**) Syntactic structure of the canonical SOV word order in Basque. The object (gizona 'man') is generated in the Verb Phrase (VP), preceding the verb (V). (**b**) Starting from the basic SOV order, OSV is generated displacing the object above the subject to the specifier position of a higher projection (XP)

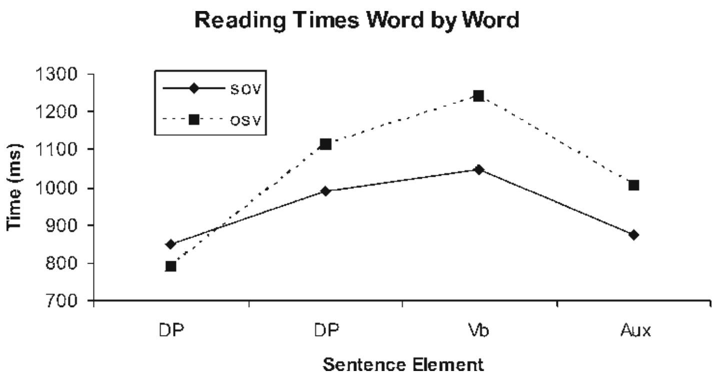

Fig. 2 Word-by-word mean reading times of canonical SOV and derived OSV word orders. The *y*-axis features reaction times in milliseconds; in the *x*-axis the different constituents of each sentence are depicted (*DP* Determiner Phrase; *Vb* Verb; *Aux* Auxiliary verb) (Adapted from Erdocia et al. 2009)

The derived OSV word order triggered syntactic reanalysis in the second DP[1] position probably due to the fact that participants processed the first DP as the Subject of an intransitive sentence (see Fig. 2).

In addition to reading times, ERPs provided evidence favoring the interpretation that OSV is syntactically derived: OSV sentences showed increasing negativities in

[1] Throughout the paper, we will use the label DP (Determiner Phrase), which is more accurate than NP (Noun Phrase) for the syntactic label of the Subject and Object constituents involved.

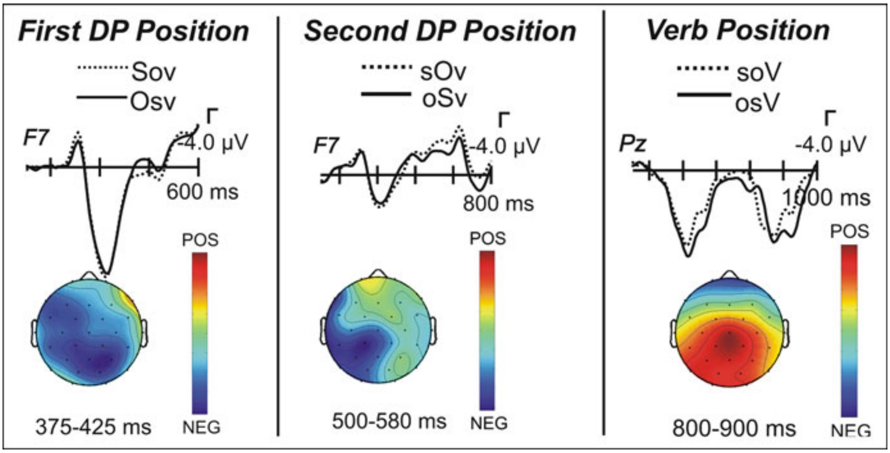

Fig. 3 ERP comparison of SOV and OSV word orders in Basque. In first and second DP positions, the negativities indicated that Subjects and Objects were differently processed. At the verb position, the late P600 effect represents the higher processing cost of derived words orders (Adapted from Erdocia et al. 2009)

both Subject and Object DP positions (Fig. 3). These negativities at DP positions suggested that Subjects and Objects were processed differently. A P600 effect was observed in the Verb position when compared to the canonical SOV word order; this P600 effect reflects the higher processing cost of the derived OSV word order.

Here we report results obtained from experiments designed to investigate how verb-medial sentences (SVO/OVS) are processed by native speakers of Basque. Verb-medial word orders are taken to be derived from canonical SOV structures (Etxepare and Ortiz de Urbina 2003). The syntactic representations below (Fig. 4) illustrate schematically how the verb-medial structures are derived from SOV structure.

1.3 *Pro-Drop and Ergativity in Basque*

Basque has a pluripersonal verb-agreement system, as a consequence of which it is a three-way pro-drop language (Ortiz de Urbina 1989; Laka 1993, 1996); this means that subjects, objects and datives can be phonologically unrealized:

(7) a. *pro*$_{SUBJ}$ *pro*$_{IO}$ *pro*$_{OBJ}$ *eman d-i-zu-t*
(I) (you) (it) given it-root-you-me
'I have given it to you'

b. *pro*$_{SUBJ}$ *pro*$_{OBJ}$ *ikusi na-u-zu*
(you) (me) seen me-root-you
'you have seen me'

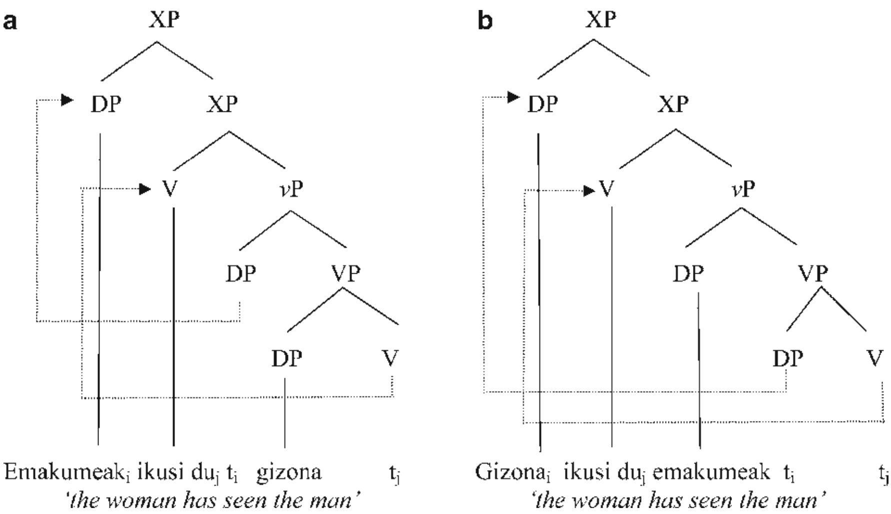

Fig. 4 (**a**) Syntactic representation of the derived SVO word order in Basque. The subject (emakumeak 'woman') and the verb (ikusi du 'has seen') are displaced above the object. (**b**) The OVS is derived displacing the object and verb above the subject

Basque is also an ergative language (Levin 1983; Laka 2006): subjects of intransitive clauses and objects of transitive clauses are morphologically identical and bear no case ending (8a, b), while subjects of transitive clauses are morphologically marked by an ergative case marker (8c):

(8) a. ***Gizon-a*** *etorri da* (subject of intransitive sentence)
man-DET arrived is
'The man arrived'
b. *Emakume-a-k* ***gizon-a*** *ikusi du* (object of transitive sentence)
woman-DET-ERG man-DET seen has
'The woman has seen the man'
c. ***Gizon-a-k*** *emakume-a ikusi du* (subject of transitive sentence)
man-DET-ERG woman-DET seen has
'The man saw the woman'

Given this combination of grammatical features, if the DP constituent *gizon-a* "the man" is encountered at the beginning of an utterance, the following possibilities arise:

(i) it is the Subject of an SV intransitive sentence like (8a);
(ii) it is the Object of an OSV sentence like (8b);
(iii) it is the Object of an OV transitive sentence where S has been omitted as in (7a,b).

1.4 Ambiguities

We also investigated how syntactically ambiguous sequences are processed. Basque has a morphologically ambiguous form shown in (9), where both subject and object constituents present the same ending *–ak*.

(9) *Emakume-**a-k*** *gizon-**ak*** *ikusi* *d-it-u*
woman-DET.SG-ERG man-DET.PL seen 3PL-has-3SG
'The woman has seen the men'

In (9), the singular transitive subject of the sentence *emakumeak* "the woman (erg)" carries two morphemes: the singular determiner morpheme *–a* we have seen in previous examples (8a, b), followed by the ergative case marker *–k* also illustrated before in (8c). The plural object of the sentence *gizonak* "the men" carries only one morpheme, the plural determiner *–ak*, which happens to be homophonous with the subject's morphological sequence. Moreover, given that in Basque objects can appear at the beginning of the sentence, it turns out that the sentence in (9), if prosodic information is not provided and it is only presented visually, could also be interpreted as an OSV sentence like (10):

(10) *Emakume-**ak*** *gizon-**a-k*** *ikusi* *d-it-u*
woman-det.PL man-DET.SG-ERG seen 3PL-has-3SG
'The man has seen the women'

By measuring the reading times of fully ambiguous verb final declarative sentences (e.g., sentences like 9 and 10) we have shown in a previous study (Erdocia et al. 2009) that they are straightforwardly processed as SOV canonical sentences by native speakers. We interpret these results as showing that the first DP constituent is processed as a singular ergative subject (NP-*a-k*) and hence the second DP constituent is processed as a plural object (NP-*ak*). Hence, verb final word orders seem to reveal a strong *subject first* processing strategy in Bates et al. (1988; see also Kretzschmar et al. and Lamers in this volume).

Furthermore, as shown in (11), a sentence can be ambiguous with respect to its initial constituent and be morphosyntactically disambiguated by a subsequent constituent. That is, we can start a sentence marking the first DP constituent with the ambiguous *–ak* ending, so that temporarily it could either be an ergative singular Subject or a plural Object but if the second constituent is morphologically unambiguous, the structure is instantly disambiguated.

(11) *Emakume-**ak*** *gizon-**ek*** *ikusi* *d-it-uzte*
woman-DET.PL man-DET.PL-ERG seen 3PL-has-3PL
'The men saw the women'

Example (11) starts ambiguously (the first constituent could be the Subject or the Object of the sentence) but it is disambiguated at the second constituent position by means of the unambiguous *–ek* plural ergative subject marker. This plural ergative *–ek*

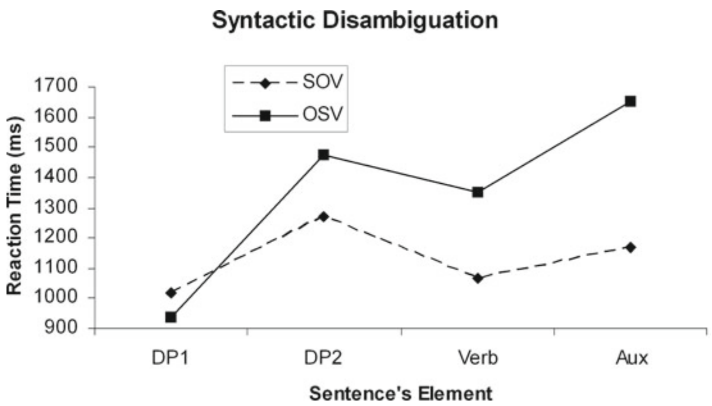

Fig. 5 Syntactic disambiguation effect at the second DP position of OSV derived sentences (adapted from Erdocia et al. 2009)

ending results from the merging of the plural determiner *–ak* and the ergative case marker *–k* via morphophonological processes of epenthesis and deletion that we do not detail here (see de Rijk 2007). Thus, once the second constituent is processed, the first constituent should necessarily be interpreted as the Object of the sentence. In our previous study, we showed that these temporally ambiguous sequences (e.g., sentence type 11) are disambiguated syntactically at the second constituent position (Erdocia et al. 2009). Comparing the canonical SOV sentences and these temporarily ambiguous OSV sentences, the reading times increased significantly at the sentence second position of the temporally ambiguous sentences (Fig. 5).

Thus, the result of temporally ambiguous sentences suggests that participants initially processed the first ambiguous constituent as the subject of the sentence but upon finding the unambiguous plural subject at the sentence second position, they were forced to reanalyze their initial processing hypothesis, changing the *subject-before-object* interpretation to the derived *object-before-subject* interpretation. In an ERP experiment (Erdocia et al. 2009, exp. 3), we also observed a specific modulation of a negative frontal-posterior component at the disambiguation point of temporally ambiguous sentences, which were disambiguated by means of the world knowledge at the verb constituent. The frontal-posterior negativity spread from 500 until 1,000 ms after the disambiguation point. We interpreted this modulation as an index related to working memory costs induced by syntactic reinterpretation analysis (changing the default SOV interpretation to OSV in ambiguous sentences).

In the present study we took advantage of these morphologically ambiguous *–ak* markers to explore the syntactic disambiguation effect in verb medial structures: SVO and OVS. Furthermore, we explored whether these syntactically derived (non-canonical) structures are equally or differently processed in terms of reading times.

2 Comparing Derived SVO and OVS Word Orders

The aim of the present study was to measure the syntactic complexity and the ambiguity resolution processes that word order variation generates. By using *self-paced reading* (Just et al. 1982) and a *comprehension task*, we studied the processing of sentences with SVO and OVS word orders in Basque, in order to measure differences between the *subject-before-object* and *object-before-subject* effects.

3 Material

The experimental material consisted in 100 sentences like (12a). Starting from this type of sentence, we generated the rest of the conditions by means of changing the order and number of constituents.[2] Thus we have 100 sentences of singular SOV structure (12a), 100 sentences of singular OSV (12b), 100 sentences of ambiguous structure (12c), 100 sentences of plural SOV structure (12d) and finally 100 sentences of plural OSV (12e). Altogether there were 500 stimuli.

(12)	a.	*Gizon-a-k*	*ikusi*	*du*	*emakume-a*	[S_{SING}-V-O_{SING}]
		Man-DET.SG-ERG	see	has	woman-DET.SG	
		'The man has seen the woman'				
	b.	*Emakume-a*	*ikusi*	*du*	*gizon-a-k*	[O_{SING}-V-S_{SING}]
		Woman-DET.SG	see	has	man-DET.SG-ERG	
		'The man has seen the woman'				
	c.	*Gizon-ak*	*ikusi*	*ditu*	*emakume-ak*	[AMB-V-AMB]
		man-AMB	see	has	woman-AMB	
		'The man has seen the women' or				
		'The woman has seen the men'				
	d.	*Gizon-ek*	*ikusi*	*dituzte*	*emakume-ak*	[S_{PL}-V-O_{PL}]
		men-DET.PL-ERG	see	have	women-DET.PL	
		'The men have seen the women'				
	e.	*Emakume-ak*	*ikusi*	*dituzte*	*gizon-ek*	[O_{PL}-V-S_{PL}]
		women-DET.PL	see	have	men-DET.PL-ERG	
		'The men have seen the women'				

Recall that the constituents carrying the morpheme *-ak* are ambiguous. Therefore, sentences (12a), (12c) and (12e) are ambiguous at the first constituent position. Sentences (12a) and (12e) are disambiguated at the auxiliary position. In the case of

[2] The Subjects and the Objects were controlled in length and frequency using EHME (http://ehu.es/ehg/ehme/). The subjects were 8 (±1.9) letters long and the objects 8.1 (SD ± 2.1) letters ($t(99) = 0.4$, $p < 0.6$). The difference in frequency of S (12.5 per million ±2.6) and O (15.7 per million, SD ± 15.7) was not significant ($t(99) = -1.2$, $p < 0.2$).

(12a) the resulting structure is SVO and in the case of (12e) the resulting structure is OVS. Only sentences like (12c) are fully ambiguous because both constituents carry the *-ak* ending.[3]

Stimuli were divided into five lists. Sentences were randomized (Latin-square) and one version of each item was assigned to one of the five lists. This method allowed every participant to read only once each version of a sentence. The five lists were balanced across participants ensuring that the material was correctly rotated across conditions and participants. This ensured that each version of each sentence was read an equal number of times across participants. The experimental items were presented along with 16 practice trials (2 sentences of each condition and 6 fillers) to verify that participants understood the instructions of the experiment.

We created 100 filler sentences, which were also presented in the experiment. Half of the fillers were intransitive sentences with the absolutive subject realized (see example 13). The remaining 50 fillers were ditransitive sentences where the ergative subject was dropped. The absolutive direct object and the dative indirect object were realized in the sentence and they varied in the position they occupied in the sentences (see examples 14a and 14b)

(13)	*Mutiko-a*	*aizto-a-z*	*ebaki*	*da*
	Boy-DET.SG	knife-DET.SG-with	cut	is

‘The boy has cut himself with the knife’

(14)	a.	*pro*	*etorkin-a-ri*	*hil*	*d-i-o-te*	*ume-a*
		(they-ERG)	immigrant-DET.SG-DAT	kill	3SG-have-3.DAT-3PL	child-DET.SG

‘They have killed the immigrant’s child’

b.	*pro*	*idazle-a*	*aurkeztu*	*d-i-o-te*	*itzultzaile-a-ri*
	(they-ERG)	writer-DET.SG	introduce	3SG-have-3.DAT-3PL	translator-DET.SG-DAT

‘They have introduced the writer to the translator’

The same fillers were used in the five lists. Like in the experimental conditions, the fillers were four words long.

4 Method

The experimental data were obtained by presenting the materials to the participants using a Self Paced Reading Moving Window paradigm (Just et al. 1982) and performing a Comprehension Task. We measured the participants’ reading times for each word separately in every sentence. In order to obtain the reading time of the

[3] Although conditions (12a), (12c) and (12e) start ambiguously, we decided to label only the constituents of the fully ambiguous condition (12c) with the *AMB* gloss.

whole sentence we summed the reading times of each separate word. We could determine whether the participants understood the sentences correctly through the comprehension task (see below) and we also measured the reaction time of the comprehension task itself.

Different methods could be chosen for stimuli presentation using the self-paced reading technique (Just et al. 1982; Kennedy and Murray 1984). Due to the agglutinative morphology of the Basque language we decided to present the sentences word by word. In this manner participants read the words as they would normally read them in a written text. The moving window technique used here (Just et al. 1982) requires that sentences are presented word by word and once a word has been read it turned into a string of asterisks. When participants finished reading the sentence this way, a comprehension question appeared on the screen. In order to answer the question of the comprehension task, participants had to press the button corresponding to 1 and 2 in the keyboard. Participants did not receive feedback about their answers. The amount of time the participant spent reading each word was recorded as the time between key-presses.

The comprehension task ensured that the participants had understood the sentences they read. In the case of fully ambiguous conditions, the comprehension task allowed us to know the preferred interpretation of the participants when confronting fully ambiguous sentences. That is, the comprehension task showed whether a participant interpreted an ambiguous chain as SVO or as OVS. The task consisted in a yes-or-no question after each sentence. The answer to half of the questions of each word order was "yes" and the other half was "no". Example (15) would be the question corresponding to the test item of (12a); in this case the answer would be positive:

(15)	*egi-a*	*al*	*da emakume*	*bat-ek*	*ikusi du-ela*	*gizon bat?*
	true	Q[4]	is woman	one-ERG	seen has-comp	man one
	'Is it true that one woman has seen a man?'					

For each variable (DP1, DP2, V, Aux, Total Reading Times, Reaction Time and Amount of Errors in the CT), a repeated-measures ANOVA analysis (Huynh-Feldt correction) was carried out, introducing Condition as a general factor (5 levels). When this effect was significant, we computed pairwise comparisons between the different conditions. We used Bonferroni correction in order to prevent false positive results (for 10 pairwise comparisons in each variable, we only report those effects with a $p<0.005$).

4.1 Participants

Twenty nine native speakers of Basque participated in the experiment as volunteers, all of them undergraduate students of the Faculty of Letters (University of the

[4] The interrogative particle *al* is used in yes-no questions.

Basque Country UPV/EHU). All participants who made more than 7 mistakes out of 20 sentences of each condition were rejected from the statistical analysis. However, in the case of ambiguous sentences we included the participants who made more than seven mistakes for statistical analysis since in any case their answers could not be taken as incorrect. All in all, we analyzed data from 24 subjects (2 men and 22 women[5]; mean age 20, SD ± 3.21).

The participants filled out a Basque-Spanish bilingualism questionnaire (adapted from Weber-Fox and Neville 1996). The results of the questionnaire showed that participants use the Basque language more often than Spanish.[6] More specifically the results for Basque obtained 1.9 ± 0.3 (SD) points in a 1–7 point scale where 1 corresponded only to Basque use and 7 only Spanish. Subjects had to rate themselves in comprehension, in reading, in speaking and in writing. In a 4-point scale where 4 was 'very good' and 1 was 'bad', the mean values for the present sample were 3.94 ± 0.2 for Basque and 3.5 ± 0.6 for Spanish. They were also asked in which language they felt more comfortable or preferred (in general); six participants answered they felt equally comfortable in both languages, one preferred Spanish and the rest of the participants felt more comfortable in Basque. In sum, the present sample is very fluent in Basque and is the language that is usually used in their environment.

4.2 Recording

Participants were instructed to read at a normal, comfortable pace and in a way that would enable them to understand the sentences. Sentences were presented using a standard Personal Computer and running the EXPE6 (Pallier et al. 1997) program. The computer recorded the time interval since a word was first displayed until the next press of the space bar. The choice program recorded the reaction times and the answers of the participants. More specifically the program recorded: (i) the required time to read each word of the sentence, (ii) the required time to read and answer the question of the comprehension task and (iii) whether the answer to the question was correct or not.

5 Results

A repeated-measures ANOVA analysis was carried out involving the factor Condition (five levels, one per condition). The ANOVA analysis was carried out for each variable and only when the main effect of Condition reached a significant value, pairwise comparisons between conditions were computed.

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[5] In previous literature, no differences between males and females have been found in language processing. Given this, we did not particularly seek to keep equal numbers of males and females in the groups.

[6] One of the participants, who was from Hendaye (a town in the French side of the Basque Country), filled the bilingualism questionnaire for French-Basque.

5.1 Whole Sentence Processing and Comprehension Task

The omnibus ANOVA for the variable *Total Reading Times* for the five *Conditions* showed a significant effect ($F(4,92) = 16.6$, $p < 0.001$). The pairwise comparisons split the conditions into two groups, the singular conditions and the plural conditions (see Fig. 6a). The comparison between S_{SING}-V-O_{SING} (3,210 ms) and O_{SING}-V-S_{SING} (3,163 ms), both singular conditions, was not significant ($t(23) = 0.6$, $p > 0.1$). The pairwise comparison between both plural conditions (S_{PL}-V-O_{PL} = 3,643 ms; O_{PL}-V-S_{PL} = 3,669 ms) did not show any statistical difference ($t(23) = -0.3$, $p < 0.7$). On the other hand, the direct comparisons of the singular conditions with plural counterparts were significant (S_{SING}-V-O_{SING} vs. S_{PL}-V-O_{PL} $t(23) = -5.9$, $p < 0.001$; O_{SING}-V-S_{SING} vs. O_{PL}-V-S_{PL} $t(23) = -5.8$, $p < 0.001$). Besides, the mean reading time for the fully ambiguous condition (AMB-V-AMB = 3,661 ms) behaved like the plural sentences (S_{SING}-V-O_{SING} vs. AMB-V-AMB $t(23) = -4.7$, $p < 0.001$; O_{SING}-V-S_{SING} vs. AMB-V-AMB $t(23) = -4.1$, $p < 0.001$; S_{PL}-V-O_{PL} vs. AMB-V-AMB $t(23) = 0.2$, $p < 0.8$; O_{PL}-V-S_{PL} vs. AMB-V-AMB $t(23) = -0.1$, $p < 0.9$).

The omnibus ANOVAs carried out for the *Comprehension Task* (reaction time and amount of errors) showed the main effects of the *Condition* in both cases (mean reaction time comprehension task, $F(4,92) = 15.2$, $p < 0.001$; amount of errors in the CT $F(4,92) = 43.6$, $p < 0.001$). Figure 6b depicts the mean reaction time in the comprehension task for the different conditions. The questions about the S_{SING}-V-O_{SING} condition were faster than any other experimental condition (S_{SING}-V-O_{SING} vs. O_{SING}-V-S_{SING} $t(23) = -4.1$, $p < 0.001$; S_{SING}-V-O_{SING} vs. S_{PL}-V-O_{PL} $t(23) = -6.3$, $p < 0.001$; S_{SING}-V-O_{SING} vs. O_{PL}-V-S_{PL} $t(23) = -6.7$, $p < 0.001$; S_{SING}-V-O_{SING} vs. AMB-V-AMB $t(23) = -6.7$, $p < 0.001$). Comparing O_{SING}-V-S_{SING} to O_{PL}-V-S_{PL} the difference was also significant ($t(23) = -3.0$, $p < 0.007$). The difference between O_{SING}-V-S_{SING} and S_{PL} -V- O_{PL} was not significant ($t(23) = -1.9$, $p > 0.07$). Finally, comparing O_{SING}-V-S_{SING} to the ambiguous condition (AMB-V-AMB) the difference in the reading and answering of the comprehension task did not reach a significant level (considering the Bonferroni corrected p-value) ($t(23) = -2.8$, $p > 0.009$).

For the analysis of the amount of errors in the comprehension task, SVO and OVS conditions showed a statistical difference when the constituents of the sentences were singular (S_{SING}-V-O_{SING} vs. O_{SING}-V-S_{SING} $t(23) = 3.1$, $p = 0.005$). Nevertheless, when the constituents were plural the error rate did not show any significance (S_{PL}-V-O_{PL} vs O_{PL}-V-S_{PL} $t(23) = 0.2$, $p > 0.8$). The rest of the pairwise comparisons between SVO and OVS conditions were not significant. In the fully ambiguous condition, recall that the error rate of the comprehension task corresponded to the SVO or OVS interpretation of the ambiguous chain. The results of the comprehension task of the fully ambiguous condition did not show any preference for SVO nor OVS interpretation (AMB-V-AMB = 42.5%, see Fig. 6c).

Summarizing, we have seen that Basque speakers processed sentences containing singular constituents faster but no difference was found between the SVO and OVS word orders. On the other hand, the comprehension task showed that ambiguous

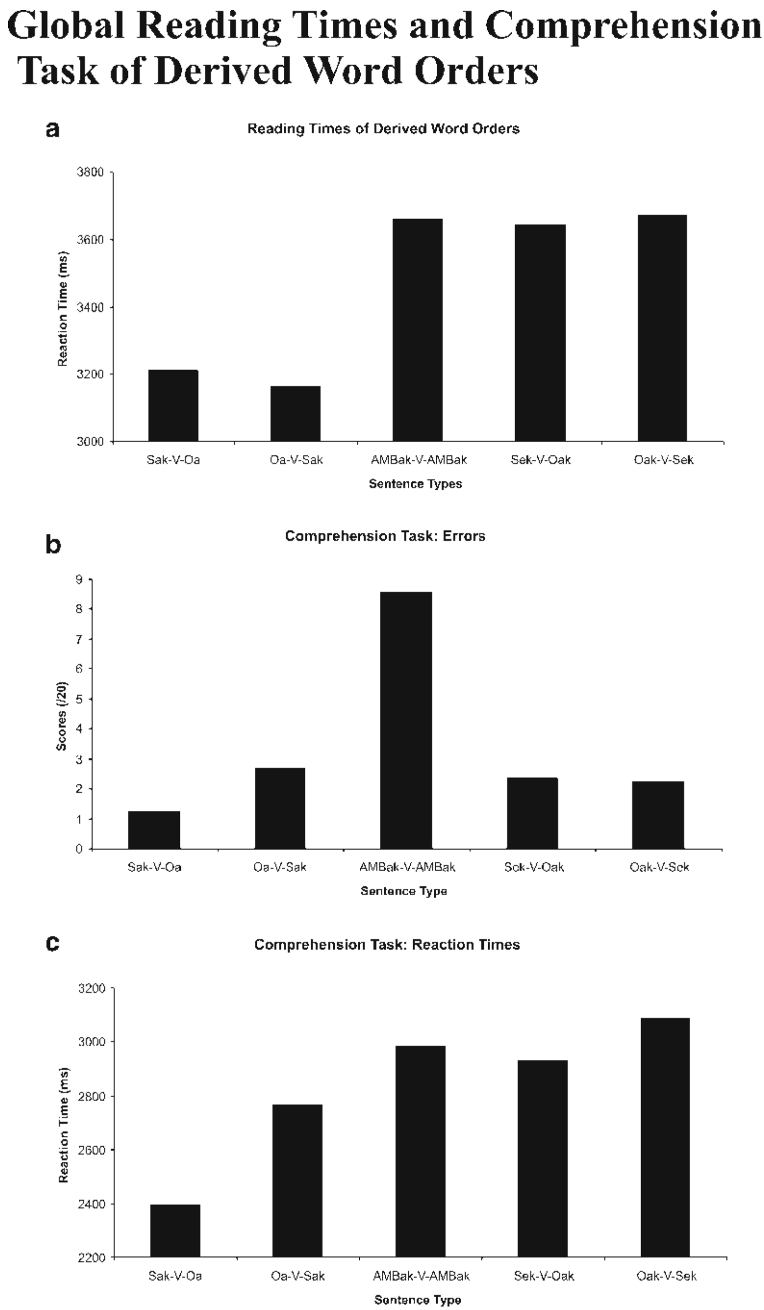

Fig. 6 (**a**) Mean reading times of the five verb-medial derived conditions. (**b**) Means of the performance of the Comprehension Task. (**c**) Error rates (out of 20) of the Comprehension Task of the five experimental conditions

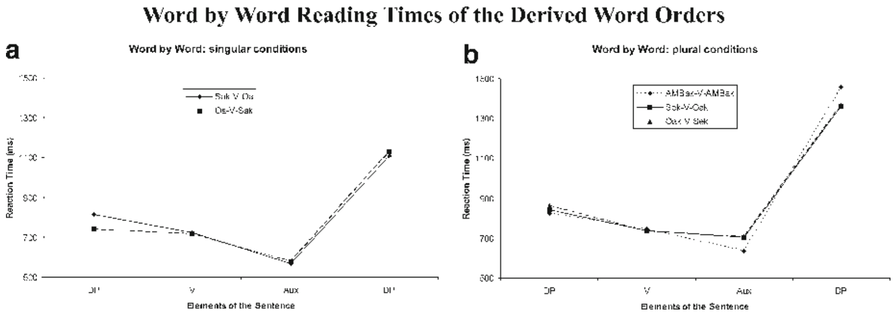

Fig. 7 Word by word comparison of SVO and OVS. (**a**) Mean reading times of every word in singular conditions. (**b**) Means of every word in plural and fully ambiguous conditions

chains did not show any preference favoring SVO or OVS interpretation. In order to shed further light on the differences we observed across these conditions, we carried out in the next section a word by word comparison for each constituent.

5.2 Word-by-Word Analysis

At the sentence initial position (DP1), the omnibus ANOVA was significant ($F(4,92) = 6.2$, $p = 0.001$). Comparing word by word S_{SING}-V-O_{SING} and O_{SING}-V-S_{SING} conditions, the difference did not survive the Bonferroni correction at the first word position ($t(23) = 2.4$, $p < 0.026$), although a trend is observed that points out that the singular absolutive O_{SING} was processed faster than the ambiguously marked S_{SING} (see Fig. 7a). Notice that this difference has also been reported in previous studies (see Fig. 3 and Erdocia et al. 2009), which could be considered a replication of the previous finding although with a marginal level of significance. When comparing the O_{SING} with the first constituents of the other conditions the difference was significant (O_{SING} vs. S_{PL} $t(23) = -4.0$, $p < 0.001$; O_{SING} vs. O_{PL} $t(23) = -3.7$, $p < 0.001$; O_{SING} vs. AMB $t(23) = -2.8$, $p = 0.009$).[7]

At the sentence second position (V), the omnibus ANOVA did not show any significance ($F(4,92) = 0.5$, $p < 0.7$). Thus, no furthered pairwise comparisons were carried out.

At the auxiliary position, the omnibus ANOVA showed a significant effect ($F(4,92) = 18.8$, $p < 0.001$). As Fig. 7 shows, the fastest auxiliary was '*du*' in S_{SING}-V-O_{SING} (568 ms) and O_{SING}-V-S_{SING} (578 ms), then the auxiliary of the fully ambiguous condition '*ditu*' (635 ms) and finally the auxiliary with plural agreement with subject and object '*dituzte*' in S_{PL}-V-O_{PL} (701 ms) and O_{PL}-V-S_{PL} (708 ms). The pairwise comparisons revealed that the differences between the conditions with the

[7] The comparison between the O_{SING} and the AMB did not survive the Bonferroni correction procedure.

same auxiliary were not significant (S_{SING}-V-O_{SING} vs. O_{SING}-V-S_{SING} $t(23)=0.6$, $p>0.5$; S_{PL}-V-O_{PL} vs. O_{PL}-V-S_{PL} $t(23)=0.3$, $p>0.8$). However, the difference between the singular (S_{SING}-V-O_{SING} and O_{SING}-V-S_{SING}) auxiliary and the AMB auxiliary was significant (*du* vs. *ditu* $t(23)=-3.3$, $p<0.003$), the difference between the singular auxiliary and the plural (S_{PL}-V-O_{PL} and O_{PL}-V-S_{PL}) auxiliary was significant (*du* vs. *dituzte* $t(23)=-5.5$ $P<0.001$) and the difference between AMB and plural conditions (S_{PL}-V-O_{PL} and O_{PL}-V-S_{PL}) was also significant (*ditu* vs. *dituzte* $t(23)=-3.6$, $p<0.002$). It could be argued that these differences between auxiliaries could be due to their differences in letter length or to their differences in morphological complexity.

Finally, at the sentence final position (DP2), the omnibus ANOVA analysis was significant ($F(4,92)=10.2$, $p<0.001$). The pairwise comparison revealed that the second DP of S_{SING}-V-O_{SING} and O_{SING}-V-S_{SING} conditions had similar mean reading times ($t(23)=-0.4$, $p>0.7$), as well as for the S_{PL} -V- O_{PL} and O_{PL} -V- S_{PL} conditions ($t(23)=0.1$, $p>0.95$). Fully ambiguous condition and conditions with plural constituents also showed similar reading times (S_{PL}-V-O_{PL} vs. AMB-V-AMB $t(23)=1.3$, $p>0.2$; O_{PL}-V-S_{PL} vs. AMB-V-AMB $t(23)=1.1$, $p>0.3$). The pairwise comparisons of the S_{SING}-V-O_{SING} condition with the S_{PL}-V-O_{PL} condition ($t(23)=-4.6$, $p<0.001$), O_{PL}-V-S_{PL} condition ($t(23)=-4.4$, $p<0.001$) and AMB-V-AMB condition ($t(23)=-4.7$, $p<0.001$) were significant. Similarly, the comparisons of O_{SING}-V-S_{SING} with the S_{PL}-V-O_{PL} condition ($t(23)=-3.6$, $p<0.002$), O_{PL}-V-S_{PL} condition ($t(23)=-3.7$, $p<0.001$) and AMB-V-AMB condition ($t(23)=-3.6$, $p<0.001$) were significant.

6 Discussion

6.1 Whole Sentence Processing

The present study revealed that verb-medial SVO and OVS sentences in Basque do not display a processing asymmetry; in particular, we did not find an advantage for the Subject initial order (SVO) as compared to the Object initial order (OVS). These results converge with claims made in Basque Linguistics that all word orders other than SOV are derived via syntactic displacement. However, studies of word order processing in German, another SOV language, report an advantage of Subject initial (SVO) versus Object initial (OVS) orders. In German, where canonical order is SOV and V2 applies in main sentences, Bader and Meng (1999) showed that participants were consistently garden-pathed in OSV temporally ambiguous structures and favored the SOV interpretation. Using ERPs, Rösler et al. (1998) showed that sentences whose word order deviates from the SOV canonical structure were more difficult to process (see also Bornkessel et al. 2002; Schlesewsky et al. 2003 among others). In verb medial sentences, ERPs differentiated between SVO and OVS structures in German (Matzke et al. 2002). In Basque, behavioral and ERP measurements differ significantly for canonical SOV and derived OSV word orders (Erdocia et al. 2009): reading times showed longer reading times and syntactic reanalysis effects for OSV structures (see also Fig. 2) and ERPs showed negativities in both DPs and P600 at verb position suggesting that derived OSV word order required further computational resources (Erdocia et al. 2009; Fig. 3 in this chapter). Thus, while German and Basque reveal a similar processing advantage for SOV versus OSV, an advantage that has also been reported for Japanese, also SOV,[8] processing of verb-medial word orders yields diverging results: in German, a Subject-initial advantage has been reported, whereas in Basque both Subject-initial and Object-initial orders reveal equivalent measures of processing complexity. Arguably, this difference might be due to the fact that German is a V2 language, whereas Basque is not. In V2 languages, main sentences have the inflected auxiliary or verb always in the second position in the sentence and the most frequent constituent preceding the inflected verb is the Subject; this entails that SVO is in fact a rather frequent word order for a V2, main sentence in German, whereas this is not the case for Basque. This explanation is consistent with the results from German, showing a preference of SOV versus OVS and then a preference for SVO versus OVS, whereas Basque displays a preference for SOV versus OVS but no preference in the case of SVO and OVS.

The differences we found between singular and plural conditions were arguably due to conceptual and/or morphological complexity but clearly not to syntactic structure. From a syntactic standpoint, sentences that differ only in having singular or plural subjects are identical and therefore so were the S_{SING}-V-O_{SING} and S_{PL}-V-O_{PL} sentences in our Basque materials. Hence, the reading time differences must be due to something other than the processing of the syntactic structure. Two candidates for the asymmetry encountered are the conceptual representation, which is more complex for plural entities and morphology, given that plural morphology is marked both phonologically and semantically. In Basque, like in many languages, plural forms carry extra morphemes. These morphemes increase the complexity of morphological processing and the length of the words. Wagers et al. (2009) report a similar result; singular subjects were processed faster than plural subjects in a self-paced reading experiment (see Experiment 1 in Wagers et al. 2009). Unfortunately, their data, as well as our data do not allow us to discriminate which possible explanation would be correct. The additional cost of plural sentences could be due to the conceptual differences between singular and plural and/or to differences in morphological complexity but not to syntactic structure. Finally, fillers could also have had an impact in the differences between singular and plural conditions. As shown in examples (13–14) all DP-constituents of the filler sentences were singular.

[8] In Japanese, whose structure is always verb-final, some behavioral studies found differences between SOV and OSV structures (Miyamoto and Takahashi 2002; Mazuka et al. 2002) but some others did not find any difference (Yamashita 1997; Tamaoka et al. 2003). Using ERPs, the differences between canonical SOV and derived OSV arose in Japanese (Hagiwara et al. 2007; Wolff et al. 2008).

6.2 Word by Word Reading Times

The word by word analysis we carried out informed about the sources of the differences between conditions. In the first word position, the reading times showed that the fastest processed element was the singular Object (O_{SING}) (see also Erdocia et al. 2009; and Fig. 3 in this chapter). This result diverges sharply from what is usually obtained with the same self-paced reading method in other languages such as Dutch (Kaan 1997) and Russian (Sekerina 1997). In these languages Subjects are always processed faster than Objects. This divergent result could be due to one language-particular property: Basque is an ergative language, whereby Objects and intransitive Subjects belong in the same morphological class, whereas transitive Subjects carry an extra morpheme (−*k*), and constitute a class of their own. This extra morpheme on transitive Subjects could be the cause of the increase in processing time for S_{SING}/S_{PL} and the ambiguous condition that could be interpreted either as a singular Subject or a plural Object. Moreover, given ergativity, a sentence initial O_{SING} can be hypothesized to be an intransitive Subject, thus participants can postulate a simple intransitive sentence-structure and which would in turn yield faster processing.

At the auxiliary position (third position), the morphologically most complex auxiliary (*d-it-u-zte* "3rdperson/object-plural-root-plural/3rdperson/subject") required the longest reading time and the morphologically simplest auxiliary (*d-u* "3rdperson/object-root-3rdperson/subject") required the shortest reading time regardless of the word order (SVO or OVS) of the condition (Fig. 7). The auxiliary of the ambiguous condition fell in-between the most and the less complex auxiliaries. These differences between inflected auxiliaries could also be accounted for in terms of word length, which corresponds with morphological complexity: the shortest auxiliaries were processed faster and the longest auxiliaries were processed slowest. Whatever the factors responsible for the differences between auxiliaries, the syntactic structure of the sentences is not one of them.

At the sentence-final position reading times increased similarly in all five conditions. The pro-drop property of Basque (see Sect. 1.3 in this chapter) could be one factor behind such an increase in reading times: since both Subjects and Objects can be omitted in Basque, once participants read the auxiliary verb of a sentence, they could assume that the sentence was finished and that one of the "missing" arguments had been pro-dropped. Leaving aside this overall increase of reading times, the differences that result among conditions at the sentence final position, generally replicate the relative differences found at the auxiliary position and they are arguably due to the same reasons that provoked reading time differences at the auxiliary position: plural auxiliaries take longer to read than singular ones. However, the longer reading time obtained at the second DP position of the AMB-V-AMB condition cannot be the result of the auxiliary taking longer to read; on the contrary, the auxiliary in the AMB condition (*ditu* plural-O/singular-S) was simpler and faster than the auxiliary in the S_{PL}-V-O_{PL} condition (*dituzte* plural-O/plural-S). The longer reading time that is obtained at the sentence final position of ambiguous sentences is arguably due to the participants' realizing at that point that they were reading a fully ambiguous sentence. This interpretation is reinforced by the participants' performance in the comprehension task discussed below. Unfortunately no significant interactions result between condition and word when comparing ambiguous sentences and S_{PL}-V-O_{PL} sentences at auxiliary and second DP positions (S_{PL}-V-O_{PL} vs. AMB-V-AMB, $F(1,23)=3.6$, $p=0.071$).

6.3 Comprehension Task

The mean reaction time in the comprehension task revealed that the singular Subject-first condition (S_{SING}-V-O_{SING}) required shorter reading times. The task was performed faster in the singular Subject-first condition than in any other condition. Unfortunately, this result could have been biased by the SVO structure of the comprehension questions. The SVO order of these questions could have facilitated the task for SVO experimental sentences. This explanation, however, seems doubtful for it does not carry to the plural subject-first condition (S_{PL}-V-O_{PL}), which should also show a facilitation effect but does not, despite the fact that the questions of the comprehension task also had the same SVO word order.

Regarding errors in the comprehension task, only the comparison between S_{PL}-V-O_{SING} and O_{SING}-V-S_{PL} showed a significant advantage for the subject-initial condition. Interestingly, the responses to the comprehension task in the fully ambiguous condition did not show any preference for SVO or OVS interpretation. Participants performing the comprehension task were probably aware of the ambiguous character of these sentences. In a study about Japanese (Tamaoka et al. 2003) participants did not show any reaction time difference reading SOV versus OSV structures but in a comprehension task OSV sentences were harder to judge as correct than canonical sentences. It is possible that speakers realized that they confronted ambiguous sentences while performing the comprehension task and not before, while reading the sentences.

7 Conclusion

The aim of the present study was to measure the syntactic complexity and the ambiguity resolution processes that word order variation generates in two syntactically derived structures: verb-medial SVO and OVS. Previous results showed differences in syntactic processing when comparing canonical SOV with derived OSV, even in a free word order language such as Basque, suggesting that underlying canonical word order plays a relevant role in sentence processing (Erdocia et al. 2009). By using *self-paced reading* and the *comprehension task*, the current study showed that both verb-medial word orders were equally processed by native Basque speakers. This result suggests that both derived word orders required similar computational resources, with no advantage for the subject-before-object sequence. On the other hand, our data did not indicate any ambiguity resolution process reading temporally ambiguous sentences and fully ambiguous chains.

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Prominence Facilitates Ambiguity Resolution: On the Interaction Between Referentiality, Thematic Roles and Word Order in Syntactic Reanalysis

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1 Introduction

Over the past decades, research in sentence comprehension has focused on how the relative ease or difficulty of understanding a sentence is influenced by the interplay of different linguistic information types. In this regard, there is an ongoing debate on whether the human sentence parser draws on all available information during initial processing stages (e.g., MacDonald et al. 1994) or whether its initial decisions are primarily based on syntactic information, with other linguistic domains not taken into account until a later stage (e.g., Frazier and Rayner 1982; Rayner et al. 1983). Models of sentence comprehension based on these alternative architectural assumptions have been tested primarily against data from experiments that investigated the processing of garden path sentences in a variety of languages. In this vein, a major instance of garden-pathing in German, so-called subject-object ambiguities, have been examined in various sentence structures with both on-line and off-line methods (cf. Bader and Meng 1999; Bornkessel et al. 2004; Knoeferle et al. 2008; Mecklinger et al. 1995; Scheepers et al. 2000). An uncontroversial key finding of previous

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research in this domain is that, given an ambiguous clause-initial noun phrase, the parser adopts a subject-initial analysis (the "subject preference"). For example, Schriefers et al. (1995) showed in a series of self-paced reading experiments that a case-ambiguous relative pronoun is preferentially interpreted as the (nominative) subject of the clause. Later disambiguation towards an object-before-subject structure engenders a significant increase in processing costs that is visible in substantially longer reading times for the disambiguating verb. This finding accords well with traditional views claiming that subject-initial structures are the unmarked base order in both unambiguous and ambiguous strings (cf. Lenerz 1977; Gorrell 2000).

Yet, syntactic reanalysis is affected by information types other than syntax. There is ample evidence that word order in the medial part of German clauses (the *Mittelfeld*) is subject to semantic constraints such as the thematic role hierarchy or the relative semantic "prominence" of arguments in terms of features such as animacy or definiteness/specificity. These factors interact with the syntax such that unmarked word order may be determined by numerous constraints (cf. Lenerz 1977; Müller 1999; Primus 1999, for theoretical arguments; and Bornkessel et al. 2003, 2005; Grewe et al. 2005, 2006; Haupt et al. 2008; Schlesewsky and Bornkessel 2004, for empirical evidence). The present paper aims to further extend these findings by examining the interaction of the subject preference with thematic-role assignments and noun phrase specificity/referentiality in natural reading.

Although most previous studies of semantic word order constraints have examined unambiguous sentences, some linking-based accounts of sentence processing have recently provided an indication as to how these information types might apply in the incremental interpretation of locally ambiguous sentences (cf. Bornkessel and Schlesewsky 2006; Bornkessel-Schlesewsky and Schlesewsky 2009; de Hoop and Lamers 2006). These models assume to a greater or lesser extent that, based on their inherent properties (e.g. animacy, definiteness/specificity), verbal arguments can be characterized as more or less prominent and that the interpretation of an argument as "more Agent-like" (Actor) or "more Patient-like" (Undergoer) involves a relational assessment of relative argument prominence. For example, Bornkessel-Schlesewsky and Schlesewsky (2009) argue that semantic prominence features are not only used to determine an argument's role prototypicality during incremental sentence processing (i.e. the goodness of fit between an argument and the Actor or Undergoer role) but that they may also influence role assignments (i.e. which argument is analyzed as the Actor and which is analyzed as the Undergoer). The degree to which role assignments depend on different types of semantic prominence information is assumed to differ from language to language (cf. Wang et al., this volume, for evidence of animacy-based role assignments in ambiguous verb-final structures in Chinese).

A complete survey of all (cross-linguistic) prominence scales is beyond the scope of the present paper (see Aissen 2003 and Comrie 1989, for a typological approach; Bornkessel-Schlesewsky and Schlesewsky 2009, for a psycholinguistic perspective). Rather, we concentrate on the interaction between the thematic hierarchy (higher-ranking thematic role > lower-ranking thematic role), and the definiteness/specificity hierarchy (definite/specific > indefinite/nonspecific) in the processing of word order variations.[1] For present purposes, we define an argument's prominence status as the sum of its rankings on all accessible prominence hierarchies. Sentences are easiest to process when the hierarchies converge, i.e. when they all pick out the same argument as being more prominent (see Primus 1999, for theoretical arguments; and Bornkessel-Schlesewsky and Schlesewsky 2008, for psycholinguistic motivations). In addition, there is a preference for more prominent arguments to precede less prominent arguments in terms of linear order (Bornkessel et al. 2005; Grewe et al. 2005, 2006; Haupt et al. 2008; Wolff et al. 2008). Hence prominence information serves a twofold purpose during language comprehension: it is used (a) to determine and assess role assignments, and (b) to render word order variations (e.g. object-initial orders) more accessible. By measuring eye movements during reading, the present study aims to investigate the interplay between these two functions of prominence information in the comprehension of locally ambiguous structures.

A number of previous studies support the hypothesis that the reanalysis towards an object-initial order is influenced by the interaction of multiple prominence hierarchies. For example, Bornkessel et al. (2004) measured visually evoked event-related potentials (ERPs) in order to examine subject-object reanalyses in sentences with accusative (e.g. *stören*, 'to disturb') and dative-active verbs (e.g. *danken*), and found qualitative differences between the reanalyses engendered by both verb types. While disambiguation towards an object-initial order via an accusative verb elicited a P600 (a positive deflection in the electrical brain activity peaking around 600 ms post word-onset), disambiguation towards the same order via a dative verb elicited an N400 (a negative deflection peaking at approximately 400 ms). Bornkessel and colleagues interpreted the P600 as reflecting the revision of phrase structure representations, i.e. the establishment of an additional position targeted by the movement of the accusative NP. For the dative structures, by contrast, they conjectured that only a reassignment of case labels was required because of the principled availability of unmarked (base-generated) dative-initial structures in German (e.g., impersonal passives, sentences with object-experiencer verbs). These findings relate to the prominence hierarchies described above because unmarked dative-initial sentences occur when the dative argument bears a higher-ranking thematic role than its nominative co-argument (e.g., dative Experiencer – nominative Stimulus).

More recently, Haupt et al. (2008) measured auditory ERPs and found a biphasic N400-late positivity pattern for subject-object reanalyses with both accusative and dative verbs. They attributed the N400 to syntactic reanalysis and considered this process to be independent of object case. The late positivity, by contrast, was interpreted as a correlate of the markedness of scrambled word orders. By assuming a movement-independent account of scrambling in German (cf. Fanselow 2001; Heck 2000), Haupt et al. (2008) posit that the late positivity observed in their

[1] '>' reads as 'is more prominent than'. Note that these hierarchies directly translate into corresponding linearization principles. In the following, we will subsume both usages under the cover term 'hierarchy'.

studies is functionally distinct from the monophasic P600 observed for phrase structure revisions in other garden paths (e.g., the subordinate clause object/main clause subject ambiguity in English). In this way, Haupt and colleagues extended the phrase-structure-independent account proposed by Bornkessel et al. (2004) for subject-object reanalyses in dative constructions to all verb types in German.

Interestingly, they also argued that ERP components for accusative verbs may be more susceptible to task-specific strategies in visual ERPs using word-by-word presentation with RSVP (rapid serial visual presentation). In our first eye-tracking experiment, we thus aimed to investigate the relevance of different object cases in the reanalysis of the subject preference in order to examine whether data obtained in a more natural reading environment align with previous auditory ERP results or with visually evoked ERPs. Specifically, by comparing accusative verbs with dative-active verbs in an eye-tracking experiment we tested to what extent the verb-type effects described above generalize across further on-line methods using visual stimuli.

The interaction between syntactic reanalysis and the thematic hierarchy has also been tested more directly. In a second ERP study, Bornkessel et al. (2004) examined the processing of dative object-experiencer verbs (e.g., *gefallen* 'be appealing to') that link the higher-ranking Experiencer role to the syntactically lower-ranking object NP and the thematically lower-ranking Stimulus role to the syntactically more prominent subject NP (cf. Primus 1999; Wunderlich 1997). This mismatch eventually results in a preference for object-before-subject structures as the object outranks the subject on the thematic hierarchy (see the rating study in Haupt et al. 2008, for empirical evidence). In terms of ERP correlates, Bornkessel et al. (2004) found that the reanalysis towards an object-initial structure appears to be less costly for sentences with dative object-experiencer as opposed to dative active verbs, since a dispreferred disambiguation via an object-experiencer verb yielded a less pronounced N400 (cf. Bornkessel et al. 2005, for corresponding evidence from neuroimaging). From this finding, Bornkessel and colleagues concluded that the object-initial order is more easily reconstructed with these verbs as it conforms to the preferred linearization of thematic roles.[2] Following up on these findings, our second experiment focused on the interaction between word order and thematic roles by comparing subject-object reanalyses induced by dative-active and dative object-experiencer verbs.

Finally, previous research on the influence of argument prominence suggests that the costs of a reanalysis towards an object-initial order may be modulated by the arguments' relative rankings on nominal hierarchies such as the animacy hierarchy or the definiteness/specificity hierarchy (for theoretical motivations, see Lenerz 1977, 2001; Müller 1999; for empirical evidence from unambiguous sentences, see Grewe et al. 2006; for initial evidence from ambiguous sentences, see Wang et al., this volume). For example, Scheepers and colleagues found in a questionnaire study that compliance with the animacy hierarchy can promote object scrambling in

[2]Note that this facilitation in reanalysis is reduced if the object-experiencer verbs permit an agentive reading of the nominative argument, as is the case with accusative object-experiencer verbs in German (see Scheepers et al. 2000).

ambiguous structures containing accusative object-experiencer verbs (see Footnote 2) by excluding the agentive reading for the inanimate Stimulus and supporting the mapping of the higher-ranking thematic role (animate Experiencer) onto the syntactic object function. (For findings concerning animacy and definiteness in unambiguous structures, see the rating study in Haupt et al. 2008).

This raises the question of whether such influences also apply in on-line comprehension. Although it has not been demonstrated that lower prominence of the clause-initial NP affects the application of the subject preference in German, there is evidence that the resolution of subject-object ambiguities is more difficult if nominal hierarchies are additionally violated. For example, in Haupt et al.'s (2008) materials, a specific proper name was clause-initial in one half of all sentences and a nonspecific bare plural NP in the other. In sentences with initial bare plurals, reanalysis towards an object-initial order was more difficult, as reflected in lower acceptability ratings and a more pronounced reanalysis N400. This suggest that the recovery from a subject-object ambiguity is also influenced by the relative ranking of the arguments on nominal prominence hierarchies.

A similar investigation from Dutch suggests that definiteness/specificity may even affect the initial subject preference. Using self-paced reading, Kaan (2001; see also Kaan 1998) observed that the subject preference in Dutch is reduced substantially when the second ambiguous noun phrase was a second person pronoun outranking the clause-initial common noun in terms of definiteness and specificity. However, in contrast to the German studies described above, the definiteness/specificity hierarchy was additionally supported by the person hierarchy (1st/2nd person > 3rd person) in Kaan's critical sentence materials. This might have contributed to the different findings.

In sum, nominal hierarchies appear to affect the ease with which word order variations are processed. At the same time, there is diverging evidence as to the phase in which these effects emerge. In both of the present experiments, we examined the influence of the definiteness/specificity hierarchy on syntactic ambiguity resolution. In particular, we aimed to clarify whether a violation of this hierarchy may reduce the subject preference or whether it only impedes reanalysis. Whereas Experiment 1 investigated the interplay between this hierarchy and different types of object case, Experiment 2 examined the role of the thematic hierarchy.

2 Testing the Interaction of Syntactic Reanalysis and Prominence Hierarchies

2.1 Experiment 1

Experiment 1 investigated the resolution of word order ambiguities in German embedded clauses, when disambiguation is effected by either accusative (cf. 1a,b) or dative-active verbs (cf. 1c,d). Furthermore, and in accordance with the considerations outlined in the introduction, we manipulated argument prominence along the definiteness/specificity hierarchy by presenting the same sentence types with the bare plural preceding the proper name.[3]

(1) a. *Dass Erich Nachbarinnen stört, hat jeden verwundert.*
that Erich-AMB.SG neighbors-AMB.PL disturb-ACC.SG, has everyone surprised
'It surprised everyone that Erich disturbs neighbours.'

b. *Dass Erich Nachbarinnen stören, …*
that Erich-AMB.SG neighbors-AMB.PL disturb-ACC.PL
'It surprised everyone that neighbors disturb Erich.'

c. *Dass Erich Nachbarinnen dankt, …*
that Erich-AMB.SG neighbors-AMB.PL thank-DAT.SG
'It surprised everyone that Erich thanks neighbors.'

d. *Dass Erich Nachbarinnen danken, …*
that Erich-AMB.SG neighbors-AMB.PL thank-DAT.PL
'It surprised everyone that neighbors thank Erich.'

Like Haupt et al. (2008), we chose not to manipulate definiteness directly, e.g. by comparing noun phrases with definite and indefinite determiners, because the indefinite determiner *ein(e)* ('a') is also compatible with a numeral reading ('one') in German. It could therefore be interpreted as a quantifier (Fodor and Sag 1982), thereby leading to a confound during word order processing (cf. the results of the rating study in Haupt et al. 2008, for a first indication of such an influence). Specificity is also difficult to manipulate directly in German as it is not morphologically expressed (in contrast to languages such as Turkish, e.g. Comrie 1989). Hence, we drew upon a subpart of the definiteness/specificity hierarchy, which, following Croft (2003), can be termed the "referentiality hierarchy" (cf. 2).

(2) Referentiality hierarchy (Croft 2003, p. 130)
pronoun>proper name>common noun

In accordance with the hierarchy in (2), the present study manipulated the referentiality of the arguments by contrasting proper names with bare plural common nouns at the position of NP1 vs. NP2, thereby allowing for word order disambiguation via number agreement at the position of the clause-final verb.[4] Furthermore, proper names and bare plurals introduce a three-way ambiguity between nominative, accusative and dative case, which was required for the implementation of the object case manipulation.

[3] Abbreviations: SG – singular; PL – plural; AMB – ambiguity between nominative, accusative, and dative case; ACC – accusative verb; DAT – dative-active verb.

[4] Whereas bare plurals may lead to an ambiguity between a non-specific and a specific (generic) reading (Carlson 1977), it suffices for the purposes of the present manipulation that, even under a specific reading, they are still outranked by proper names on the definiteness/referentiality scales. In contrast to bare plurals, which denote sets of entities, proper nouns are uniquely identifiable.

In accordance with previous results, we expected to observe robust reanalysis effects for the disambiguating verb region and likely also for the spillover region (i.e., the region following the verb) in early and late eye movement measures. In addition, we hypothesized that these effects should be influenced by the type of object case. If there is indeed an interaction between the two factors, the crucial question is where it should be expected to emerge. Following grammatical theories which consider the dative as a non-default case that signals deviations from either the ideal Actor or the ideal Undergoer role in the semantic representation of a verb (cf. Van Valin 2005), a disadvantage for dative verbs should emerge as soon as information about the verb's argument structure is retrieved. Since argument structure information typically affects early eye movement measures (e.g. see Staub 2007, Experiment 3), this predicts early effects of case assignment in the present experiment. If these (lexically specified) non-default role properties of dative verbs serve to render word order reanalysis more difficult, an additional early interaction between case and word order might be expected. By contrast, if word order reanalysis is unaffected by case information or if the licensing of dative-initial structures in German is accomplished in a post-initial step, there may be no interaction effect at all or comprehensive measures of eye movements may be more suited to detecting this effect.

2.1.1 Method

Participants

Forty students (20 females; mean age: 23.1 years, range: 18–30) from the University of Marburg participated in the experiment. Participants were native speakers of German and had normal or corrected-to-normal vision. Four further participants had to be excluded from all analyses due to technical problems during the experiment (2), low performance in the comprehension task (1), or alcohol misuse prior to the experiment (1).

Materials

In order to maximize comparability with previous results, we employed a modified subset of Bornkessel et al.'s (2004) materials (cf. 1a–d). Crucially, syntactic disambiguation and case information are both provided by the embedded verb. We fully crossed the factors CASE (accusative [ACC] vs. dative [DAT]), ORDER (subject-before-object [SO] vs. object-before-subject [OS]), and NP (proper name-before-bare plural [PN] vs. bare plural-before-proper name [BP]), yielding eight conditions. We constructed 8 sets of 32 sentences, which were distributed across 8 lists such that 4 items occurred per condition. Subjects were allocated to one of these lists, and none of them read the same sentence twice. The experimental items were interspersed with 138 unrelated filler sentences from other experiments, and all sentences were presented in a randomized order. A yes/no question appeared after 25% of all trials. As the main purpose of these comprehension questions was to assure participants' attention, we balanced the required answers within a list such that participants had to answer yes or no to an equal number of questions. The average accuracy was 84%.

Apparatus

Participants' eye movements were recorded via an Eyelink 1000 eye-tracker with an angular resolution of 10–30 min of arc. The sampling rate was 1,000 Hz. Viewing was binocular, with the right eye recorded. Stimuli were displayed on a 21-in. monitor and participants were seated 60 cm in front of the computer screen. At this distance, 2.7 characters equalled 1° of visual angle. The experiment was run using the EyeTrack software provided by the University of Massachusetts, Amherst (http://www.psych.umass.edu/eyelab/software).

Procedure

Participants were tested individually. They were instructed to read the stimuli for comprehension and at their usual reading rate. A calibration routine was performed that lasted approximately 5 min. Every session started with ten practice trials each followed by a comprehension question. None of these practice items was related to the experimental or filler items. Subsequently, calibration was checked again and the experiment started. Calibration accuracy was checked after every trial and calibration was repeated after a break or as warranted by the calibration check. The entire experimental session lasted about 75 min.

Analysis

Prior to all analyses, less than 2% of all trials were excluded because of track losses or presentation problems. In addition, short fixations of less than 80 ms in duration were incorporated into an adjacent fixation if the distance between these two did not exceed one character, and fixations less than 40 ms in duration were treated similarly if they were within three characters of an adjacent fixation. Short fixations (less than 80 ms) that did not meet these criteria were excluded. Fixations longer than 800 ms were also excluded, as they are likely to reflect track losses (Rayner and Pollatsek 1989). In total, less than 1% of fixations was eliminated based on these criteria. For the purpose of analysis, we divided the sentences into six regions as shown for a subject-before-object clause in (3), where "/" indicates regions of analysis and "|" indicates the counterbalancing of lexical material across conditions. Region 4 contained the disambiguating verb, while regions 2 and 3 were counterbalanced with regard to NP type (with number agreement on the verb adjusted accordingly). The spillover region (region 5) comprised two words because the short auxiliary *hat* was very likely to be skipped.

(3) Dass$_1$/ Erich | Nachbarinnen$_2$/ Nachbarinnen | Erich$_3$/ stört | stören$_4$/ hat jeden$_5$/ verwundert.$_6$

We computed the following measures (cf. Clifton et al. 2007): (1) first fixation duration (the duration of the first fixation on a region regardless of whether additional fixations followed); (2) first pass time (the sum of all fixations in a region from first entering it until leaving it to the right; referred to as gaze duration for single words); (3) first-pass regressions, (or 'regressions out'; the percentage of trials in which a region was terminated by a regressive saccade to earlier parts of the sentence); (4) go-past time (or regression path duration; includes first-pass reading time as well as any time spent re-reading material to the left of the critical region up to the point where the reader leaves the critical region with a progressive saccade.); (5) 'regressions in' (the probability of a region being the landing site of a regressive saccade; cf. Staub and Rayner 2007), and (6) total time (the sum of all fixations in a region). Measures 1–3 are typically considered early measures, whereas measures 4–6 are assumed to reflect later processing stages (cf. Clifton et al. 2007). Note that, because both NP types and verb types differ significantly in length (mean lengths: 6.12 characters for accusatives vs. 8.62 characters for dative-active verbs; 11.18 characters for bare plurals vs. 5.84 characters for proper names), we report first-pass and total reading times with both unadjusted times and with residual times that are corrected for length by subtracting obtained reading times from reading times predicted on the basis of a region's length (cf. Ferreira, and Clifton 1986; Trueswell et al. 1994).[5] For residual times, negative values indicate faster-than-predicted reading times, whereas positive values indicate slower-than-predicted reading times.

Note that for brevity, effects for the complementizer region are not reported for this and the second experiment. The effects for this region did not reveal any reliable

[5]Bare plurals and proper names also differed with respect to word frequency. Specifically, bare plurals were less frequent than proper names (mean log frequency class 15.37 vs. 10.97, where higher values indicate lower frequency; cf. www.wortschatz.uni-leipzig.de). A main effect of NP type on the critical noun phrases in unadjusted and residual reading times would thereby be confounded by lexical processing of a low-frequency vs. a high-frequency word. Accordingly, we could expect a main effect of NP on the verb region with longer reading times if the verb immediately followed a bare plural (as the preview benefit is limited because of enhanced foveal load on the long, low-frequency plural; cf. Henderson and Ferreira 1990; Rayner 1998). However, throughout both experiments, this prediction was not borne out, as we found increased reading times if the verb immediately followed the high-frequency proper name. Additionally, there were interactions of NP type with the other two factors suggesting that the disadvantage for bare plurals is locally resolved while fixating the respective NP. More importantly, syntactic reanalysis effects affected fixation durations on both NP regions regardless of NP order in Experiment 1 (cf. total times on NP1) and there were differential effects for bare plurals and proper names depending on the verb in Experiment 2. Overall, these effects cannot be accounted for by frequency differences.

Table 1 Mean reading times (in ms) and percent regressions (in %) for the ambiguous regions in Experiment 1

Measure	NP1	NP2	Measure	NP1	NP2
First fixation			*Go-past time*		
ACC-SO-PN	195 (5)	228 (5)	ACC-SO-PN	310 (15)	483 (24)
ACC-SO-BP	217 (6)	249 (7)	ACC-SO-BP	617 (24)	393 (25)
ACC-OS-PN	213 (7)	228 (6)	ACC-OS-PN	323 (15)	500 (21)
ACC-OS-BP	202 (5)	258 (8)	ACC-OS-BP	576 (22)	416 (25)
DAT-SO-PN	207 (6)	224 (5)	DAT-SO-PN	350 (16)	500 (24)
DAT-SO-BP	214 (5)	255 (8)	DAT-SO-BP	606 (28)	384 (20)
DAT-OS-PN	207 (6)	233 (6)	DAT-OS-PN	345 (16)	557 (27)
DAT-OS-BP	209 (6)	252 (7)	DAT-OS-BP	630 (33)	369 (21)
First pass time			*Residual first pass time*		
ACC-SO-PN	232 (9)	409 (18)	ACC-SO-PN	−85 (10)	−50 (16)
ACC-SO-BP	444 (22)	303 (11)	ACC-SO-BP	−15 (21)	−14 (10)
ACC-OS-PN	248 (10)	434 (18)	ACC-OS-PN	−67 (10)	−19 (17)
ACC-OS-BP	387 (20)	319 (14)	ACC-OS-BP	−70 (18)	1 (13)
DAT-SO-PN	259 (11)	432 (18)	DAT-SO-PN	−60 (11)	−25 (17)
DAT-SO-BP	457 (25)	295 (10)	DAT-SO-BP	−1 (24)	−25 (9)
DAT-OS-PN	252 (10)	452 (20)	DAT-OS-PN	−64 (10)	−5 (19)
DAT-OS-BP	421 (22)	297 (12)	DAT-OS-BP	−33 (19)	−22 (11)
Total time			*Residual total time*		
ACC-SO-PN	331 (18)	615 (32)	ACC-SO-PN	−134 (16)	−84 (27)
ACC-SO-BP	766 (35)	420 (19)	ACC-SO-BP	62 (28)	−55 (15)
ACC-OS-PN	425 (23)	756 (36)	ACC-OS-PN	−46 (20)	64 (29)
ACC-OS-BP	919 (46)	571 (31)	ACC-OS-BP	218 (38)	102 (27)
DAT-SO-PN	395 (20)	648 (31)	DAT-SO-PN	−78 (18)	−53 (28)
DAT-SO-BP	754 (36)	427 (22)	DAT-SO-BP	55 (29)	−46 (18)
DAT-OS-PN	444 (25)	776 (38)	DAT-OS-PN	−29 (19)	75 (32)
DAT-OS-BP	889 (46)	503 (30)	DAT-OS-BP	195 (39)	35 (25)
Regressions out			*Regressions in*		
ACC-SO-PN	22 (3)	10 (2)	ACC-SO-PN	23 (3)	35 (4)
ACC-SO-BP	29 (4)	13 (3)	ACC-SO-BP	42 (4)	24 (4)
ACC-OS-PN	25 (4)	10 (3)	ACC-OS-PN	42 (4)	47 (4)
ACC-OS-BP	34 (4)	14 (3)	ACC-OS-BP	58 (4)	34 (4)
DAT-SO-PN	25 (4)	8 (2)	DAT-SO-PN	32 (4)	34 (4)
DAT-SO-BP	22 (3)	13 (3)	DAT-SO-BP	40 (4)	28 (4)
DAT-OS-PN	27 (4)	15 (3)	DAT-OS-PN	45 (4)	45 (4)
DAT-OS-BP	28 (4)	11 (3)	DAT-OS-BP	51 (4)	34 (4)

Standard error is given in parentheses

SO subject-before-object, *OS* object-before-subject, *ACC* accusative verb, *DAT* dative-active verb, *PN* proper name-before-bare plural, *BP* bare plural-before-proper name

effects in early eye movement measures and they did not differ significantly from the effects for the critical NP regions in comprehensive measures. Factorial 2×2×2 repeated-measures ANOVAs were calculated treating participants (F_1) and items (F_2) as random factors. Tables 1 and 2 present the mean reading times for the critical regions, and Table 3 summarizes the statistical tests.

Table 2 Mean reading times (in ms) and percent regressions (in %) for the verb and the following regions in Experiment 1

Measure	Verb region	Spillover region	Final region
First fixation			
ACC-SO-PN	278 (9)	210 (4)	274 (10)
ACC-SO-BP	275 (9)	218 (5)	271 (10)
ACC-OS-PN	287 (10)	232 (7)	275 (11)
ACC-OS-BP	293 (10)	227 (7)	296 (12)
DAT-SO-PN	289 (9)	211 (5)	284 (10)
DAT-SO-BP	274 (10)	217 (6)	286 (12)
DAT-OS-PN	290 (10)	234 (8)	282 (11)
DAT-OS-BP	279 (10)	234 (8)	290 (12)
First pass time			
ACC-SO-PN	334 (11)	383 (14)	426 (24)
ACC-SO-BP	364 (15)	386 (13)	425 (21)
ACC-OS-PN	375 (15)	445 (20)	420 (24)
ACC-OS-BP	389 (19)	435 (16)	457 (24)
DAT-SO-PN	415 (17)	379 (13)	400 (19)
DAT-SO-BP	470 (19)	414 (15)	409 (20)
DAT-OS-PN	501 (23)	463 (19)	422 (20)
DAT-OS-BP	486 (26)	441 (20)	411 (20)
Residual first pass time			
ACC-SO-PN	3 (10)	−31 (13)	9 (23)
ACC-SO-BP	16 (14)	−30 (13)	5 (20)
ACC-OS-PN	28 (14)	36 (20)	2 (23)
ACC-OS-BP	56 (17)	23 (16)	41 (23)
DAT-SO-PN	28 (16)	−32 (13)	−19 (20)
DAT-SO-BP	49 (17)	3 (15)	−12 (19)
DAT-OS-PN	86 (21)	50 (20)	1 (20)
DAT-OS-BP	93 (23)	30 (19)	−9 (20)
Go-past time			
ACC-SO-PN	462 (27)	440 (21)	818 (51)
ACC-SO-BP	470 (23)	450 (23)	1,032 (71)
ACC-OS-PN	564 (34)	591 (38)	1,077 (73)
ACC-OS-BP	742 (51)	657 (50)	1,303 (94)
DAT-SO-PN	583 (29)	474 (27)	940 (66)
DAT-SO-BP	622 (34)	461 (21)	1,026 (74)
DAT-OS-PN	688 (37)	671 (46)	1,046 (68)
DAT-OS-BP	846 (60)	611 (43)	1,180 (98)
Total time			
ACC-SO-PN	419 (17)	533 (24)	509 (30)
ACC-SO-BP	501 (26)	591 (23)	538 (28)
ACC-OS-PN	572 (28)	656 (31)	511 (26)
ACC-OS-BP	693 (37)	698 (32)	558 (28)
DAT-SO-PN	597 (26)	558 (22)	507 (27)
DAT-SO-BP	634 (28)	604 (27)	523 (29)
DAT-OS-PN	725 (32)	696 (31)	514 (23)
DAT-OS-BP	820 (45)	678 (33)	528 (27)

(continued)

Table 2 (continued)

Measure	Verb region	Spillover region	Final region
Residual total time			
ACC-SO-PN	−75 (16)	−87 (23)	−124 (31)
ACC-SO-BP	−22 (21)	−34 (22)	−105 (30)
ACC-OS-PN	53 (23)	43 (29)	−126 (30)
ACC-OS-BP	201 (30)	74 (30)	−78 (28)
DAT-SO-PN	2 (21)	−64 (23)	−135 (30)
DAT-SO-BP	3 (23)	−18 (26)	−126 (28)
DAT-OS-PN	96 (27)	72 (29)	−125 (26)
DAT-OS-BP	225 (35)	62 (30)	−112 (30)
Regressions out			
ACC-SO-PN	21 (3)	8 (2)	46 (4)
ACC-SO-BP	20 (3)	8 (2)	55 (4)
ACC-OS-PN	23 (3)	12 (3)	57 (4)
ACC-OS-BP	32 (4)	13 (3)	56 (4)
DAT-SO-PN	20 (3)	11 (2)	54 (4)
DAT-SO-BP	19 (3)	7 (2)	50 (4)
DAT-OS-PN	23 (3)	15 (3)	62 (4)
DAT-OS-BP	32 (4)	13 (3)	53 (4)
Regressions in			
ACC-SO-PN	8 (2)	34 (4)	–
ACC-SO-BP	16 (3)	38 (4)	
ACC-OS-PN	16 (3)	34 (4)	
ACC-OS-BP	17 (3)	33 (4)	
DAT-SO-PN	20 (3)	38 (4)	
DAT-SO-BP	16 (3)	33 (4)	
DAT-OS-PN	20 (3)	36 (4)	
DAT-OS-BP	17 (3)	38 (4)	

Standard error is given in parentheses
SO subject-before-object, *OS* object-before-subject, *ACC* accusative verb, *DAT* dative-active verb, *PN* proper name-before-bare plural, *BP* bare plural-before-proper name

Table 3 Summary of the statistical analyses for Experiment 1

	Verb region		Spillover region		Final region	
	F_1	F_2	F_1	F_2	F_1	F_2
First fixation						
Case	<1	<1	<1	<1	1.29	<1
Order	1.62	2.76	11.39**	12.80***	1.13	<1
NP	1.49	<1	<1	<1	1.03	1.04
First pass time						
Case	85.79***	22.03***	2.17	1.21	2.66	2.07
Order	20.78***	11.93**	17.43***	17.91***	1.26	<1
NP	2.29	2.12	<1	<1	<1	<1
Order × NP	2.97	4.28*	3.07	2.11	<1	<1

(continued)

Table 3 (continued)

	Verb region		Spillover region		Final region	
	F_1	F_2	F_1	F_2	F_1	F_2
Residual first pass time						
Case	14.35***	5.15*	2.25	1.4	2.74	2.28
Order	20.13***	13.16***	17.54***	21.26***	1.32	1.08
NP	1.99	2.67	<1	<1	<1	<1
Go-past time						
Case	22.21***	17.09**	<1	1.06	<1	<1
Order	28.24***	43.50***	26.73***	52.76***	9.28**	14.45***
NP	14.32***	12.93***	<1	<1	9.51**	9.89**
Order × NP	6.46*	5.14*	<1	<1	<1	<1
Total time						
Case	57.90***	28.93***	<1	<1	<1	<1
Order	54.06***	108.20***	27.25***	56.32***	<1	<1
NP	14.23***	11.72**	3.96†	4.59*	2.1	3.5
Residual total time						
Case	6.60*	5.21*	<1	<1	<1	<1
Order	55.58***	114.32***	27.85***	57.61***	1.04	<1
NP	15.83***	19.26***	3.66†	3.91†	2.28	1.38
Order × NP	10.59**	7.97**	1.41	<1	<1	<1
Regressions out						
Case	<1	<1	<1	1.27	<1	<1
Order	8.36**	9.51**	4.72*	6.58*	3.19	5.42*
NP	2.1	1.73	<1	<1	<1	<1
Order × NP	8.67**	6.20*	<1	<1	1.96	1.72
Case × NP	<1	<1	<1	1.86	4.04†	5.91*
Regressions in						
Case	3.73†	3.64†	<1	<1	–	–
Order	<1	1.1	<1	<1		
NP	<1	<1	<1	<1		
Case × NP	3.94†	3.45	<1	<1		

	NP1		NP2	
	F_1	F_2	F_1	F_2
First Fixation				
Case	<1	<1	<1	<1
Order	<1	<1	<1	<1
NP	2.28	1.12	16.77***	14.31***
Order × NP	11.93***	5.89*	<1	<1
First pass time				
Case	5.21*	2.6	<1	<1
Order	1.87	3.32	2.85	2.12
NP	93.84***	84.03***	108.78***	55.50***
Order × NP	3.96†	4.51*	<1	<1

(continued)

Table 3 (continued)

	NP1		NP2	
	F_1	F_2	F_1	F_2
Residual first pass time				
Case	4.45*	2.94*	<1	<1
Order	1.6	2.34	2.9	2.24
NP	9.54**	4.03†	<1	<1
Order × NP	4.79*	4.68*	<1	<1
Case × NP	<1	<1	4.84*	3.76†
Go-past time				
Case	5.88*	2.32	<1	<1
Order	<1	<1	2.58	1.24
NP	230.70***	120.15***	62.39***	35.66***
Case × NP	<1	<1	5.47*	6.01*
Total time				
Case	<1	<1	<1	<1
Order	25.43***	29.55***	30.21***	36.44***
NP	171.37***	233.49***	95.55***	50.04***
Order × NP	6.32*	3.31	<1	<1
Residual total time				
Case	<1	<1	<1	<1
Order	25.57***	35.13***	30.29***	40.09***
NP	57.30***	60.96***	<1	<1
Order × NP	6.06*	5.07*	<1	<1
Regressions out				
Case	<1	<1	<1	<1
Order	2.68	3.12	<1	<1
NP	2.62	1.26	1.11	<1
Regressions in				
Case	<1	<1	<1	<1
Order	35.55***	29.13***	13.36***	15.72***
NP	21.01***	36.13***	11.03**	13.98**
Case × NP	5.19*	6.16*	1.07	<1

For participant analyses df = 1,39 (except spillover region with df = 1,38); for item analyses df = 1,31. Interactions are not reported unless significant for at least one of the critical regions
†$p \leq .07$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

2.1.2 Results

Regions 2 and 3: The Two Case-Ambiguous Noun Phrases (NP1, NP2)

Both NP1 and NP2 showed effects of NP from early measures onwards. These effects were mostly due to longer fixation durations for bare plural NPs vs. proper names and could therefore be explained via the length/frequency differences between the two NP types. By contrast, the first fixation duration on NP2 was longer for proper names.

This could be regarded as a spillover effect from the bare plural NP1 as the first fixation after a low-frequency word can be modestly inflated (cf. Inhoff and Rayner 1986). Later measures (unadjusted and residual total times, 'regressions in') additionally showed effects of ORDER that were due to longer fixations/higher proportions of regressions to the NP regions for object-initial sentences.

At the position of NP1, the effects of ORDER and NP were qualified by an interaction between the two factors in several measures. For early measures, resolving this interaction by NP did not reveal any fully reliable effects (first fixation duration: the effect of ORDER was only reliable by participants in both the PN-first ($p_1 < .04$, $p_2 < .2$), and the BP-first conditions ($p_1 < .05$; $p_2 < .08$); first pass analyses: no significant effects for PN-first conditions; effects of ORDER only significant by items for the BP-first conditions (unadjusted: $p_1 < .09$, $p_2 < .04$; residual: $p_1 < .08$, $p_2 < .05$). For residual total times, by contrast, the resolution of the interaction revealed significant effects of ORDER for both levels of NP, with the interaction due to a larger difference between object-initial and subject-initial structures in the BP conditions (PN: $F_1(1,39) = 14.61$, $p < .001$; $F_2(1,31) = 9.09$, $p < .01$; BP: $F_1(1,39) = 20.55$, $p < .001$; $F_2(1,31) = 23.26$, $p < .001$).

In sum, the pattern of eye movements on both NP regions confirms that object-initial orders caused processing disruption, suggesting that readers regressed to the two case-ambiguous NPs in order to recover from their initial (subject-initial) misanalysis.[6]

Region 4: The Disambiguating Verb

First fixation durations showed no significant main effects or interactions. ORDER affected all remaining measures for this region except 'regressions in',

[6] At a first glance, the interaction between word order and NP type in the early eye-tracking record for NP1 could be taken to suggest that readers already obtained syntactic cues to guide their initial structural interpretation while fixating the first case-ambiguous NP. This information would need to be obtained parafoveally from the second word (word $n+2$) to the right of the currently fixated word, which is known as a parafoveal-on-foveal effect (for a recent overview, see Kennedy 2008). The effect was most apparent when the short proper name intervened between bare plural and disambiguating verb, which is in accordance with previous results showing that parafoveal-on-foveal effects from word $n+2$ especially occur when word $n+1$ is rather short (cf. Kliegl et al. 2007). However, several points render the assumption of a parafoveal-on-foveal effect less likely. First, we still observed reanalysis costs on the disambiguating region in the same conditions that showed the supposed parafoveal-on-foveal effect. In fact, the data in go-past time for the disambiguating verb suggest that reanalysis was even more difficult to accomplish in these cases. Second, the proper name (word $n+1$) in our experiment was almost about twice as long as the length usually reported for word $n+1$ when there were parafoveal-on-foveal effects from word $n+2$. Apparently, these effects are most likely to occur when word $n+1$ does not exceed more than three letters in length (cf. Angele et al. 2008). Finally, there is no corresponding effect on NP1 in our second experiment which used an identical set of NPs. Altogether, these facts speak against a parafoveal-on-foveal effect.

with higher fixation durations for object-initial orders. The effect of ORDER was modified by an interaction with NP in unadjusted first pass time (marginal), first-pass regressions, go-past time, and in residual total reading times. Resolving the fully significant interactions revealed that, for both go-past time and residual total times, ORDER had a significant influence in both NP conditions (go-past time: PN: $F_1(1,39) = 19.94$, $p < .001$, $F_2(1,31) = 12.06$, $p < .01$; BP: $F_1(1,39) = 19.31$, $p < .001$; $F_2(1,31) = 26.28$, $p < .001$; residual total time: PN: $F_1(1,39) = 19.99$, $p < .001$; $F_2(1,31) = 22.41$, $p < .001$; BP: $F_1(1,39) = 49.74$, $p < .001$; $F_2(1,31) = 76.17$, $p < .001$). The interaction reflected the fact that, while reanalysis costs were apparent for both PN and BP conditions, the difference between OS and SO conditions was larger in plural-first sentences. Object-initial clauses also led to significantly more regressions in BP sentences ($F_1(1,39) = 17.20$, $p < .001$; $F_2(1,31) = 12.65$, $p = .001$; 32% for OS vs. 20% for SO), whereas there was no difference for conditions with an initial proper name (Fs < 1).

CASE influenced reading times from first pass time onwards. Whereas the significant effects in residual measures suggest that these differences were not due to length, length confounds cannot be ruled out for the marginally higher rater of 'regressions in' for dative verbs. Crucially, the interaction between CASE and ORDER did not approach significance in any measure.

Region 5: The Spillover Region (Auxiliary Plus Indefinite Pronoun)

The main effect of ORDER consistently spilled over from the disambiguating region to the spillover region, where it affected early and late measures of eye movements. Object-initial vs. subject-initial sentences led to increased fixation durations or a higher probability of making a regressive saccade. The factors ORDER and CASE did not interact in any measure. Furthermore, unadjusted and residual total times evidence a marginal main effect of NP, which resulted from longer reading times for plural-first sentences.

Region 6: The Final Region (Past Participle of the Matrix Verb)

Our analyses only revealed effects for regressive eye movement measures. Go-past time revealed main effects of ORDER and NP, with object-initial clauses and initial bare plurals engendering increased reading times. First-pass regressions showed an almost significant interaction between CASE and NP ($p_1 = .051$; $p_2 < .03$). Resolving this interaction by NP showed that readers were somewhat more likely to regress in the PN conditions when the disambiguating region contained a dative-active verb, but not in the corresponding BP conditions (PN: $F_1(1,39) = 3.68$, $p < .07$; $F_2(1,31) = 4.06$, $p = .06$; BP: $F_1(1,39) = 1.28$, $p < .3$; $F_2(1,31) < 1$). This effect appeared to result from the OS-PN condition, in which the proper name is linked to the less prominent object function, yielding additional processing efforts.

2.1.3 Discussion

Overall, the results of Experiment 1 confirmed our hypothesis concerning reanalysis costs for the dispreferred object-before-subject structure. Evidently, readers followed the subject preference upon encountering the first case-ambiguous NP in the embedded clause. When the supposed subject did not meet the agreement requirements of the clause-final verb, the entire structure had to be revised, which led to clearly visible reanalysis costs on the verb and the immediately following region. This garden path effect already appeared in early eye movement measures and lasted until late processing stages. Object-initial sentences also engendered more first-pass regressions. Thus, word order ambiguities elicited strong garden path effects (including increased fixation times and regressions) that were difficult to overcome (cf. Frazier and Rayner 1982). Late eye tracking measures additionally showed that readers spent more time re-reading both ambiguous noun phrases, likely due to the need for reanalysis. This pattern adds to the large body of results confirming the robust effects of the subject preference and subsequent syntactic reanalysis across different stimuli and experimental methods.

Although we observed reanalysis effects across several regions, they did not interact with case information at any time. Thus, there is no evidence to suggest that syntactic reanalysis was easier with dative verbs. Rather, we found a general disadvantage for dative case on the verb as early as in (residual) first pass time. One possible interpretation of this finding is that it reflects the need to interpret a two-argument relation that is not ideally transitive: dative-active verbs do not assign all possible generalized semantic roles (cf. dative as a non-macrorole case: Van Valin 2005; Bornkessel and Schlesewsky 2006) or call for the assignment of a generalized role with only a low number of prototypical features (cf. the "dative default" principle in Primus 1999).[7] The additional effect on first-pass regressions in the sentence-final region suggests that the dative disadvantage affected sentence wrap-up processes as well. In particular, this effect was evident in the condition in which the more highly referential proper name had to be mapped to the less prominent object (OS-PN). This observation could be viewed as evidence for a linking mismatch between the referentiality hierarchy and the syntactic hierarchy that is more severe for marked transitive events. The interaction between object case and referentiality provides additional support for an interpretation of the case effect in terms of thematic processing: if it were simply due to lexical or formal differences between the two verb types (e.g. the assignment of lexical vs. structural object case

[7] Note that the verb types did not differ with respect to token frequency. Hence, the prolonged fixation durations for dative verbs do not reflect a lexical frequency effect. Nevertheless, since the class of dative-assigning verbs is less frequent than the class of accusative-assigning verbs, the disadvantage for dative verbs could also be due to type frequency. However, in contrast to a thematically-based account (see the main text), a frequency-based account does not provide an explanation for the interaction between verb type and noun phrase prominence.

or type frequency), it is not clear why it should interact with a semantic prominence hierarchy such as referentiality.

Let us finally turn to linearization and the definiteness/specificity hierarchy. Our data showed a preference for proper nouns, which are higher in referentiality (as a subtype of definiteness/specificity), to precede bare plurals across all eye movement measures under investigation (see Clifton and Frazier 2004, for a similar observation regarding definiteness in English double-object constructions). These observations are in accordance with theoretical assumptions about the definiteness/specificity hierarchy and word order in German (cf. Lenerz 1977; Müller 1999). Crucially, however, our findings suggest that noun phrase referentiality does not reverse the subject preference. If bare plurals were preferentially analyzed as objects due to their lower semantic prominence status, we should have observed an advantage for an object-before-subject order in BP-sentences. However, this prediction was not borne out. Rather, supporting evidence from the referentiality hierarchy only appeared to aid reanalysis (e.g. in residual total times at the verb, the difference between SO and OS in the PN conditions was approximately 38 ms, whereas it amounted to 203 ms for BP conditions).[8] This result provides converging evidence for the assumption (see the introduction) that Kaan's (2001) apparent finding of a referentiality-based reduction of the subject preference was likely due to the person hierarchy, i.e. to the dissociation between a second person-speech act participant and a third person referent (cf. DeLancey 1981).

2.2 Experiment 2

Experiment 2 investigated the interaction between the thematic hierarchy and the syntactic (subject-object) hierarchy. In particular, we aimed to examine whether the reanalysis effects for object-initial structures are modified by an interaction

[8]This is also expected under the assumption that scrambled bare-plural objects in German entail a generic, nonspecific interpretation, whereas non-scrambled bare plural objects can only receive an existential interpretation (cf. Kratzer 1995). With regard to bare plural subjects, it has been proposed that the interpretation of bare plurals depends on whether they appear as subjects of either stage-level or individual-level predicates, with only stage-level predicates allowing for a generic interpretation (Diesing 1992; Kratzer 1995). By contrast, more recent investigations assume only non-existential readings for bare plural subjects (cf. Kallulli 2006). A post-hoc inspection of the verbs used here revealed that the majority of them in fact belonged to stage-level predicates. However, in our experiment, bare plurals were semantically ambiguous because case-ambiguous NPs in a verb-final clause cannot provide information about word order. Due to this inherent ambiguity, and since we presented isolated sentences, we cannot rule out that readers preferred to give initial bare plurals an existential and specific interpretation. Nevertheless, as argued in the introduction to Experiment 1, bare plurals are still lower in referentiality than proper names even under these circumstances and therefore lower on the overall definiteness/specificity hierarchy.

between verb type and word order. Specifically, object-initial structures should be less costly with dative object-experiencer verbs, whereas subject-initial sentences should be easier to process with dative-active verbs. Predictions concerning referentiality as a subtype of the definiteness/specificity hierarchy remained identical to Experiment 1.

2.2.1 Method

Participants

Forty students (20 females; mean age: 23.5 years, range: 18–28) from the University of Marburg participated in the experiment. Participants were native speakers of German and had normal or corrected-to-normal vision. None of them had participated in Experiment 1. Four further participants had to be excluded from all analyses due to low performance in the comprehension task (1), technical problems during the experiment (1), or excessive track losses (2).

Materials

The stimuli differed from the sentences used in Experiment 1 with regard to the verb types used, as we replaced accusative verbs with dative object-experiencer verbs. All other experimental factors, sentence construction and allocation to lists remained identical. In each list, the experimental items were interspersed with 112 filler items from other experiments. A yes/no question appeared after 25% of all trials. The average accuracy was 86%. The entire experiment lasted 60 min.

Apparatus and Procedure

Apparatus and procedure were the same as in Experiment 1.

Analyses

Prior to all analyses, less than 3% of all trials had to be removed due to track losses or presentation problems. Less than 1% of fixations was eliminated based on the criteria described for Experiment 1. Sentences were divided into the same regions as in Experiment 1. We computed the same eye movement measures and repeated-measures ANOVAs with the following two exceptions: first, as the crucial verbs did not differ with respect to length (8.62 characters for dative-active verbs vs. 8.73 characters for dative object-experiencer verbs), we only report unadjusted reading

Table 4 Mean reading times (in ms) and percent regressions (in %) for the ambiguous regions in Experiment 2

Measure	NP1	NP2	Measure	NP1	NP2
First fixation			*Go-past time*		
EXP-SO-PN	215 (7)	245 (7)	EXP-SO-PN	334 (15)	502 (21)
EXP-SO-BP	215 (7)	256 (8)	EXP-SO-BP	553 (31)	383 (21)
EXP-OS-PN	225 (7)	249 (6)	EXP-OS-PN	337 (16)	545 (24)
EXP-OS-BP	215 (6)	252 (7)	EXP-OS-BP	525 (24)	327 (12)
DAT-SO-PN	212 (7)	241 (6)	DAT-SO-PN	329 (16)	568 (33)
DAT-SO-BP	208 (6)	251 (8)	DAT-SO-BP	546 (26)	326 (14)
DAT-OS-PN	217 (6)	246 (7)	DAT-OS-PN	343 (13)	531 (27)
DAT-OS-BP	214 (6)	240 (6)	DAT-OS-BP	547 (23)	343 (19)
First pass time			*Residual first pass time*		
EXP-SO-PN	289 (13)	443 (20)	EXP-SO-PN	−27 (12)	−32 (18)
EXP-SO-BP	473 (24)	302 (12)	EXP-SO-BP	−5 (20)	−18 (12)
EXP-OS-PN	291 (13)	479 (20)	EXP-OS-PN	−33 (11)	3 (17)
EXP-OS-BP	470 (24)	290 (9)	EXP-OS-BP	−4 (22)	−22 (9)
DAT-SO-PN	301 (15)	479 (21)	DAT-SO-PN	−12 (14)	26 (22)
DAT-SO-BP	479 (23)	295 (10)	DAT-SO-BP	−4 (20)	−26 (10)
DAT-OS-PN	292 (11)	460 (17)	DAT-OS-PN	−23 (12)	−10 (17)
DAT-OS-BP	467 (19)	286 (11)	DAT-OS-BP	2 (21)	−34 (11)
Total time			*Residual total time*		
EXP-SO-PN	353 (15)	602 (30)	EXP-SO-PN	−58 (14)	−14 (26)
EXP-SO-BP	650 (33)	389 (19)	EXP-SO-BP	31 (28)	−26 (17)
EXP-OS-PN	374 (19)	630 (29)	EXP-OS-PN	−39 (17)	12 (26)
EXP-OS-BP	657 (32)	402 (18)	EXP-OS-BP	42 (28)	−4 (16)
DAT-SO-PN	360 (17)	646 (34)	DAT-SO-PN	−52 (16)	24 (30)
DAT-SO-BP	616 (29)	351 (14)	DAT-SO-BP	−1 (25)	−64 (14)
DAT-OS-PN	392 (17)	690 (37)	DAT-OS-PN	−18 (14)	70 (34)
DAT-OS-BP	691 (36)	371 (17)	DAT-OS-BP	70 (30)	−42 (14)
Regressions out			*Regressions in*		
EXP-SO-PN	8 (2)	11 (3)	EXP-SO-PN	20 (3)	25 (4)
EXP-SO-BP	8 (2)	14 (3)	EXP-SO-BP	26 (4)	14 (3)
EXP-OS-PN	9 (2)	10 (2)	EXP-OS-PN	19 (3)	23 (3)
EXP-OS-BP	9 (2)	9 (2)	EXP-OS-BP	33 (4)	23 (3)
DAT-SO-PN	6 (2)	8 (2)	DAT-SO-PN	17 (3)	23 (3)
DAT-SO-BP	8 (2)	6 (2)	DAT-SO-BP	21 (3)	15 (3)
DAT-OS-PN	13 (3)	6 (2)	DAT-OS-PN	22 (3)	31 (4)
DAT-OS-BP	12 (3)	10 (2)	DAT-OS-BP	33 (4)	13 (3)

Standard error is given in parentheses

SO subject-before-object, *OS* object-before-subject, *EXP* dative object-experiencer verb, *DAT* dative-active verb, *PN* proper name-before-bare plural, *BP* bare plural-before-proper name

times for the disambiguating verbs; second, since both verbs assign dative case, we substituted the factor CASE with VERB (dative-object experiencer verb [EXP] vs. dative-active verb [DAT]). Tables 4 and 5 present the mean reading times for the critical regions, and Table 6 summarizes the statistical tests.

Table 5 Mean reading times (in ms) and percent regressions (in %) for the verb and following regions in Experiment 2

Measure	Verb region	Spillover region	Final region
First fixation			
EXP-SO-PN	296 (10)	239 (6)	317 (13)
EXP-SO-BP	297 (10)	247 (8)	312 (12)
EXP-OS-PN	283 (10)	248 (7)	277 (10)
EXP-OS-BP	305 (11)	246 (8)	303 (13)
DAT-SO-PN	271 (7)	221 (6)	312 (12)
DAT-SO-BP	282 (9)	231 (6)	327 (13)
DAT-OS-PN	290 (8)	241 (8)	319 (12)
DAT-OS-BP	280 (9)	241 (8)	306 (12)
First pass time			
EXP-SO-PN	398 (19)	382 (14)	516 (27)
EXP-SO-BP	429 (19)	406 (16)	495 (27)
EXP-OS-PN	424 (18)	415 (15)	452 (27)
EXP-OS-BP	456 (22)	419 (21)	476 (27)
DAT-SO-PN	392 (15)	352 (13)	484 (26)
DAT-SO-BP	453 (22)	362 (13)	470 (23)
DAT-OS-PN	454 (20)	422 (18)	473 (25)
DAT-OS-BP	440 (17)	403 (16)	519 (30)
Go-past time			
EXP-SO-PN	500 (28)	502 (37)	914 (64)
EXP-SO-BP	498 (25)	442 (23)	838 (65)
EXP-OS-PN	527 (28)	520 (35)	756 (54)
EXP-OS-BP	639 (42)	486 (28)	975 (73)
DAT-SO-PN	491 (24)	429 (22)	736 (44)
DAT-SO-BP	524 (25)	450 (25)	791 (66)
DAT-OS-PN	624 (35)	592 (43)	892 (61)
DAT-OS-BP	559 (30)	520 (36)	855 (52)
Total time			
EXP-SO-PN	556 (31)	525 (22)	622 (31)
EXP-SO-BP	536 (28)	486 (21)	556 (29)
EXP-OS-PN	537 (23)	525 (21)	535 (33)
EXP-OS-BP	637 (34)	567 (32)	608 (35)
DAT-SO-PN	477 (17)	462 (18)	557 (29)
DAT-SO-BP	561 (27)	497 (22)	551 (31)
DAT-OS-PN	645 (33)	579 (28)	554 (29)
DAT-OS-BP	570 (25)	513 (22)	589 (31)
Regressions out			
EXP-SO-PN	13 (3)	11 (3)	39 (4)
EXP-SO-BP	9 (2)	4 (2)	30 (4)
EXP-OS-PN	14 (3)	9 (2)	35 (4)
EXP-OS-BP	20 (3)	8 (2)	41 (4)
DAT-SO-PN	13 (3)	11 (2)	30 (4)
DAT-SO-BP	13 (3)	10 (3)	34 (4)
DAT-OS-PN	21 (3)	14 (3)	38 (4)
DAT-OS-BP	12 (3)	10 (2)	36 (4)

(continued)

Table 5 (continued)

Measure	Verb region	Spillover region	Final region
Regressions in			
EXP-SO-PN	19 (3)	23 (3)	–
EXP-SO-BP	9 (2)	15 (3)	
EXP-OS-PN	13 (3)	23 (3)	
EXP-OS-BP	13 (3)	21 (3)	
DAT-SO-PN	10 (2)	19 (3)	
DAT-SO-BP	12 (3)	25 (4)	
DAT-OS-PN	19 (3)	24 (3)	
DAT-OS-BP	12 (3)	16 (3)	

Standard error is given in parentheses

SO subject-before-object, *OS* object-before-subject, *EXP* dative object-experiencer verb, *DAT* dative-active verb, *PN* proper name-before-bare plural, *BP* bare plural-before-proper name

Table 6 Summary of the statistical analyses for Experiment 2

	Verb region		Spillover region		Final region	
	F_1	F_2	F_1	F_2	F_1	F_2
First fixation						
Verb	5.53*	3.53†	4.69*	6.60*	1.02	1.68
Order	<1	<1	4.59*	2.74	3.63†	4.39*
NP	1.07	<1	<1	1.29	<1	<1
Verb × Order × NP	3.74†	3.22	2.26	<1	3.50†	5.47*
First pass time						
Verb	<1	<1	4.36*	4.51*	<1	<1
Order	5.53*	4.72*	10.94**	8.74**	<1	1.15
NP	2.95	2.73	<1	<1	<1	<1
Verb × Order	<1	<1	3.31	2.36	4.00†	2.09
Go-past time						
Verb	<1	<1	<1	<1	3.07	1.16
Order	11.86***	32.65***	7.42**	6.98*	2.15	<1
NP	<1	<1	2.09	1.57	<1	<1
Verb × Order	<1	<1	4.90*	2.87	2.48	2.72
Verb × NP	4.30*	2.75	<1	<1	<1	<1
Verb × Order × NP	6.59*	6.46*	2.4	1.04	7.04*	4.41*
Total time						
Verb	<1	<1	<1	<1	1.34	<1
Order	16.57***	15.50***	13.25***	12.92**	<1	<1
NP	1.05	1.71	<1	<1	<1	<1
Verb × Order	1.3	4.80*	<1	<1	<1	<1
Order × NP	<1	<1	<1	<1	3.66†	5.04*
Verb × Order × NP	11.41**	11.61**	7.89**	8.47**	3.31	1.42

(continued)

Table 6 (continued)

	Verb region		Spillover region		Final region	
	F_1	F_2	F_1	F_2	F_1	F_2
Regressions out						
Verb	<1	<1	6.01*	2.6	<1	<1
Order	3.83†	6.39*	<1	<1	1.76	2.29
NP	<1	<1	3.18	2.86	<1	<1
Verb × NP	3.77†	1.93	<1	<1	<1	<1
Verb × Order × NP	6.15*	4.77*	1.83	<1	5.11*	5.77*
Regressions in						
Verb	<1	<1	<1	<1	–	–
Order	<1	<1	<1	<1		
NP	5.52*	3.33	1.23	<1		
Verb × Order × NP	7.19**	4.75*	4.41*	4.41*		

	NP1		NP2	
	F_1	F_2	F_1	F_2
First fixation				
Verb	1.57	<1	1.74	1.87
Order	2.91	1.74	<1	<1
NP	<1	<1	<1	<1
First pass time				
Verb	<1	<1	<1	<1
Order	<1	<1	<1	<1
NP	76.86***	70.04***	124.31***	54.68***
Verb × Order	<1	<1	3.71†	2.78
Residual first pass time				
Verb	<1	<1	<1	<1
Order	<1	<1	<1	<1
NP	1.86	1.68	2.68	<1
Verb × Order	<1	<1	4.49*	4.01†
Go-past time				
Verb	<1	<1	<1	<1
Order	<1	<1	<1	<1
NP	80.48***	107.02***	84.11***	57.64***
Verb × Order × NP	<1	<1	5.84*	4.24*
Total time				
Case	<1	<1	2.35	<1
Order	5.72*	2.11	2.93	4.27*
NP	98.65***	98.18***	85.79***	56.06***
Verb × NP	<1	1.92	4.94*	5.60*
Residual total time				
Verb	<1	<1	<1	<1
Order	4.87*	3.74†	2.63	5.62*
NP	16.49***	11.85**	5.50**	3.43
Verb × NP	<1	<1	5.30*	5.26*

(continued)

Table 6 (continued)

	NP1		NP2	
	F_1	F_2	F_1	F_2
Regressions out				
Verb	<1	<1	3.71†	5.22*
Order	4.16*	4.59*	<1	<1
NP	<1	<1	<1	<1
Regressions in				
Verb	<1	<1	<1	<1
Order	7.89**	4.06†	2.49	2.08
NP	9.67**	15.54***	10.23**	11.81**
Verb × NP	<1	<1	4.42*	2.54
Verb × Order × NP	<1	<1	4.86*	6.47*

For participant analyses df = 1,39; for item analyses df = 1,31 (except sentence-final region with df = 1,30). Interactions are not reported unless significant for at least one of the critical regions
†$p \leq .07$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

2.2.2 Results

Regions 2 and 3: The Two Case-Ambiguous Noun Phrases (NP1, NP2)

At both NP positions, unadjusted total times revealed an effect of ORDER, which also reached significance in residual total times for NP1, but was only significant by items at NP2. For NP1, an almost significant effect of ORDER was also observed for 'regressions in'. Thus, as in Experiment 1, object-initial orders triggered additional re-reading of the NP positions. (An additional effect of ORDER for first-pass regressions from NP1 is difficult to account for, since disambiguating information was not yet available in this region).

Analyses for NP2 additionally revealed several interactions. Go-past time showed a significant three-way interaction, which, when resolved by VERB, showed a marginal interaction NP × ORDER for dative object-experiencer verbs only ($F_1(1,39) = 8.44$, $p < .01$; $F_2(1,31) = 3.61$, $p < .07$). This effect was mainly due to longer reading times for subject-initial vs. object-initial orders in BP conditions ($F_1(1,39) = 4.00$, $p < .06$; $F_2(1,31) = 4.42$, $p < .05$; in the PN-first conditions: $F_1(1,39) = 4.15$, $p < .05$; $F_2(1,31) = 1.14$, $p < .3$). Both total time measures revealed interactions between VERB and NP. Resolving these by VERB showed a robust NP effect for both verb types (unadjusted total times: EXP: $F_1(1,39) = 61.04$, $p < .001$; $F_2(1,31) = 48.51$, $p < .001$; DAT: $F_1(1,39) = 61.38$, $p < .001$; $F_2(1,31) = 45.92$, $p < .001$; residual total times: EXP: Fs < 1; DAT: $F_1(1,39) = 8.83$, $p < .01$; $F_2(1,31) = 6.10$, $p < .02$). In all cases, bare plurals engendered longer reading times than proper names (as is expected based on length and frequency differences) and this difference was more pronounced with dative-active verbs. Finally, the 3-way interaction observed for 'regressions in' showed no fully reliable effects for either verb type when resolved (EXP: $F_1(1,39) = 4.36$, $p < .05$; $F_2(1,31) = 2.89$, $p < .1$; DAT: $F_1(1,39) = 1.94$, $p < .2$; $F_2(1,31) = 3.59$, $p < .07$).

In summary, the late eye movement measures revealed an overall pattern largely similar to the one found in Experiment 1 in that readers refixated both case-ambiguous noun phrases in order to recover from their initial misanalysis.

Region 4: The Disambiguating Verb

First fixation durations revealed a main effect of VERB which was only significant by participants and a marginal 3-way interaction approaching significance by participants and almost by items, which did not yield any reliable effects when resolved. First pass time revealed a reliable main effect of ORDER, with longer reading times for object-initial clauses, but no interactions. First-pass regressions and go-past time exhibited similar results in that both showed a main effect of ORDER (though only marginal for first-pass regressions), suggesting a higher regression rate for OS sentences (first pass regressions: 12% for SO vs. 17% for OS; go-past time: 503 vs. 587 ms). The interaction of VERB and NP in first-pass regressions approached significance by participants, but fell far short of significance by items. In addition, both first-pass regressions and go-past time showed significant 3-way interactions, which did not yield consistent results across the participants and items analyses when resolved by VERB (first-pass regressions: EXP: $F_1(1,39)=5.17$, $p<.03$; $F_2(1,31)=1.81$, $p<.2$; DAT: $F_1(1,39)=2.44$, $p<.2$; $F_2(1,31)=3.77$, $p<.07$; go-past time: EXP: $F_1(1,39)=5.55$, $p<.03$; $F_2(1,31)=2.97$, $p<.1$; DAT: $F_1(1,39)=2.45$, $p<.2$; $F_2(1,31)=3.65$, $p<.07$).

The results in unadjusted total times revealed a main effect of ORDER and an interaction between VERB and ORDER that was only significant in the analysis by items. The 3-way interaction reached full significance and resolving it by VERB indicated a marginal interaction between ORDER and NP for dative object-experiencer verbs ($F_1(1,39)=7.37$, $p=.01$; $F_2(1,31)=3.62$, $p<.07$) and a fully reliable 2-way interaction for dative-active verbs ($F_1(1,39)=7.77$, $p<.01$; $F_2(1,31)=13.12$, $p=.001$). We further resolved these 2-way interactions by NP and found an effect of ORDER in BP conditions containing dative object-experiencer verbs (PN: $F\text{s}<1$; BP: $F_1(1,39)=9.26$, $p<.01$; $F_2(1,31)=6.29$, $p<.02$), and an effect of ORDER in PN conditions with dative-active verbs (PN: $F_1(1,39)=15.53$, $p<.001$; $F_2(1,31)=28.91$, $p<.001$; BP: $F\text{s}<1$). Both of these effects were due to extra processing costs for object-initial sentences (EXP-BP: SO 534 ms vs. OS 637 ms; DAT-PN: 477 ms vs. 645 ms), but the difference between subject-initial and object-initial sentences was smaller for dative object-experiencer verbs (103 vs. 168 ms). Recall, however, that for dative object-experiencer verbs, each word order involves a mismatch between the syntactic and the thematic hierarchy (see Introduction). Hence, the attenuation of the reanalysis effect may be due to increased fixation durations for subject-initial structures.

For ‘regressions in’, we found a main effect of NP significant in the analysis by participants and a reliable 3-way interaction for regressions into the verb region. Resolving this interaction by VERB revealed no fully significant 2-way interactions for either verb type (EXP: $F_1(1,39)=3.46$, $p<.07$; $F_2(1,31)=3.13$, $p<.09$; DAT: $F_1(1,39)=2.65$, $p<.2$; $F_2(1,31)=2.29$, $p<.2$).

Region 5: The Spillover Region (Auxiliary Plus Indefinite Pronoun)

Effects of VERB and ORDER were apparent from first fixation durations onwards, due to longer reading times for experiencer verbs and object-initial structures. By contrast, a marginal effect of VERB in first-pass regressions was due to a higher proportion of regressions for dative-active verbs.

Whereas the interaction between VERB and ORDER was only significant by participants in go-past time, total times exhibited a significant interaction between all three factors. Resolving the 3-way interaction by VERB showed an interaction of ORDER × NP only for the conditions containing dative-active verbs (EXP: $F_1(1,39)=2.64$, $p<.2$; $F_2(1,31)=2.61$, $p<.2$; DAT: $F_1(1,39)=5.66$, $p<.03$; $F_2(1,31)=4.18$, $p<.05$). This interaction was due to the fact that the dative-active conditions showed reanalysis effects in the PN conditions (PN: $F_1(1,39)=17.40$, $p<.001$; $F_2(1,31)=8.58$, $p<.01$), but not in the BP conditions (BP: Fs<1). The 3-way interaction was also significant for the 'regressions in' measure. Resolving it by VERB revealed no differences for dative-object-experiencer verbs (Fs<1), and only a very marginal effect for dative-active verbs ($F_1(1,39)=3.34$, $p<.08$; $F_2(1,31)=3.44$, $p<.08$).

Region 6: The Final Region (Past Participle of the Matrix Verb)

For the sentence-final region, there was a marginal main effect of ORDER in first fixation durations. The 3-way interaction also approached significance, but failed to yield significant effects when resolved. The 3-way interaction was also significant for first-pass regressions and, when resolved by VERB, revealed no effects for dative-active verbs (Fs<1), but an interaction NP × ORDER for dative object-experiencer verbs that was marginal by items ($F_1(1,39)=4.60$, $p<.04$; $F_2(1,31)=3.32$, $p<.08$). Further inspection of this effect showed that it was mainly due to differences in the BP conditions (PN: $F_1(1,39)=1.21$, $p<.3$; $F_2<1$; BP: $F_1(1,39)=3.37$, $p<.08$; $F_2(1,31)=4.13$, $p=.051$), with more regressions initiated in the object-initial than in the subject-initial condition (41% vs. 30%). Similarly, the 3-way interaction reached full significance in go-past time. Resolving this interaction by VERB revealed no further effects for dative-active verbs (Fs<1), whereas the interaction of ORDER by NP was significant for dative object-experiencer verbs ($F_1(1,39)=13.10$, $p=.001$; $F_2(1,31)=3.88$, $p<.06$). Further inspection of this interaction did not reveal any effects that were reliable by both subjects and items (PN: $F_1(1,39)=7.76$, $p<.01$; $F_2(1,31)=2.74$, $p<.2$; BP: $F_1(1,39)=4.06$, $p=.051$; $F_2(1,31)=1.87$, $p<.2$).

In total times, there was an almost significant interaction between ORDER and NP, which, when resolved by NP, again did not yield consistent results across participants and items (PN: $F_1(1,39)=2.88$, $p<.1$; $F_2(1,30)=4.38$, $p<.05$; BP: $F_1(1,39)=1.52$, $p<.3$; $F_2(1,30)=1.42$, $p<.3$).

2.2.3 Discussion

The purpose of Experiment 2 was to determine whether thematic role information is able to reduce reanalysis costs. As in Experiment 1, there were consistent effects of syntactic reanalysis towards the object-initial structure. In the verb and spillover regions, first pass times showed that disambiguation towards an object-initial order led to reading time increases that were independent of other information types. In contrast to Experiment 1, however, reanalysis effects were more susceptible to the semantic influences: late measures of eye movements revealed interactions between all three experimental manipulations, indicating that thematic role information and referentiality information are both taken into account in conflict resolution. In particular, object-experiencer verbs only showed a processing disadvantage for object-initial vs. subject-initial sentences with initial bare plurals in total times at the verb and a similar pattern was observed for first-pass regressions from the sentence-final region. This pattern contrasts with Experiment 1, in which noun phrase referentiality attenuated the reanalysis effect in late measures, but did not eliminate it. The results of Experiment 2 demonstrate that, when the object-initial order is supported both by referentiality and by the thematic hierarchy, the processing conflict for object-initial structures is resolved relatively rapidly and hence no longer apparent in comprehensive reading time measures such as total times for the disambiguating region. An explanation along these lines is consistent with the proposal by Bornkessel et al. (2004), who argued that the thematic information provided by dative object-experiencer verbs renders the object-initial target structure more readily accessible during reanalysis.

The facilitative effect of dative object-experiencer verbs on the processing of object-initial orders is achieved by a principled conflict between the grammatical function hierarchy (subject > object) and the thematic hierarchy. This conflict is reflected in longer reading times for dative object-experiencer verbs, as shown by early measures on the spillover region. Interestingly, this hierarchy mismatch was also visible in Bornkessel et al.'s (2004) ERP study, which revealed a distinctive electrophysiological component for subject-initial structures containing dative object-experiencer verbs (a left-anterior negativity, LAN).

For dative-active verbs, the definiteness/specificity hierarchy has a different impact than for dative object-experiencer verbs. Here, the syntactic and thematic hierarchies converge and, consequently, object-initial structures are marked both syntactically and thematically, while the subject-before-object order is supported by both hierarchies. Not surprisingly, there is thus no facilitative effect of the definiteness/specificity hierarchy in scrambled clauses. Rather, sentences involving a marked linearization in terms of referentiality led to a general increase in reading times, which may have masked the continuing effects of word order reanalysis (e.g., SO-BP: 561 ms vs. OS-BP: 570 ms for the verb region in total times, in comparison to 477 ms for SO-PN). This resembles the effect found in Experiment 1, where bare plural-preceding-proper name was dispreferred regardless of grammatical function order.

Finally, it is worth noting again that the interaction of syntax with the thematic and the definiteness/specificity hierarchy above only reached significance in later eye movement measures on the critical verb. This observation provides further converging support for the assumption that that prominence in argument linking exerts a late influence on readers' eye movements. In particular, it seemed to affect syntactic reanalysis and the final linking stages that may comprise well-formedness evaluations. This finding concurs with the similarly late effects in Experiment 1 and also with late effects reported for other instances of prominence variation (e.g., Foraker and McElree 2007; Mak et al. 2006).[9]

3 General Discussion

With two eye-tracking experiments, we have provided further evidence for the pervasive and autonomous occurrence of the subject preference in German. We found evidence for a strong disruption in participants' eye movement records when they had to revise an initial misanalysis in order to establish the correct object-initial structure. Despite this clear reanalysis effect, the influence of other (non-syntactic) factors was also apparent, with their precise impact varying according to the type of information.

In particular, we did not find evidence that any of the (semantic) prominence hierarchies lowered the parser's preference to adopt a subject-initial analysis when encountering a case-ambiguous noun phrase. Rather, our results are in line with previous research by emphasizing the influence of semantic prominence hierarchies on disambiguation and reanalysis, and by showing that the prominence of verbal arguments modulates late eye movement measures. Our first experiment demonstrated that the linear order of NPs that differed in referentiality interacted with syntactic reanalysis such that the dispreferred order of NPs made reanalysis more difficult. Experiment 2 went one step further and showed that the syntactic hierarchy interacted with the thematic-role hierarchy and the definiteness/specificity hierarchy. Our data suggest that the human parser preferably links the unmarked variants of each hierarchy to one another when computing the final sentence meaning. In the case of conflicting hierarchies, verbs show different weightings as to which hierarchy outranks another. We replicated the finding that the thematic hierarchy may partly override the syntactic hierarchy by modulating the preferred word order

[9] Note, however, that this conclusion may require some refinement when applied to *unambiguously* case marked arguments. In a series of eye-tracking experiments in Korean, Lee et al. (2007) found effects of both the definiteness and the person hierarchy as early as in gaze duration on the critical noun phrases that were unambiguously marked for nominative case. Despite this temporal difference, their findings are by and large in accordance with our results reported above as they confirm that the convergence of prominence hierarchies facilitates comprehension.

for dative object-experiencer verbs. Furthermore, the syntax-semantics mismatch inherent to these verbs is crucial in paving the way for an influence of definiteness/specificity in aiding reanalysis. If, by contrast, thematic and syntactic hierarchies converge (as in the case of dative-active verbs), specificity violations affect both word orders equally, thereby masking word order reanalysis. Since these effects occurred in fairly late eye movement measures and partly at the sentence ending, they may have been boosted by sentence or clause wrap-up processes on the critical verb. It therefore remains to be tested whether eye movements may reveal similar mismatch effects for clause-medial verbs.

Finally, let us turn to the question of how the present findings relate to previous ERP results. First, the eye movement patterns observed in Experiments 1 and 2 are highly compatible with previous results on the 'reanalysis N400': Bornkessel et al. (2004) and Haupt et al. (2008) demonstrated that this effect is modulated by the thematic hierarchy and the definiteness/specificity hierarchy, respectively. As in the present findings, a reanalysis effect (in the form of an N400 for object-initial vs. subject-initial orders) was present for all disambiguations towards an object-initial order, but the magnitude of this effect was influenced by the semantic prominence hierarchies. By contrast, the late positivity effects observed by Haupt and colleagues were not modulated by the prominence manipulation. Hence, the present results provide strong converging evidence for a reanalysis-based interpretation of the N400 in word order manipulations. As argued by Bornkessel et al. (2004) on the basis of an SAT study, this effect appears to reflect both dynamic and non-dynamic aspects of the comprehension process (i.e. both the speed of computing the alternative analysis and the likelihood that it will be computed correctly).

Second, with regard to the discrepancies in previous ERP studies regarding the role of object case in reanalysis, the findings of Experiment 1 are most consistent with previous auditory ERP results, since they showed no interactions between word order and object case in the disambiguating or post-disambiguating region. This may be due to the fact that natural reading, as in the present study, differs fundamentally from the type of reading behavior adopted in a visual ERP setting. In this way, the present findings are compatible with Haupt et al.'s (2008) conjecture that the differing ERP patterns for subject-object reanalysis in accusative and dative structures in previous studies using visual presentation (Bornkessel et al. 2004; Schlesewsky and Bornkessel 2006) might be due to the increased susceptibility of accusative sentences to task- and strategy-related influences (which are augmented in settings using rapid serial visual presentation).

Third, the present findings also show an interesting mismatch with regard to previous ERP results: Whereas Experiment 1 showed increased fixation durations for dative-active verbs, previous ERP studies have consistently revealed increased N400 effects for *accusative* in comparison to dative-active verbs. This observation was first made by Bornkessel et al. (2004) for sentences in which word order disambiguation was effected by the main verb and confirmed by the results in Schlesewsky and Bornkessel (2006) using structures in which disambiguation occurred at a clause-final auxiliary. In the latter case, the past participle provided semantic (and case) information, while word order disambiguation depended on the number marking of the following auxiliary.[10] Crucially, the N400 only emerged on the accusative participle, and this was interpreted as a correlate of the more complex semantic representation for accusative verbs, which contain both an Actor and an Undergoer role while dative verbs generally lack one of these (cf. Van Valin 2005 and see above). The computation of unmarked transitive events is thus accompanied by a higher degree of neuronal activity that is not reflected in the behavioral output. This intriguing result, namely an inverse correlation between neural activity (in the form of an increase in N400 amplitude) and fixation durations, indicates that the correlation between ERPs and eye movements is less straightforward than is typically assumed. Tentatively, this could be taken to suggest that ERPs and eye movements are sensitive to different aspects of the comprehension process or that there are certain differences between natural reading and the processing of sequentially presented linguistic input (as in auditory presentation or in rapid serial visual presentation). However, both of these conjectures clearly require further investigation in future research, for example by means of a combination of ERPs and eye-tracking in a single experiment.

To conclude, the present findings demonstrate that word order processing in German is influenced by a range of non-syntactic information types. However, rather than influencing the initial analysis of an ambiguous clause, these semantic prominence hierarchies step in to modulate the relative ease or difficulty of the reanalysis towards an object-initial order.

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[10] Though Haupt et al. (2008), who examined identical sentence structures to Schlesewsky and Bornkessel (2006) using auditory presentation, do not report ERP data for the position of the participle, these can be found in Haupt's (2008) dissertation. Like Schlesewsky and Bornkessel's (2006) findings, the results of this study revealed a negativity for accusative in comparison to dative verbs.

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Grammar- Versus Frequency-Driven Syntactic Ambiguity Resolution: The Case of Double-Object Constructions

Jana Häussler and Markus Bader

1 Introduction

A major task of the human sentence processing mechanism (HSPM) is to infer the syntactic function of each NP that it identifies in the input string. The grammar of a language can aid in making the correct inferences by rigidly associating each syntactic function with a particular position within a larger phrase-structure tree, or by overtly marking each NP for its syntactic function by means of case morphology or case particles. Grammars are not always helpful in this way, however. When a language combines a flexible word order with NPs showing a substantial degree of ambiguity with respect to their case (case syncretism), the correct assignment of syntactic functions can become quite an intricate task for the HSPM. Among the languages for which this is true is German, a language well-known for its high degree of ambiguity with respect to the syntactic function borne by an NP. In this paper, we present a series of experiments examining an ambiguity of this kind in German. In contrast to the much-studied subject-object ambiguities, the particular syntactic-function ambiguity, that is the focus of our study, has not received much attention so far (but see, Bader and Bayer 2006 for an overview of object-object ambiguities in German).

For purposes of illustration, consider the following example found on the webpage of the German newscast 'Tagesschau' (16.02.2009).[1]

[1]http://www.tagesschau.de/ausland/clinton198.html

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(1) *Clinton zieht Asien Europa vor.*
C. prefers Asia Europe PRT
'Clinton prefers Asia to Europe.'

Sentence (1) contains three NPs that are all ambiguous with respect to their case. In accordance with the strong evidence for a subject-before-object preference in German (for recent reviews of the relevant literature see Bader and Bayer 2006; Bornkessel and Schlesewsky 2006), we assume that the parser takes the first NP as the subject. The two proper names *Asien* and *Europa* must then be parsed as either accusative object preceding dative object (ACC > DAT) or dative object preceding accusative object (DAT > ACC). The intended parse becomes clear only later when processing the next sentence or by prior knowledge about Clinton's visit to Asia.

We have investigated sentences containing the same type of ambiguity as in (1) in order to shed new light on a fundamental question concerning the resolution of syntactic ambiguities by the HSPM. When confronted with a syntactic ambiguity, does the HSPM base its decision on purely grammar-internal information or does it rely on probabilistic information derived from usage-based frequencies? In order to address this question, we present three experiments as well as new corpus data concerning sentences with both an accusative and a dative object.

The organization of this paper is as follows. First, we raise the question of which information is used for syntactic ambiguity resolution. Particular attention is given to grammatical information (with preferences captured in terms of prominence hierarchies) versus frequency information. Next, we address double-object constructions for which object-object ambiguities can arise. Afterwards, we present corpus data regarding the use of accusative and dative objects in German. Thereafter, we present the experiments. The results of these experiments are then used for evaluating structure-based and frequency-based theories of syntactic ambiguity resolution.

2 What Information Is Used for Syntactic Ambiguity Resolution?

How might the HSPM proceed when syntactic functions follow neither from phrase-structure configurations nor from case morphology? One way to approach this question is by looking at the inverse problem, namely the problem of serializing a verb's arguments in situations where the phrase-structure rules of a language alone are not sufficiently rigid to determine a definite order. With regard to the problem of argument serialization, a range of prominence hierarchies have been proposed (for overviews, see Siewierska 1993; Primus 1999; Croft 2003). Among these are discourse-related hierarchies (e.g., 'definite before indefinite') and weight-related hierarchies (e.g., 'short before long'). These hierarchies are not relevant for the upcoming experiments and will not be considered here.

A further class of prominence hierarchies is based on the semantic properties of verbs and their arguments. These are the *Semantic Role Hierarchy* and the *Personal Hierarchy* that are given in (2) and (3) in the formulation of Siewierska (1993, 831).

(2) *The Semantic Role Hierarchy*
agent > patient > recipient > benefactive > instrumental > spatial > temporal
(3) *The Personal Hierarchy*
1 > 2 > 3 human > higher animals > other organisms > inorganic matter > abstracts

It is probably no exaggeration to say that the Semantic Role Hierarchy is one of the most controversial concepts within linguistic theory (for a comprehensive review of the criticisms and alternative approaches, see Levin and Rappaport Hovav 2005; Primus 2006, 2008). It is not only the exact set of roles and their ranking that is a matter of dispute but also the very nature of semantic roles (cf. Dowty 1991). The ranking in (2) is justified by patterns of *argument realization*, that is, the mapping from lexical-conceptual meaning to syntactic functions. With regard to argument serialization, this hierarchy has been invoked too but, as pointed out by Siewierska (1993), the only good evidence for this comes from the observation that an NP realizing the agent role typically precedes all other NPs. However, given that agents are typically realized as subjects and subjects typically precede all other arguments, even the agent-first constraint might be spurious. We come back to this issue in the next section.

In contrast to the Semantic Role Hierarchy, the importance of the Personal Hierarchy in (3) has been firmly established. Various aspects of this hierarchy have been shown to affect argument realization (e.g., Ferreira 1994) and argument linearization (e.g., Hoberg 1981; Kempen and Harbusch 2004), as well as other grammatical phenomena like agreement patterns and regularities of number marking (cf. Corbett 2000). For its relevance in language comprehension see Lamers and De Hoop (2005) and Lamers (this volume). The Personal Hierarchy is a prototypical instance of a natural prominence scale reflecting cognitive salience. The self is maximally salient, therefore first-person is ranked highest on the hierarchy. The subsequent ranking might be based on empathy and/or significance and is possibly modulated by cultural distinctions (for an attempt to provide a cognitive grounding for the prominence of animate entities see Dahl 2008).

In addition to the two semantically defined hierarchies in (2) and (3), purely syntactic hierarchies have also been proposed, namely the *Syntactic Function Hierarchy* and the *Case Hierarchy*. There is a broad consensus to rank the terms as shown in (4) and (5) (e.g., Keenan and Comrie 1977; Blake 2001; Croft 2003).

(4) *The Syntactic Function Hierarchy*
subject > direct object > indirect object > oblique
(5) *The Case Hierarchy*
nominative > accusative > dative

The Syntactic Function Hierarchy and the Case Hierarchy have not been postulated with argument linearization in mind. For example, Keenan and Comrie (1977) introduced what they called 'NP accessibility hierarchy' to account for patterns of relative clause formation. Later the hierarchies were used to account for various phenomena such as case marking, agreement, pronoun resolution and argument alternations like causativation (for an overview see Croft 2003). However, the two hierarchies – or parts thereof – have been invoked for linearization purposes as well. The two hierarchies correspond to each other insofar as subjects canonically bear nominative case, direct objects bear accusative case and indirect objects bear dative case. For ease of exposition, we only use the term *Case Hierarchy* in the following but our discussion pertains to the *Syntactic Function Hierarchy* in similar ways.

Insofar as the above hierarchies are responsible for argument serialization, they must be consulted during the process of language production. For example, conceptual accessibility has been shown to affect functional assignment. More accessible words tend to obtain more prominent grammatical functions (e.g., Bock and Warren 1985). Since animacy is among the factors making an argument more prominent, subject NPs predominantly refer to animate entities. Given that subjects typically precede non-subjects, linearization is in alignment with both the Case Hierarchy and the Personal Hierarchy. In languages with a relatively free constituent order, animate arguments often – although not necessarily – precede inanimate arguments independently of syntactic function (for corpus evidence in German see Hoberg 1981; Kempen and Harbusch 2004; Pappert et al. 2007; Bader and Häussler 2010). As a result of being at work during language production, the prominence hierarchies are visible in statistical patterns, which in turn might be used in comprehension.

While serialization is one of the major tasks of the language production mechanisms, the HSPM is part of the language comprehension mechanisms and therefore faced by the reverse task: it must infer syntactic functions from a known linearization of the arguments. When confronted by an ambiguity regarding the syntactic function of an NP, the HSPM might consult one of the hierarchies in order to come to a decision. However, in contrast to the language production mechanisms, it is not necessary for the HSPM to consult the hierarchies directly. Instead, the HSPM might be tuned to certain statistical regularities that result when language production mechanisms apply the hierarchies for purposes of arguments linearization.

There are thus two principal ways how the HSPM might proceed when confronted with a syntactic ambiguity. First, the HSPM can base its decision on knowledge encoded in the mental grammar. The exact content and organization of the mental grammar is a matter of theoretical debate. In particular, some linguists consider prominence hierarchies as merely descriptive generalizations whereas others consider them as an integral part of the grammar. Relational Grammar (cf. Blake 1990), for instance, takes grammatical relations as primitives and gives hierarchies a central status. Generative grammar in the principles and parameters tradition gives grammatical relations no independent status but defines them configurationally in terms of tree-geometrical relations. Within Optimality Theory (Prince and Smolensky 1993), prominence hierarchies have been incorporated by means of harmonic alignment (cf. Aissen 1999).

Alternatively, the HSPM can make use of statistical properties found in actual language usage.[2] For later reference, we translate the two principal options into the hypotheses stated in (6) and (7).

(6) *The Grammar Hypothesis*: Syntactic ambiguities are resolved by reference to properties derived from the mental grammar.
(7) *The Frequency Hypothesis*: Syntactic ambiguities are resolved by reference to frequency properties derived from language use.

When it comes to a decision between grammar and frequency as the driving force behind syntactic ambiguity resolution, two obstacles arise immediately. First of all, syntactic structures that are favored by grammatical criteria are often also favored by frequency counts. Second, as it stands, neither the Grammar Hypothesis nor the Frequency Hypothesis is sufficiently precise to be subjected to experimental tests without further qualifications.

Within psycholinguistic work on German, no ambiguity has been investigated more rigorously than the ambiguity between an SO- and an OS-structure. With few exceptions, this research has led to the conclusion that a clear preference in favor of the SO-structure exists; recent reviews of this research are found in Bader and Bayer (2006) and Bornkessel and Schlesewsky (2006). However, subject-object ambiguities are of no help for deciding between the Grammar Hypothesis and the Frequency Hypothesis since both predict the observed SO preference.

Under the Grammar Hypothesis, the easiest way to derive the SO preference and accordingly processing difficulties for locally ambiguous OS sentences is in terms of the Case Hierarchy. This hierarchy predicts that the first NP is preferably taken as a nominative subject since both nominative case and subject function are ranked highest on their according scales.[3]

Consider next the Frequency Hypothesis. Instead of particular instantiations of this hypothesis (e.g., Jurafsky 1996; Hale 2006; MacDonald and Seidenberg 2006; Levy 2008), we address the more fundamental *grain problem* that has been succinctly stated by Crocker and Keller (2006: 231): “What is the level of granularity at which the human sentence processor ‘keeps track’ of frequencies? Does it count lexical frequencies or structural frequencies (or both), or perhaps frequencies at an intermediate level, such as the frequencies of individual phrase structure rules?” With regard to the issue of syntactic function ambiguities, the prominence hierarchies discussed above provide a useful starting point for approaching the grain problem.

[2] There is an ongoing debate whether frequency information is a matter of performance systems only, or whether such information is coded in some way within the mental grammar as well; see Bod et al. (2003) for a comprehensive discussion. This issue is orthogonal to our purposes.

[3] Reasons of space prevent us from discussing further grammar-based explanations of the preference under consideration. For example, if one assumes a fixed base order for the subject, direct object and indirect object, economy conditions on phrase-structure building and chain formation would make the same predictions.

First of all, we can compute frequencies defined in terms of the Case Hierarchy by counting how often an NP occurs with a specific case/syntactic function independently of the larger syntactic context. Nominative NPs occur more often than accusative objects, which in turn occur more often than dative NPs (see Table 1 on page 283). Thus the frequency ranking mirrors the ranking in the Case Hierarchy. If the HSPM uses frequency information of this type, it should assign nominative case to the first ambiguous NP it encounters and accusative case to the second NP. The same prediction follows when the level of granularity is provided by sentences with two NP arguments, subclassified by the units of the Case Hierarchy. According to the corpus study of Bader and Häussler, about 75% of all sentences with one NP in SpecCP and another NP in the middlefield are sentences with SO order.

A finer level of granularity results when we also take the Personal Hierarchy into account. Corpus studies have consistently revealed that this hierarchy has a strong effect on the order of subject and object (see Hoberg 1981; Kempen and Harbusch 2004; Bader and Häussler 2010). Sentences with SO order most of the time have an animate subject and an inanimate object, whereas sentences with OS order preferentially have an inanimate subject and an animate object. In other words, the first argument of a sentence is typically animate and the second argument inanimate. However, these counts are of no help to resolve the ambiguity arising when the two NPs are case ambiguous. What has to be counted is the distribution of syntactic functions for all sentences in which the first NP is animate and the second NP inanimate. When this is done, we again see a clear preference for SO order. SO sentences account for over 80% of all sentences in which an animate NP precedes an inanimate NP. The SO preference is thus also predicted when the level of granularity is made more fine-grained by jointly considering the Case Hierarchy and the Personal Hierarchy. In summary, subject-object ambiguities are not informative with regard to the level of granularity used by the HSPM because frequencies at different levels of granularity consistently predict the actually observed SO-preference.

To conclude, subject-object ambiguities are not decisive. Neither do they allow a decision between the Grammar Hypothesis and the Frequency Hypothesis-both predict an SO-preference-nor do they permit to address the grain problem. Object-object ambiguities, are more promising in this regard.

3 The Case of Double-Object Verbs

The experiments that we report below investigate the comprehension of sentences containing ditransitive verbs and hence a subject, an accusative object and a dative object. As in English, the prototypical ditransitive verb in German exhibits a particular correlation between the syntactic function, thematic role and animacy.

(8)

Subject	Dative Object	Accusative Object	
|	|	|	
Agent	Recipient	Patient	
|	|	|	
Animate	Animate	Inanimate	
|	|	|	
… *dass jemand*	*einem Lehrer*	*einen Hinweis*	*gegeben hat.*
that somebody	a teacher	a hint	given has

'… that somebody gave a teacher a book.'

The sentence in (8) has an unmarked order among its arguments, with constituent order markedness defined in terms of focus potential. An unmarked order allows for sentence-wide focus whereas a sentence with marked order is restricted to a narrow focus on one constituent (cf. Lenerz 1977 and much subsequent work; Höhle 1982). The order in (8) does neither follow from the Case Hierarchy nor from the Personal Hierarchy. However, the two hierarchies fail in different ways. With regard to the Case Hierarchy, there is indeed a mismatch because the accusative object is higher than the dative object on this hierarchy but the latter precedes the former in (8). With regard to the Personal Hierarchy, there is no mismatch but a form of indeterminism. While the inanimate object correctly follows the two animate arguments, the order among the latter two cannot be resolved by the Personal Hierarchy because both subject and dative object are animate NPs.

Even if the Personal Hierarchy does not imply a definite order between all arguments, in cases where it applies it seems to be decisive. Evidence for this conjecture is provided by certain non-prototypical ditransitive verbs (e.g., Haider 1993). As shown in (9), some ditransitive verbs can take an animate accusative object and an inanimate dative object.

(9)

Subject	Accusative Object	Dative Object	
|	|	|	
Agent	Patient	Recipient	
|	|	|	
Animate	Animate	Inanimate	
|	|	|	
… *dass jemand*	*ein Kind*	*einer Gefahr*	*ausgesetzt hat.*
that somebody	a child	a danger	exposed has

'… that somebody exposed a child to a danger.'

Example sentence (9) exhibits the order accusative before dative object. This is the unmarked order when a sentence contains an animate accusative object and an inanimate dative object. This order is in line with both the Case Hierarchy and the Personal Hierarchy but contrasts with the unmarked order in prototypical double-object constructions with an animate dative object, e.g., sentence (8). Sentences like (9) thus support the hypothesis that animacy is the decisive factor for determining word order, even if it does not always determine a definite order among all arguments.

Because a sentence can contain arguments that are on the same position on the Personal Hierarchy, this kind of indeterminacy is unavoidable.

The final hierarchy to evaluate with respect to the data considered here is the Semantic Role Hierarchy. Siewierska's (1993) formulation of the Semantic Role Hierarchy given in (2) fails in the same way as the Case Hierarchy; because the patient precedes the recipient on this hierarchy, it makes the wrong prediction for a prototypical double-object sentence like (8). There are alternative formulations of the Semantic Role Hierarchy in which the patient is ranked lower than the recipient. Though such a ranking would correctly predict the argument linearization in (8) it would fail for argument realization, e.g., in terms of case assignment. In fact, the relative ranking of the recipient and patient is a central part of the debate on the Semantic Role Hierarchy (see Levin and Rappaport Hovav 2005 and references therein). The various formulations of the hierarchy can be related to the fact that they have been proposed for different purposes. As Levin and Rappaport Hovav point out, 'there is no reason to expect to find a single ranking of roles which works for all of them' (Levin and Rappaport Hovav 2005).

Furthermore, for the purpose of argument linearization, adopting an alternative formulation of the Semantic Role Hierarchy by ranking the recipient above the patient would not lead to an improvement. First of all, this would cause a mismatch between the Case Hierarchy and the Semantic Role Hierarchy, giving false results with regard to the central purpose of these hierarchies, namely argument realization. Furthermore, this reversed ranking would make an incorrect order prediction for sentence (9), at least if one is willing to assign the patient role to *ein Kind* and the recipient role to *einer Gefahr*. Under this assumption, any relative ranking of the recipient and patient necessarily fails for either (8) or (9).

In summary, with regard to the linearization patterns observed with ditransitive verbs, the Case Hierarchy and the Semantic Role Hierarchy are plainly contradicted by sentences like (8) for which they incorrectly predict ACC>DAT respectively patient>recipient order. The Personal Hierarchy, in contrast, is compatible with both (8) and (9) but leaves unordered all pairs of arguments that are equally high or low on this hierarchy. This suggests that the Personal Hierarchy is given priority when arguments have to be serialized. Only when there is a tie with regard to the Personal Hierarchy will it be necessary to consult one of the other hierarchies. A decision between the Case Hierarchy and the Thematic Hierarchy based on the data discussed here is impossible since the two hierarchies make the same predictions.

We now turn to the kind of double-object construction examined in our experiments. As noted at the beginning of this section, the prototypical ditransitive verb takes an animate dative object and an inanimate accusative object. However, as already shown by example (9), this correlation between syntactic function and animacy is not always observed. In the experiments to follow, we concentrate on verbs that allow both objects to be animate. With a few exceptions, there seem to be no verbs that require that both objects are animate.[4] Typically, a ditransitive verb requires

[4]A potential exception is the verb *überstellen* ('to commit somebody').

that its dative object is an animate NP – this is a consequence of dative objects typically realizing recipients. The patient argument, however, is often not inherently restricted with regard to its position on the Personal Hierarchy; that it is nevertheless often inanimate by default follows from language-external facts about the world.[5]

A prototypical verb that regularly takes an animate accusative object alongside an animate dative object is the verb *vorstellen* ('to introduce'). An example sentence containing this verb is given in (10), with the order DAT > ACC in (10a) and the reverse order ACC > DAT in (10b).

(10) a. *Heute müssen wir* ***einem Professor*** *einen Schriftsteller vorstellen.*
today must we a.DAT professor a.ACC author introduce
b. *Heute müssen wir einen Schriftsteller* ***einem Professor*** *vorstellen*
today must we a.ACC author a.DAT professor introduce
'Today, we have to introduce an author to a professor.'

In the syntactic literature on word order in German, the prevalent assumption is that sentences with two animate objects have DAT > ACC as unmarked order (e.g., Uszkoreit 1987; Müller 1999). This view, which is supported by the magnitude estimation results of Keller (2000) and reading time data (Pappert et al. 2007), has been captured in a constraint like 'DAT before ACC', which becomes visible when order has not already been decided on the basis of the Personal Hierarchy. If this was correct, we would get a second type of case hierarchy in addition to the Case Hierarchy in (4)/(5), a case hierarchy tailored to the needs of argument linearization. An exception is Hoberg (1981) who also sees animacy as the dominating word-order factor but considers 'ACC before DAT' as basic when there is a tie with respect to animacy.

In our opinion, it is very difficult to say whether there is a markedness difference between sentence (10a) with DAT > ACC order and sentence (10b) with ACC > DAT order. This contrasts with the sentences in (8) and (9) in which the two objects differ in terms of animacy. For these sentences, judgments are not controversial. We will come back to this issue after we have presented our corpus data and our experimental results.

Consider next sentence (11) that contains two case-ambiguous animate objects because proper names do not inflect for either accusative or dative case.

(11) *Wir haben Tom Eva vorgestellt.*
we have T. E. introduced
'We introduced Tom to Eva.' or 'We introduced Eva to Tom.'

For ambiguous sentences like (11), the Personal Hierarchy does not make any prediction regarding the relative order of the accusative and dative object because both objects refer to humans. This situation gives the Case Hierarchy and/or the Semantic Hierarchy a chance to apply. The two hierarchies consistently predict

[5] Take, for example, the verb *verkaufen* ('to sell'). The patient argument of this verb can be characterized as [−human] because we normally think of animals and things but not humans, as being subject to acts of selling. However, this restriction is not inherent to the meaning of this verb but rather a restriction resulting from our world knowledge. It does not hold in societies in which slavery is found, either legally or illegally.

that ACC > DAT is the preferred order because accusative case is ranked higher than dative case and at the same time the patient role is ranked higher than the recipient role.

In summary, grammar-based syntactic ambiguity resolution based on the hierarchies introduced in the preceding section leads to the prediction that sentences with two case ambiguous object NPs both referring to animates should be assigned a syntactic structure in which the accusative object precedes the dative object. The prediction of an ACC > DAT preference implies a garden-path effect for locally ambiguous sentences with the reverse order, that is, for DAT > ACC sentences. Unambiguous sentences with DAT > ACC order might exhibit a slight disadvantage as well, in particular when presented without a context, which would give a discourse-related motivation for diverging from the preferred order.

4 Syntactic Function Ambiguities and Corpus Frequencies

Given the lack of an a priori answer to the grain problem, we have obtained corpus counts on three levels of granularity (with some additional distinctions as explained below).

(i) *The level of syntactic functions*: What is the overall frequency of occurrence of accusative and dative objects? This level of granularity corresponds directly to the Case Hierarchy.
(ii) *The level of sentences with two objects*: When a sentence contains both an accusative and a dative object, how often do the two objects occur with ACC-DAT order and how often with DAT-ACC order? This level ignores animacy properties of the two objects.
(iii) *The level of sentences with two animate objects*: When a sentence contains an animate accusative and an animate dative object, how often do the two objects occur with ACC-DAT order and how often with DAT-ACC order?

With regard to levels (i) and (ii), we obtained frequency counts from the TIGER Treebank (Version 1) created by the Universities of Stuttgart, Saarbrücken and Potsdam.[6] The treebank contains approximately 40,000 sentences (with about 700,000 tokens) taken from the German newspaper ‘Frankfurter Rundschau’.

The relevant numbers on level (i) – the level of syntactic functions – are shown in Table 1. Separate counts are shown for subjects, accusative objects and dative objects. In addition to the total counts, two partial counts are provided. A first division concerns the type of NP. Counts are given for the subset of non-pronominal NPs separately for lexical NPs and proper names. A second division concerns the position of the two object NPs (one object in SpecCP vs. both objects in the middlefield of a root clause). Note that all counts in Table 1 are independent of animacy properties.

[6]For further information see http://www.ims.uni-stuttgart.de/projekte/TIGER.

Table 1 Number of subjects, accusative objects and dative objects in the Tiger Treebank (Version 1)

	Subject	Accusative object	Dative object	ACC-DAT ratio
Total	53,025 (63%)	26,567 (32%)	4,222 (5%)	6.3:1
Lexical NP	30,179 (60%)	17,469 (35%)	2,535 (5%)	6.9:1
Proper name	3,174 (92%)	166 (5%)	123 (4%)	1.3:1
Middlefield	15,931 (54%)	12,113 (41%)	1,623 (5%)	7.5:1
In SpecCP	16,900 (92%)	1,209 (7%)	298 (2%)	4.1:1

Both total counts and counts for particular NP types and particular clause positions are given. The last column shows the ratio between accusative and dative objects

Table 2 Number of sentences in the TIGER treebank (version) with both an accusative and a dative object

Both objects in the middlefield		One object in SpecCP	
All clauses (n = 835)		All clauses (n = 139)	
ACC > DAT	DAT > ACC	ACC > DAT	DAT > ACC
156 (.19)	679 (.81)	76 (.55)	63 (.45)
Clauses with full NP objects (n = 303)		Clauses with full NP objects (n = 55)	
ACC > DAT	DAT > ACC	ACC > DAT	DAT > ACC
34 (.11)	269 (.89)	20 (.36)	35 (.64)

Total counts and counts for the two possible orders ACC > DAT and DAT > ACC are given, separately for clauses with both objects in the middlefield and for sentences with one of the objects in SpecCP

The frequency counts in Table 1 match the Case Hierarchy: subjects occur much more often than accusative objects which in turn outnumber dative objects. This is true for all rows in Table 1, although the exact numbers differ to some extent. Note in particular that for proper names, the proportion of subjects is particularly high and accusative objects outnumber dative objects only slightly. This can be attributed to the fact that proper names typically refer to animate entities and both subjects and dative objects are prototypically animate whereas accusative objects are not (for corpus counts on the distribution of animacy among dative and accusative objects, see Pappert et al. 2007; Bader and Häussler 2010).

Table 2 shows the frequency counts obtained on level (ii), the level of sentences with two objects. Keep in mind that on level (ii) the animacy properties of the two objects are not taken into consideration. Table 2 shows how often accusative objects and dative objects occur in each of the two possible orders ACC > DAT and DAT > ACC. Separate counts are given depending on the position of the objects within the sentence. The first column gives the counts for sentences in which both objects occur in the middlefield, the second column gives the counts for sentences in which one of the two objects has been fronted to SpecCP. Since pronouns are subject to specific restrictions separate counts are given for sentences with two full (= non-pronominal) object NPs.

An inspection of Table 2 reveals a substantial difference between sentences with both objects in the middlefield and sentences with one of the objects moved to

Table 3 Number of sentences with two animate objects according to position (both objects in the middlefield vs. one object fronted) and order (ACC > DAT vs. DAT > ACC) for each of the four verbs used in Experiments 1–3

		Total	Anvertrauen	Empfehlen	Vorstellen	Vorziehen
Both objects in the middlefield	ACC > DAT	72	35	0	1	36
	DAT > ACC	20	17	1	2	0
One object in SpecCP	ACC > DAT	1	1	0	0	0
	DAT > ACC	5	5	0	0	0

SpecCP. When both objects are located in the middlefield, a strong preference for DAT > ACC is observed, which is even stronger when both objects are full NPs. When one of the objects is located in SpecCP, the two orders occur with about equal frequency in general. However, when both objects are full NPs the DAT > ACC order is preferred although not as strong as in the middlefield. A similar difference between word order in the middlefield and word order involving SpecCP was found by Bader and Häussler (2010) with regard to the order between subject and object.

With regard to the final level (iii), the level of sentences with two animate objects, the TIGER Treebank did not contain enough examples. We proceeded therefore in the following way. First of all, we selected four verbs for use in the upcoming experiments: *anvertrauen* ('to entrust'), *empfehlen* ('to recommend'), *vorstellen* ('to introduce'), *vorziehen* ('to prefer'). The dative object of these verbs either must or can be an animate NP. The accusative object of all four verbs can easily be filled by a human referent but other referents are possible as well. Furthermore, in contrast to the verb cited in footnote 4, these verbs have rather broad meanings, which allow both objects to be instantiated with proper names without any feel of unnaturalness.

For each verb, we downloaded 4,000 randomly selected instances from the corpus of written language provided by the Institute of the German Language (IDS, Mannheim, Germany), containing approx. 1 billion tokens.[7] The downloaded sentence sets were manually screened for instances with two animate objects. Because pronouns behave in special ways – a pronominal object must precede a non-pronominal object in the middlefield – we only looked for sentences in which both objects were full lexical NPs. Table 3 shows the results of the corpus survey.

There are two noteworthy properties visible in Table 3. The first is the rather low incidence of sentences containing two animate full NP objects. Only two verbs occurred with a non-negligible number of relevant instances. Secondly, when both objects are located within the middlefield, the order ACC > DAT is clearly preferred. For the verb *anvertrauen* ('to entrust'), sentences with ACC > DAT order occur twice as often as sentences with DAT > ACC order; for the verb *vorziehen* ('to prefer'), all instances had the order ACC > DAT. The numbers for the remaining two verbs are two small to make any claims. The number of sentences in which one of the objects is located in SpecCP is also quite small, with a preference favoring DAT > ACC order.

[7] For further information see http://www.ids-mannheim.de/cosmas2/uebersicht.html

Table 4 Frequency-based predictions for syntactic ambiguity resolution

	Both objects in the middlefield	One object in SpecCP
Level of syntactic functions	ACC > DAT	ACC > DAT
Level of sentences with two objects regardless of animacy	DAT > ACC	DAT > ACC
Level of sentences with two animate objects	ACC > DAT	- (too few data)

In summary, the strong bias towards DAT > ACC order that was evident when considering sentences with two objects without taking animacy features into account gives way to a strong bias toward ACC > DAT order when we restrict our attention to sentences with two animate objects. Thus, our introductory example in (1), in which a globally ambiguous object-object sequence was resolved towards the order ACC > DAT by means of world knowledge, was truly representative for sentences with an animate accusative object alongside an animate dative object. Note furthermore that the joint data shown in Tables 2 and 3 are compatible with the claim that the Personal Hierarchy takes priority in determining the order among the arguments of a verb but that the Case Hierarchy takes over when the Personal Hierarchy leads to a tie. While the data in Table 2 were obtained without taking animacy into account, they are clearly dominated by sentences conforming to the prototypical use of ditransitive verbs, that is, sentences with an animate dative object and an inanimate accusative object. The dominant linearization pattern emerging from Table 2 – DAT > ACC – follows the Personal Hierarchy under the assumption that the dative object in the majority of instances refers to an animate entity whereas the accusative object mostly refers to an inanimate entity as tentatively confirmed by the pattern for proper names in Table 1. At the same time, the trend towards DAT > ACC contrasts with the Case Hierarchy. For the data in Table 3, the Personal Hierarchy is no longer relevant due to the tie between the two objects with regard to animacy and what we now get is a dominance of the order that follows the Case Hierarchy, namely ACC > DAT, at least for sentences in which the two objects occur in the middlefield.

With the corpus results in Tables 1–3 at hand, we can finally specify the predictions that follow from the Frequency-Hypothesis contingent on the particular level of granularity. These predictions are summarized in Table 4.

5 Experimental Investigations

We now present three experiments that have investigated how the HSPM processes sentences with ditransitive verbs when both the patient and the recipient argument are animate. Two experiments have looked at sentences in the active voice and thus at the local ambiguity that arises when neither the direct nor the indirect object is marked by morphological means, as in (12).

(12) *Ich habe Tom Eva vorgestellt.*
I have T. E. introduced
'I introduced Tom to Eva.' or 'I introduced Eva to Tom.'

In (12), the substring *Tom Eva* can be parsed as showing either ACC > DAT or DAT > ACC order. This kind of local syntactic ambiguity is shared by two of the following experiments. What differs between these experiments is the position of the two objects (either both within the middlefield or one moved to SpecCP).

In a further experiment, passive sentences as illustrated in (13) were presented.

(13) *Heute wurde Tom Eva vorgestellt.*
Today was T. E. introduced
'Today, Tom was introduced to Eva.' or
'Today, Eva was introduced to Tom.'

With regard to the two NPs *Tom* and *Eva*, sentence (13) is equivalent to sentence (12) in lexical-semantic terms. In syntactic terms, however, sentence (13) does no longer contain an object-object ambiguity but an ambiguity between the subject and dative object instead. Comparing the processing of active sentences like (12) with the processing of passive sentences like (13) will allow us to determine whether the HSPM treats object-object ambiguities and subject-object ambiguities alike or not.

The sentences in (12) and (13) are both globally ambiguous. For experimental purposes, however, it is advantageous to investigate sentences that are only locally ambiguous. To this end, the syntactic ambiguity must be resolved at some later point in the sentence. All three experiments that we report below make use of the same kind of disambiguation. For sentence (12), this is illustrated in (14).

(14) a. *Ich habe Tom [**nicht nur Eva**] vorgestellt, sondern auch*
I have T. not only E. introduced but also
[**ihrer Schwester**].
her.DAT sister
'I introduced Tom not only to Eva but also to her sister.'
b. *Ich habe Tom [**nicht nur Eva**] vorgestellt, sondern auch*
I have T. not only E. introduced but also
[**ihre Schwester**].
her.ACC sister
'I introduced not only Eva to Tom but also her sister.'

The two sentences in (14) contain an extraposed conjunct that has to be associated with the focused NP in the preceding clause. Accordingly, the focused NP and the conjunct have to share their case specification. While the focused NP is case-ambiguous, the extraposed NP is morphologically marked for a particular case, thereby disambiguating the sentence as a whole. In (14a), the conjunct is marked for dative case and therefore the focused NP can only be the dative object; this in turn implies that the preceding NP *Tom* bears the case that remains, namely accusative. Thus, the sentence has ACC > DAT order. In (14b), the conjunct is marked for accusative case and accordingly the sentence has DAT > ACC order.

5.1 Experiment 1

Although our main interest concerns the processing of sentences with two ambiguous objects, as in (12), Experiment 1 tests whether the particular combination of verb class and arguments – ditransitive verbs with two animate objects – is processed as expected when transformed into a subject-object ambiguity by putting the verb into the passive voice. The patient argument is thereby promoted to the subject while the recipient argument remains a dative object. As discussed above, disambiguation was achieved by the use of focus together with an unambiguous conjunct. For Experiment 1, this leads to sentences as in (15).

(15) a. *Heute wurde Tom [nicht nur Eva] vorgestellt, sondern auch*
Today was T. not only E. introduced but also
[ihrer Schwester].
her.DAT sister
'Today Tom was not only introduced to Eva but also to her sister.'
b. *Heute wurde Tom [nicht nur Eva] vorgestellt, sondern auch*
Today was T. not only E. introduced but also
[ihre Schwester].
her.NOM sister
'Today not only Eva was introduced to Tom but also her sister.'

The Grammar Hypothesis and the Frequency Hypothesis share the prediction of an SO preference for the sentences in (15). We therefore expect a garden-path for OS sentences like (15b). In order to test this prediction, the experiment contains not only locally ambiguous sentences like (15) but also unambiguous counterparts with morphologically case-marked objects.

(16) a. *Heute wurde der Sänger [nicht nur meiner Freundin] vorgestellt,*
Today was the.NOM singer not only my.DAT friend introduced
sondern auch [ihrer Schwester].
but also her.DAT sister
'Today the singer was not only introduced to my friend but also to her sister.'
b. *Heute wurde dem Sänger [nicht nur meine Freundin] vorgestellt,*
Today was the.DAT singer not only my.NOM friend introduced
sondern auch [ihre Schwester].
but also her.NOM sister
'Today not only my friend was introduced to the singer but also her sister.'

The experiment used an orthogonal design with two factors, each at two levels. The factor Order varies the order among the two arguments: either NOM > DAT as in (15a) or DAT > NOM as in (15b). The factor Ambiguity refers to the case marking of the two NPs: either ambiguous as in (15) or unambiguous as in (16).

5.1.1 Method

Participants

Sixty-four students from the University of Konstanz (37 female and 27 male) participated for course credits or payment. In this and all other experiments, participants were always native speakers of German and naive with respect to the purpose of the experiment.

Materials

Sixteen sentence quadruples following the model in (15) and (16) were created. Within each quadruple the sentences varied according to the two factors Ambiguity (ambiguous vs. unambiguous) and Order (NOM>DAT vs. DAT>NOM). Locally ambiguous sentences contained proper names as objects whereas unambiguous control sentences contained definite NPs with a case marked determiner. We used four different verbs in our experimental material, the verbs *anvertrauen* ('to entrust'), *empfehlen* ('to recommend'), *vorstellen* ('to introduce'), *vorziehen* ('to prefer'). Each verb appeared in four sentence quadruples.

The experimental sentences were equally distributed over four lists, following a Latin square design. Each participant saw only one list and thus each sentence in only one of its four versions and four different sentences in each condition. The order of experimental sentences was randomized for each participant individually. After randomization, the experimental sentences were interspersed into a list of filler sentences covering a wide range of grammatical and ungrammatical constructions. The majority of filler items served as experimental items in unrelated experiments. The ratio of experimental sentences to filler sentences was about 1:13.

Procedure

Sentences were presented visually using the DMDX software developed by K. Forster and J. Forster at Monash University and University of Arizona. Participants sat in front of a computer monitor. Their task was to read sentences on the computer screen and judge the grammaticality of each sentence as quickly and accurately as possible. The concept of grammaticality was explained with the help of examples. Participants initiated each trial by pressing the space-bar that triggered three fixation points to appear in the center of the screen for 1,050 ms. Thereafter, the sentence appeared on the screen word by word, with each word appearing at the same position (mid-screen). Each word was presented for 225 ms plus an additional 25 ms for each character to compensate for length differences. There was no interval between the words. Immediately after the last word of a sentence, three red question marks appeared on the screen, signaling to participants that they now had to make their judgment. Participants indicated their judgment by pressing either the left or the

Table 5 Percentages of correct judgments and mean reaction times (ms) to make correct judgments, for Experiment 1

	NOM>DAT		DAT>NOM	
	Ambiguous	Unambiguous	Ambiguous	Unambiguous
Accuracy	93 (1.6)	94 (1.4)	39 (4.1)	87 (2.7)
Judgment time	622 (30)	588 (25)	905 (42)	653 (31)

Standard errors (by participants) are shown in parentheses

right shift key on a computer keyboard. If participants did not respond within 2,000 ms, a red warning line “zu langsam” (‘too slow’) appeared on the screen and the trial was finished.

5.1.2 Results

Two types of results were computed, percentages of correct answers and mean reaction times to make a correct judgment. Reaction time data were corrected for outliers in the following way. Before analysis of response times, all response times more than 2.5 standard deviations (*SD*) away from an individual subject’s mean were replaced with the cut-off value for the subject (the value equal to 2.5 *SD* above or below the mean). Less than 3% of the response times were replaced by this criterion. For this and all further experiments, analyses of variance (ANOVAs) were conducted in two ways – one treating participants as an additional random factor (F1) and the other one treating items as an additional random factor (F2).

Judgment

The first row in Table 5 shows the percentages of correct responses for Experiment 1. The most striking effect is a dramatic drop in accuracy for ambiguous sentences with DAT>NOM order (39%). ANOVAs revealed significant main effects of Ambiguity ($F1(1,63)=87.1$, $p<.001$; $F2(1,15)=203.0$, $p<.001$) and Order ($F1(1,63)=128.0$, $p<.001$; $F2(1,15)=183.2$, $p<.001$), as well as a significant Ambiguity × Order interaction ($F1(1,63)=88.0$, $p<.001$; $F2(1,15)=168.8$, $p<.001$). Planned comparisons show that the ambiguity effect is present in DAT>NOM sentences only ($t1=13.5$, $p<.001$; $t2=18.7$, $p<.001$; for NOM>DAT sentences both t-values <1). The order effect is significant for ambiguous sentences ($t1=15.4$, $p<.001$; $t2=21.3$, $p<.001$) and for unambiguous sentences, although only marginally in the subject analysis ($t1=2.1$, $p=.05$; $t2=2.9$, $p<.05$).

Judgment Times

The reaction times for correct responses are also shown in Table 5. Again, the condition ‘DAT>NOM, ambiguous’ diverges remarkably from all other conditions in exhibiting the longest judgment times (905 ms). For analyses of variance 19 subjects had to be excluded because of empty cells resulting from the high rejection rate for ambiguous DAT>NOM sentences. For the remaining subjects, ANOVAs show significant main effects of Ambiguity ($F1(1,44)=26.7$, $p<.001$; $F2(1,15)=21.9$, $p<.001$) and Order ($F1(1,44)=33.0$, $p<.001$; $F2(1,15)=26.0$, $p<.001$) and a significant Ambiguity × Order interaction ($F1(1,44)=14.9$, $p<.001$; $F2(1,15)=26.1$, $p<.001$).

Planned comparisons show that the ambiguity effect is significant in DAT>NOM sentences ($t1=6.7$, $p<.001$; $t2=8.8$, $p<.001$) but not in NOM>DAT sentences ($t1=1.2$, $p=.2$; $t2=1.6$, $p=.13$). The order effect reached significance in ambiguous sentences ($t1=7.1$, $p<.001$; $t2=9.5$, $p<.001$) and the item analysis of unambiguous sentences ($t2=2.3$, $p<.05$) but not in the corresponding subject analysis ($t1=1.6$, $p=.1$).

5.1.3 Discussion

The results of Experiment 1 fully conform to what is known from prior investigations of subject-object ambiguities: when the HSPM has a choice between assigning an SO or an OS structure, the assignment of the SO-structure is preferred. In accordance with this preference, ambiguous and unambiguous NOM>DAT sentences did not differ from each other. For DAT>NOM sentences, in contrast, the factor Ambiguity had a huge effect. Percentages of correct judgments dropped from 88% for unambiguous OS sentences to only 39% for ambiguous OS sentences; reaction times for correct answers accordingly show a substantial increase for ambiguous OS sentences. The results obtained in Experiment 1 thus once again underscore the strength of the prevalent SO preference in German.

A final remark concerns a potential confound between ambiguity and length in our material. We manipulated the ambiguity of case marking by using unambiguous definite NPs (two words) and ambiguous proper names (one word). With longer response times for sentences with shorter proper names, the data do not seem to be affected by this length confound.

5.2 Experiment 2

We now turn to the object-object ambiguity that is the main concern of the current study. Experiment 2 employs the same verbs as Experiment 1 but this time in the active voice. The experimental sentences follow the pattern in (14), a corresponding unambiguous example is given below in (17).

(17) a. *Ich habe den Sänger [nicht nur meiner Freundin] vorgestellt,*
I have the.ACC singer not only my.DAT friend introduced
sondern auch [ihrer Schwester].
but also her.DAT sister
'I introduced the singer not only to my friend but also to her sister.'

b. *Ich habe dem Sänger [nicht nur meine Freundin] vorgestellt,*
I have the.DAT singer not only my.ACC friend introduced
sondern auch [ihre Schwester].
but also her.ACC sister
'I introduced not only my friend to the singer but also her sister.'

The two objects are both located in the middlefield and are preceded by a pronominal subject that occupies the clause-initial position. The verb occurs in the clause-final position and is followed by an extraposed conjunct disambiguating the focused object with respect to case.

The same factorial design is used as in Experiment 1. The factor Ambiguity distinguishes locally ambiguous sentences like (14) and unambiguous sentences like (17) in which the two proper names were replaced by definite NPs exhibiting overt case marking. The factor Order distinguishes ACC > DAT sentences like (14a)/(17a) and DAT > ACC sentences like (14b)/(17b).

5.2.1 Method

Participants and Procedure

Twenty-eight students from the University of Konstanz (20 female and 8 male) participated for course credit or payment. The same procedure was used as in Experiment 1.

Materials

The 16 passive sentences of Experiment 1 were transformed into active sentences on the model of the sentences in (14) and (17). Each sentence appeared in four versions according to the two factors Ambiguity (ambiguous vs. unambiguous) and Order (DAT > ACC vs. ACC > DAT). The experimental sentences were equally distributed over four lists, randomized and accompanied by filler items as described for Experiment 1. The ratio of experimental to filler items was about 1:13.

5.2.2 Results

Judgments

Table 6 shows the percentages of correct responses for Experiment 2. First of all, a strong ambiguity effect is observed for DAT > ACC sentences (48% vs. 82%) but not for ACC > DAT sentences (88% vs. 95%). This results in main effects of Ambiguity ($F1(1,27) = 28.4$, $p < .001$; $F2(1,15) = 22.5$, $p < .001$) and Order ($F1(1,27) = 32.1$, $p < .001$; $F2(1,15) = 34.9$, $p < .001$), as well as an Ambiguity × Order interaction ($F1(1,27) = 10.7$, $p < .01$; $F2(1,15) = 12.0$, $p < .01$).

Table 6 Percentages of correct judgments and mean reaction times (ms) to make correct judgments, for Experiment 2

	DAT > ACC		ACC > DAT	
	Ambiguous	Unambiguous	Ambiguous	Unambiguous
Accuracy	48 (6.7)	82 (4.2)	88 (2.7)	95 (2.7)
Judgment time	920 (94)	695 (56)	740 (53)	622 (49)

Standard errors (by participants) are shown in parentheses

Planned comparisons show that the strong ambiguity effect in DAT > ACC sentences is significant ($t1 = 5.7$, $p < .01$; $t2 = 6.0$, $p < .01$) whereas the small ambiguity effect in ACC > DAT sentences is statistically not significant ($t1 = 1.0$, $p = 0.3$; $t2 = 1.1$, $p = 0.3$).

Furthermore, participants produced more judgment errors for DAT > ACC sentences than for ACC > DAT sentences. Planned comparisons show that this order effect is present both in ambiguous sentences ($t1 = 6.7$, $p < .01$; $t2 = 7.1$, $p < .01$) and in unambiguous sentences ($t1 = 2.1$, $p < .05$; $t2 = 2.2$, $p < .05$).

Judgment Times

The reaction times for correct responses are also shown in Table 6. Ambiguous sentences received longer response times than unambiguous sentences, in particular in DAT > ACC sentences. For analyses of variance six participants were excluded because of empty cells. ANOVAs revealed main effects of Ambiguity ($F1(1,21) = 36.4$, $p < .001$; $F2(1,15) = 9.3$, $p < .01$) and Order ($F1(1,21) = 5.0$, $p < .05$; $F2(1,15) = 5.9$, $p < .05$). The Ambiguity × Order interaction failed significance ($F1(1,21) = 2.8$, $p = .11$; $F2(1,15) = 2.0$, $p = .17$).

Note that the response time difference between ambiguous and unambiguous sentences cannot be attributed to the length difference between proper names and definite NPs since the latter works in the opposite direction.

5.2.3 Discussion

In Experiment 2, both the rate of erroneous rejections and the response times for correct judgments increased dramatically when locally ambiguous sentences were disambiguated toward DAT > ACC order. This strong garden-path effect for locally ambiguous DAT > ACC sentences indicates an initial preference for ACC > DAT order. We therefore conclude that the first ambiguous object NP is preferably assigned accusative case leading to processing difficulties when it turns out to be a dative object.

There was also a hint in the results that ambiguity affects ACC > DAT sentences as well, although only slightly so. We therefore have to be cautious when drawing conclusions. The pattern we see in judgment data and response times suggests that the parser, although having a preference for assigning accusative case to the first object NP, chooses dative case from time to time. In other words, the parser has only a relative preference when confronted with an object-object ambiguity. This contrasts with the absolute preference found for the subject-object ambiguity examined in Experiment 1.

5.3 Experiment 3

Experiment 3 investigates the same object-object ambiguity addressed by the previous experiment but this times in sentences in which one of the two objects is fronted to SpecCP. An example is given in (18).

(18) a. *Tom habe ich [nicht nur Eva] vorgestellt, sondern auch*
T. have I not only E. introduced but also
[ihrer Schwester].
her.DAT sister
'I introduced Tom not only to Eva but also to her sister.'

b. *Tom habe ich [nicht nur Eva] vorgestellt, sondern auch*
T. have I not only E. introduced but also
[ihre Schwester].
her.ACC sister
'I introduced not only Eva to Tom but also her sister.'

Apart from bringing the first object into the sentence-initial position, with a concomitant change of the position of the subject pronoun, the sentence material of Experiment 3 is identical to the material employed in Experiment 2.

5.3.1 Method

Participants and Procedure

Forty students from the University of Konstanz (30 female and 10 male) participated for course credit or payment. The experiment used the same procedure as the preceding experiments.

Materials

The material for Experiment 3 was obtained from the material of Experiment 2 by exchanging the subject and first object. This resulted in 16 sentences conforming to the structure illustrated in (18). As in the preceding experiments, unambiguous counterparts contained case-marked definite NPs. Each sentence appeared in four versions according to the two factors Ambiguity (ambiguous vs. unambiguous) and Order (DAT > ACC vs. ACC > DAT).

Table 7 Percentages of correct judgments and mean reaction times (ms) to make correct judgments, for Experiment 3

	DAT>ACC		ACC>DAT	
	Ambiguous	Unambiguous	Ambiguous	Unambiguous
Accuracy	43 (3.9)	78 (3.9)	80 (3.7)	89 (3.2)
Judgment time	987 (66)	737 (48)	769 (47)	626 (38)

Standard errors (by participants) are shown in parentheses

The experimental sentences were distributed over four lists, randomized and accompanied by filler items as described before. The ratio of experimental items to filler items was about 1:13.

5.3.2 Results

Judgments

Table 7 shows the percentages of correct responses for Experiment 3. We again see a strong drop in accuracy for ambiguous DAT>ACC sentences. ANOVAs show main effects of Ambiguity ($F1(1,39)=66.3$, $p<.001$; $F2(1,15)=22.8$, $p<.001$) and Order ($F1(1,39)=43.5$, $p<.001$; $F2(1,15)=78.9$, $p<.001$) as well as an interaction of the two factors ($F1(1,39)=18.8$, $p<.001$; $F2(1,15)=12.3$, $p<.01$).

Planned comparisons revealed that the ambiguity effect is significant in DAT>ACC sentences ($t1=8.2$, $p<.01$; $t2=6.7$, $p<.01$). In ACC>DAT sentences, the ambiguity effect is significant in the subject analysis but failed significance in the item analysis ($t1=2.1$, $p<.05$; $t2=1.7$, $p=0.1$). The order effect is significant both for ambiguous sentences ($t1=8.8$, $p<.01$; $t2=7.1$, $p<.01$) and for unambiguous sentences ($t1=2.7$, $p<.05$; $t2=2.2$, $p<.05$).

Judgment Times

The reaction times for correct responses are also shown in Table 7. Inspection of Table 7 reveals that ambiguous sentences receive longer judgment times and judgment times are longer in DAT>ACC sentences.

For statistical analyses, six participants had to be excluded because of empty cells. For the remaining participants, two-way ANOVAs revealed significant main effects of Ambiguity ($F1(1,33)=17.2$, $p<.001$; $F2(1,15)=33.4$, $p<.001$) and Order ($F1(1,33)=13.5$, $p<.001$; $F2(1,15)=17.7$, $p<.001$). The interaction of the two factors failed significance ($F1(1,33)=1.6$, $p=.2$; $F2(1,15)=2.7$, $p=.12$).

5.3.3 Discussion

In Experiment 3, ambiguous DAT>ACC sentences caused processing difficulties reflected in judgment errors and increased judgment times. This finding replicates the ACC>DAT preference observed in Experiment 2. Finding the same pattern of results in both experiments, despite the syntactic difference regarding the position of the first NP, suggests that the ACC>DAT preference is a general phenomenon.

A further similarity between Experiment 2 and Experiment 3 concerns the pattern of results for ACC>DAT sentences. In both experiments, ACC>DAT sentences show signs of a garden-path in locally ambiguous sentences. In Experiment 3, the ambiguity effect is significant in the subject analysis (for both judgments and judgment times) but is again non-significant in the item analysis. Therefore, any conclusions based on that trend have to be treated with caution.

5.4 Summary of Experimental Results

The results of the three experiments that we have presented in this section can be summarized as follows. Experiment 1 investigated sentences with a subject-object ambiguity and replicated the well-established SO preference. Locally ambiguous OS sentences caused a severe garden-path effect while SO sentences exhibited no difference at all between ambiguous and unambiguous sentences.

The remaining two experiments investigated sentences with two locally ambiguous objects: the objects showed up either in the order ACC>DAT or in the order DAT>ACC. The difference between these two experiments was that in Experiment 2 both objects were located within the middlefield whereas in Experiment 3 one of the objects was fronted to SpecCP. Despite this syntactic difference, the two experiments revealed the same pattern of results. First of all, DAT>ACC sentences caused a strong garden-path effect. Secondly, sentences with ACC>DAT order also showed signs of a garden-path effect. Numerically, this effect was visible both in the percentages of correct judgments and in the response times. Statistically, however, the effect was only partially significant. The preference in favor of ACC>DAT order is thus somewhat weaker than the preference for NOM>DAT order that was observed in Experiment 1.

An additional finding concerns unambiguous sentences. In all three experiments, unambiguous DAT-initial sentences were judged somewhat poorer than unambiguous ACC-initial sentences.

6 General Discussion

In the beginning, we introduced two competing hypotheses concerning the HSPM's behavior when confronted with a syntactic ambiguity – the Grammar Hypothesis in (6) and the Frequency Hypothesis in (7). We now evaluate these two hypotheses in the light of our experimental findings.

The Grammar Hypothesis in conjunction with the Case Hierarchy predicts both the SO preference that was found in the first experiment as well as the ACC>DAT preference that showed up in the two experiments on the object-object ambiguity.

The finding of a strong ACC>DAT preference in our experiments as well as in our corpus study is surprising given the view that sentences with two animate objects are serialized according to a DAT > ACC constraint (e.g., Uszkoreit 1987; Müller 1999; Keller 2000). It also contrasts with prior findings confirming such a preference for DAT > ACC (Keller 2000; Pappert et al. 2007). One reason for this discrepancy may have to do with processing issues. Note that previous experimental studies examined the processing of unambiguous sentences. Assigning a syntactic structure to a locally ambiguous sentence under real-time conditions as in the present study is different from evaluating the well-formedness of an unambiguous sentence without consideration of time as in Keller's (2000) study. If the HSPM assigns a case value to each NP as soon as it is encountered, in a situation where nominative case has already been assigned the assignment of accusative case is the natural choice given that the HSPM cannot know that a further object is coming. When rating sentences as a whole, in contrast, both objects can be taken into account simultaneously.

Pappert et al. (2007) used a self-paced reading procedure and thus an online-measurement but also examined the processing of unambiguous sentences. The slight increase in reading times they found for ACC > DAT sentences was actually locally restricted – it occurred only at the determiner of the second object NP – and was only partially significant. Interpretations have therefore to be taken with caution. The authors themselves suggest an explanation in terms of suprisal (cf. Hale 2006; Levy 2008). This view is supported by the results of an accompanying sentence completion study. Sentence fragments containing a nominative NP followed by a dative NP were in about half of the instances completed by means of an accusative object and a ditransitive verb. In contrast, fragments containing a nominative NP and an accusative NP were only rarely completed with a dative object and a ditransitive verb. Thus, a dative object is less probable after an accusative NP than the latter after the former. However, even if expectancies might affect online reading times data they seem not to affect the accuracy of grammaticality judgment data as our results show.

In addition to the processing issue, our data cast some doubt on the validity of the proposed DAT > ACC constraint. Both in Experiment 2 and Experiment 3, unambiguous DAT > ACC sentences were judged poorer than ACC > DAT sentences. Furthermore, the corpus data for sentences with two animate objects also showed a clear bias in favor of ACC > DAT (see also Hoberg 1981 for the same finding). At this point, we can only speculate about the reason for this diverging pattern. Overall, the markedness difference between unambiguous ACC > DAT and DAT > ACC sentences seems to be quite small if there is any at all. Subtle semantic differences – for example concerning the lexical material of the two objects – might therefore induce a bias towards either of the two orders.

Signs of a garden-path not only occurred in ambiguous DAT > ACC sentences but also in ACC > DAT sentences, although statistically only partially significant. Apparently, the preference for accusative over dative case is not as strong as the preference for nominative case over all other cases. How this kind of gradience is best accounted for by a grammar-driven HSPM is a question for future research.

In summary, the experimental findings confirm the grammar-based prediction and thus support the Grammar Hypothesis. Furthermore, the results are best explained with reference to the Case Hierarchy.

We now turn to the Frequency Hypothesis. As noted earlier, this hypothesis must be qualified with regard to the kind of frequency information taken into account. In Table 4, we derived predictions on three different levels of granularity. We now evaluate the Frequency Hypothesis for each level in turn.

A version of the Frequency Hypothesis based on frequency counts at the level of syntactic functions predicts the first object to be analyzed as an accusative object because accusative objects strongly outnumber dative objects in German – in the middlefield as well as in SpecCP. This prediction is confirmed by the observed ACC > DAT preference in Experiment 2 (with both objects occurring in the middlefield) and Experiment 3 (with one object located in SpecCP).

A theory based on frequencies at the level of sentences with two objects regardless of animacy makes the opposite prediction: the first object should be analyzed as a dative object since the order DAT > ACC is more frequent than the order ACC > DAT. The position of the objects should also matter with this level of granularity. The preference should be stronger with both objects in the middlefield than with one object moved to SpecCP. Since our experimental data show the reverse preference, corpus frequencies at the level of sentences with two objects cannot explain the parser's behavior in face of object-object ambiguities. Note that this is a level of granularity that has often been used in investigations of structural frequency for psycholinguistic purposes (e.g., Hale 2006; Levy 2008).

Consider finally frequencies at the level of sentences with two animate objects. A theory based on frequencies at this level predicts an ACC > DAT preference at least for sentences with both objects in the middlefield. This preference was actually found in Experiment 2. When considering sentences with one of the objects located in SpecCP, we are confronted with an instance of the sparse data problem. Our corpus data revealed a preference for DAT > ACC order but on the basis of just six sample sentences. It would therefore be premature to draw strong conclusions from the fact that Experiment 3 revealed the opposite preference.

In summary, the Frequency Hypothesis can account for our experimental data at some but not all, levels of granularity. We have thus made some progress toward delimiting the grain sizes that might be used by a frequency-based parser. The data provided by the experiments are compatible with two levels of granularity: the level of syntactic functions and the level of sentences with two animate objects. Statistical properties at the level of sentences with two objects in general, in contrast, are not able to account for the observed ACC > DAT preference.

7 Conclusion

The most important finding emerging from the experiments reported in this paper is that the HSPM preferentially analyses sentences with two ambiguous objects as exhibiting the order ACC > DAT. From the perspective of on-line processing, a preference for the order ACC > DAT can be translated into an order-independent preference for accusative over dative case. When processing a sentence from left to right, the first object NP is assigned accusative case according to this preference; the second object NP then receives dative case because this is the only case that remains to be assigned. In addition to the accusative-over-dative preference found in Experiments 2 and 3, Experiment 1 confirmed the existence of a strong preference for assigning nominative case to a sentence-initial case-ambiguous NP.

The finding of an accusative-over-dative preference for sentences with two locally ambiguous objects is a striking confirmation of the *Case Preference Principles* proposed by Bader et al. (1996). The Case Preference Principles, which are shown in (19), were stated on the assumption that the nominative and accusative are structural cases whereas the dative is a lexical case.

(19) The Case Preference Principles
  a. If possible, prefer structural Case over lexical Case.
  b. If possible, prefer nominative Case over accusative Case.

The original evidence showing a preference for accusative over dative case was found for sentences with a single object. In an experiment measuring event-related potentials, Bader et al. (1996) investigated sentence pairs as in (20).

(20) a. *Menschen, die in Not sind, sollte man unterstützen.*
  people.ACC who in distress are should one support
  ‘One should support people who are in distress.’
 b. *Menschen, die in Not sind, sollte man helfen.*
  people.DAT who in distress are should one help
  ‘One should help people who are in distress.’

In (20a), the clause-final verb *unterstützen* (‘to support’) assigns accusative case to its single object; in (20b), *helfen* (‘to help’) assigns dative case. The data of Bader et al. (1996) show that disambiguation toward dative case, as in (20b), causes a garden-path effect. Taken together with the results of the current experiments, this allows the conclusion that the HSPM has a general preference for accusative case when a DP is locally ambiguous between accusative and dative case. In particular, the results presented here show that the preference for accusative case found by Bader et al. (1996) is in no way tied to the fact that sentence (20b) contains a monotransitive verb. For monotransitive verbs, it is generally assumed that dative case is a lexical case. For ditransitive verbs, in contrast, the status of the dative object with respect to the structural versus lexical distinction is a matter of debate. Bader et al. (1996) assumed that dative case is always a lexical case and that the Case Preference Principles therefore apply to all dative NPs alike. This assumption is clearly borne out by the results of the present experiment.[8]

To our knowledge, the Case Preference Principles in (19) come closest to a parsing principle that incorporates the grammatical Case Hierarchy in a direct way. In fact, the linguistic rationale that was given in Bader et al. (1996) for the Case

[8]Note that calling the dative case a *lexical case* does not imply that dative case is always a lexical idiosyncratic property. This is clearly not so for ditransitive verbs and might not even been true in general for monotransitive verbs with a dative object (see Primus 2008).

Preference Principles includes some of the reasons that have led to the formulation of the Case Hierarchy. For example, the preference for accusative over dative case was motivated by the fact that dative case is morphologically more marked than accusative case. In this sense, the HSPM's preference for accusative case was assumed to reflect a preference for unmarked morpho-syntactic structures. The complexity of morphological marking has also been a main argument for the Case Hierarchy proposed in the typological literature.

Note, however, that the Case Preference Principles are not the sole determinant of preferred syntactic function assignments according to the theory proposed in Bader et al. (1996). In fact, Bader et al. (1996) assumed that the Case Preference Principles are only invoked when the preferred syntactic function of a case-ambiguous NP does not already follow from phrase-structural parsing principles, including parsing principles that regulate the postulation of filler-gap dependencies (e.g., the Active Filler Hypothesis of Frazier 1987 or the Minimal Chain Principle of De Vincenzi 1991). A further step was taken by Bader and Bayer (2006) who dropped the first clause of the Case Preference Principles ("If possible, prefer structural Case over lexical Case"). This was made possible by a change concerning the phrase-structural representation of case-marked NPs. Under the assumption that dative NPs but not nominative or accusative NPs are embedded within an additional layer of functional structure (a "Kase Phrase"), the observed preferences for structural case over dative case follow from standard economy principles on phrase-structure parsing (e.g., Minimal Attachment of Frazier 1979).

These theoretical developments reiterate a point already made above, namely what is the status of prominence hierarchies in general and the Case Hierarchy in particular. There is no consensus on this question within linguistic theory and, as shown by the preceding discussion, even though the observed case preferences match the Case Hierarchy, this does not necessarily mean that the HSPM actually consults the Case Hierarchy when processing syntactic ambiguities of the kind considered here (for further discussion of this point, see Bader and Lamers 2008).

The corpus data presented above pave the way for yet an alternative foundation of the observable case preferences. The HSPM might consult some kind of 'frequency table' accumulated over prior encounters with the syntactic structures at hand when faced with an NP that is ambiguous with respect to its syntactic function. As shown by our corpus data, this would amount to exactly the same preferences as encoded by the Case Preference Principles in (19).

In summary, the data presented here falsify neither the Grammar nor the Frequency Hypothesis wholeheartedly. Nevertheless, by turning our attention to sentences with two ambiguous objects we have made some progress. While the well-known subject-object preference is not helpful for delimiting the grain size that is needed under the Frequency Hypothesis, our experimental results on the object-object ambiguity eliminate an important level of granularity. Despite the fact that the vast majority of sentences with two objects exhibit the order DAT > ACC, we observed a preference for ACC > DAT in our experiments. We can thus conclude that the level of ordered syntactic functions is not the level on which the HSPM keeps track of structural frequencies (if it keeps track of such frequencies at all).

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Lexical Preference and Global Structure Contributions to Syntactic Choice in Sentence Production

Clare J. Huxley, Janet F. McLean, Holly P. Branigan, and Martin J. Pickering

1 Introduction

An important aspect of language processing is how speakers choose which syntactic structures to produce. One possible explanation is that the verb specifies a preferred argument structure. Another possible account is that syntactic structure preferences exist independently of lexical content. For example, active voice structures are greatly preferred to passive voice structures in English (Svartvik 1966). Similarly, within the ditransitive alternation in English, there is a general preference for the prepositional object (PO) structure *The nun gave the jug to the monk* over the double object (DO) structure *The nun gave the monk the jug* (e.g. Branigan et al. 2006). This chapter discusses lexical and structural influences in the choice of syntactic structure and their implications for how language is processed.

First, an overview of psycholinguistic literature will examine evidence for lexical and structural influences on the selection of syntactic structures and then we will consider various grammars which incorporate lexical approaches to building syntactic structures and their predictions for language processing. We will also discuss a study which directly compares lexical and global structural influences on selection of local syntactic structure. Having considered the available evidence, we propose that lexical factors alone do not determine choice of syntactic structure and that current models for the processing of, or representation of, syntactic structures should incorporate influence from global syntactic structure.

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2 Psycholinguistic Studies of Syntactic Processing

A number of psycholinguistic studies have investigated possible influences on the processing of syntactic structures, including lexical or structural factors. Methods used to investigate syntactic processing include description tasks, sentence recall and structural priming paradigms.

2.1 Lexical Influence on Syntactic Processing

If syntactic structures and grammatical rules are accessed and processed entirely separately from the lexicon, there should be no effects of lexical preference upon the choice of syntactic structures. But if the choice of verb does influence the choice of syntactic structure, this indicates that some information about syntactic structures and preferences is stored and accessed with the verb at the lexicon.

F. Ferreira (1994) demonstrated that verb type affected the choice of syntactic structure. Participants read two nouns and a verb on a screen and then produced transitive sentences. Theme-experiencer verbs, where the object is the one who experiences the psychological state, e.g. *frighten*, elicited more passives than agent-patient actional transitive verbs like *paint*. This tendency increased when the nouns included one animate and one inanimate noun instead of two animates. Animacy did not affect choice of syntactic structure for actional transitive verbs. These findings demonstrate a clear influence on choice of syntactic structure according to verb type and furthermore that this distinction based on the meaning of this category of verbs and the roles specified by the theme-experiencer verbs.

V.S. Ferreira (1996) found evidence that structure preferences specified by the verb affected processing during production. Participants produced utterances from words presented on a screen and the time from presentation to onset of speech was measured. Speech onset was faster for verbs which permit multiple structures such as 'give' than for verbs such as 'donate' which permit one structure. Ferreira suggested that having multiple possible structures available facilitates faster processing than having only one possible structure as an incremental processor would be able to choose the most suitable structure as lexical items become available for processing.

Pickering and Branigan (1998) demonstrated a clear lexical influence on syntactic selection. In a sentence completion priming task, participants completed ditransitive prime sentence fragments which allowed only a prepositional object (PO) or double object (DO) completion and then completed target fragments which permitted either alternative. Priming occurred when the verb was different between prime and target but was stronger when the verb was repeated. This was unaffected by changes in the verb's tense, number or aspect. Priming that occurs when there is no lexical overlap suggests that there may be a purely structural component to priming. However, the fact that verb repetition enhances priming suggests that lexical factors such as verb-subcategorisation may still play an important role.

In a corpus study of written and spoken English, Gries (2005) found evidence for structural preferences at the level of individual verbs. Using the British section of the

International Corpus of English (ICE-GB), Gries found syntactic priming for the ditransitive alternation and verb-particle constructions. He found different subcategorisation preferences for the verbs used in Pickering and Branigan (1998). This suggests that a lexical entry for a verb not only lists which structures are permitted but also the degree of preference for those structures.

Supporting experimental evidence for verb-subcategorisation comes from Melinger and Dobel (2005), who found an influence of verb on structure choice in both German and Dutch. In a priming study, participants read a single ditransitive verb which selected for either a PO or DO structure and then described a target picture showing a ditransitive event which allowed either ditransitive alternation. Priming occurred for both German, which has an overall DO preference, and Dutch, which prefers PO structures: speakers tended to produce the syntactic structures previously specified by the prime verb-subcategorisation preferences. By using only the verb in isolation, this indicates that priming associated with verbs comes from features associated with the verb itself and not just from the word sequence it occurs with. This has been a possible confound in previous studies.

However, Kaschak and Borreggine (2008) argue that structural priming occurs at an abstract structural level that is separate from representations concerning the behaviour of lexical items in particular constructions. Using a sentence completion task, they investigated long-term priming effects using specific verbs which were presented either predominantly in a PO construction or a DO construction, or a balance of the two. Long-term priming was not affected by participants' experience with a particular verb and the construction in which it occurred. This does not necessarily suggest that lexical items cannot have structural preferences or associated structure. It does suggest that such preferences could either be overridden by strong enough structural cues or that long-term structural learning focuses on abstract structural information (see also Hartsuiker et al. 2008).

The evidence for the association of grammatical structures and the lexicon is quite clear and diverse. Effects of verb-subcategorisation, where structural preferences are specified at the verb, are found in research involving elicited production (F. Ferreira 1994; V.S. Ferreira 1996; Pickering and Branigan 1998) and corpus data (Gries 2005). If selection of syntactic structures were purely syntactic then there should be no effect of individual verbs upon the selection of structures. However, verbs are shown to dictate quite clearly which structures they permit (Melinger and Dobel 2005) and the degree of preference that exists for alternate structures (Gries 2005). The data presented by Kaschak and Borreggine (2008) suggest that lexical influence on the processing of structures may have specific limitations.

2.2 *Influence of Structure on Syntactic Processing*

A number of structural priming studies have investigated the processing of syntactic structures independent of verb preferences and other lexical influences. Structural priming in production is the tendency for speakers to produce a syntactic structure which they have previously experienced, either through comprehension or previous production. For example, Bock (1986) asked participants to repeat a sentence and then describe a semantically unrelated picture. There was a significant tendency to reuse the syntactic structures encountered in the previously repeated sentence when describing the pictures. Structural priming is found across a variety of structures and also for word orders within a specific syntactic structure. Structural priming can also be used to examine whether the position of a structure within a larger complex sentence affects the choice of structure. For example, a structure can occur as a simple matrix clause *The girl kissed the boy* or as a subordinate clause *The passerby noticed that the girl kissed the boy.* Are there differences in how they are processed? Finally, factors affecting choice of syntactic structure can indicate possible processing strategies employed in language production and processing.

Priming occurs with different syntactic structures and in different languages. Using a picture description task, Hartsuiker and Kolk (1998) observed priming for datives and passive structures in Dutch. Dative primes included prepositional object, double object and medial datives, e.g. *De zeeman schrijft aan zijn vriendin een lange brief* ('The sailor writes to his girlfriend a long letter'), and passive primes included clause final by-phrase and sentence-final passive participle passives, e.g. *De wandelaar wordt door de modder bevuild* ('The walker is dirtied by the mud'). Priming occurred for both frequent and less frequent structures.

Cleland and Pickering (2003) demonstrated priming of noun phrase structures including a simple noun phrase *the red square* and a complex noun phrase containing a relative clause *the square that's red*. Priming increased when there were semantically related nouns in the prime and target, suggesting that increased lexical activation affects syntactic processing and hence that lexical factors are implicated in syntactic processing.

In languages with a fairly flexible word order like Dutch, as well as choosing a syntactic structure, the speaker must also select the word order within that constituent. Hartsuiker et al. (1999) showed word order priming in a picture description priming task using utterances with the same overarching structure but differing word orders, such as *On the table is a ball* and *A ball is on the table*. They suggested that once the constituent is chosen a linearisation process selects the actual serial order of words. A further study of priming in Dutch word order (Hartsuiker and Westenberg 2000) demonstrated priming of auxiliary verb and past participle positions in subordinate clauses. This occurred for sentence completion tasks in both written and spoken language.

Using spoken and written priming tasks, Pickering et al. (2002) found differing priming effects for structures which share the same syntactic dominance hierarchy but differ in word order. The study compared PO and DO distransitive structures with the shifted ditranstive construction, as in *The racing driver showed to the mechanic the extremely dirty and badly torn overall.* They found that the number of PO target responses was greater after the PO primes than the shifted primes even though they share hierarchical relations. However, there were still more PO target responses after shifted primes than after the DO primes. On the basis of these results, they proposed that constituent structure is selected in one stage instead of selecting syntactic relations first followed by selecting word order.

Evidence shows that the syntactic position of a structure within a sentence can be primed. Scheepers (2003) found priming for relative clauses with both high and low attachment in German noun phrases. In the noun phrase '*the score of the candidate, who'* the *who* refers to the candidate and is low-attaching, but in the noun phrase '*the score of the candidate, that',* the *that* refers to the score and is high-attaching. A written sentence completion task showed that participants tended to produce high-attached relative clauses after high-attached relative clauses, but low-attached relative clauses after low-attached relative clauses.

However, in a spoken sentence completion task, Branigan et al. (2006) found no effect of global syntactic structure on choice of local syntactic structure. Six experiments demonstrated priming of ditransitives when global syntactic structure was not shared between prime and target. Priming to a main clause target occurred from a main clause, a main clause after an initial adverbial phrase, and a main clause after a sentence-initial clause. Sentences with main and subordinate clauses showed priming to a subordinate clause from primes in a subordinate clause or a main clause, as well as priming from a subordinate prime to a main clause. Priming occurred between main and subordinate clauses to a similar degree regardless of prime structure position. This suggests that local syntactic structures are chosen without considering their position in the global syntactic structure.

These studies demonstrate clearly that syntactic processing is affected and informed by structural information that exists independently of individual lexical items. The phenomenon of syntactic priming can be found across a variety of structures such as passives (Hartsuiker and Kolk 1998), noun phrases and relative clauses (Cleland and Pickering 2003). Priming effects occur in different languages including Dutch (Hartsuiker and Kolk 1998) and German (Scheepers 2003). Priming can occur not only for the set of syntactic relations but for the linear word order within a syntactic structure (Hartsuiker et al. 1999; Hartsuiker and Westenberg 2000).

However, it is uncertain how larger, complex sentence structures are processed. Scheepers (2003) found evidence that a relative clause and its syntactic relations within a larger structure can be primed (Scheepers 2003), but a later study found no evidence for an effect of global syntactic complexity on processing of a local syntactic structure (Branigan et al. 2006). It remains unclear whether information from the global syntactic structure affects the choice of a local syntactic structure.

2.3 Summary of Psycholinguistic Evidence

Overall, the psycholinguistic literature shows evidence that verb-subcategorisation and lexical preferences do affect choice of syntactic structure therefore suggesting that lexical information does play a role in syntactic processing. However, other psycholinguistic research shows that syntactic information which exists independently of lexical items can affect syntactic processing. In the next section, we look at three different theoretical grammar approaches which incorporate syntactic information in the lexicon and their predictions for processing behaviour. A further study then shows evidence for an interaction between lexical preferences and verb-subcategorisation preferences.

3 Grammars

In addition to the question of how syntactic structures are formed, there is the question of how this information is stored. There are several grammars which explicitly address the issue of how to build syntactic structures and how to store the necessary information including a lexical approach. These grammars come from varied disciplines such as Linguistics, Psychology, Philosophy and Computer Science, and employ a variety of approaches. They are motivated by different concerns such as compatibility with linguistic data, creating a plausible psychological model of language processing, and modelling the computational processes involved. However, despite the different foci and motivations, a comparison of these approaches reveals underlying assumptions and strategies which are shared among these models. We will discuss Tree-Adjoining Grammar, Incremental Procedural Grammar and Construction Grammar, and their implications/predictions for language production processes.

3.1 Tree-Adjoining Grammar

F. Ferreira (2000) presents an account of language production using Tree-Adjoining Grammar (TAG) (Joshi 1985; Joshi et al. 1975; Kroch and Joshi 1985), combining elements of Principles and Parameters or Minimalist Grammars with psycholinguistic observations. Ferreira states that the TAG approach can be integrated with different linguistic theories of grammar; the grammar dictates permitted structures and TAG performs syntactic operations according to a basic set of operations. TAG itself consists of a set of syntactic trees and a set of operations which can be performed on those trees. These tree structures can be of differing size and there are different types of tree. Elementary trees consist of a lexical head and arguments that it licenses. For example, a verb such as 'kick', which may license a Determiner Phrase (DP) position, can be filled later by an activated DP such as 'the ball'.

There are two kinds of elementary tree: 'auxiliary trees' and 'initial trees'. The distinguishing feature of auxiliary trees is that the root node is the same as one of the non-terminal nodes in that structure. This allows the auxiliary trees to be recursive. For example, a matrix clause (with a complementiser phrase CP as root node) may take itself a clause (with a non-terminal complementiser phrase CP node) as the complement to the verb. Initial trees are all other trees which are not auxiliary trees. These trees do not permit recursion. For example, a DP structure consisting of a determiner and noun phrase only is an initial tree where the determiner is the

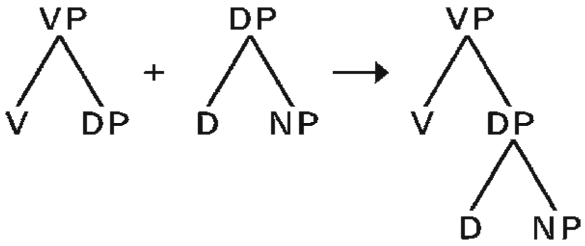

Fig. 1 Substitution operation in Tree-Adjoining Grammar

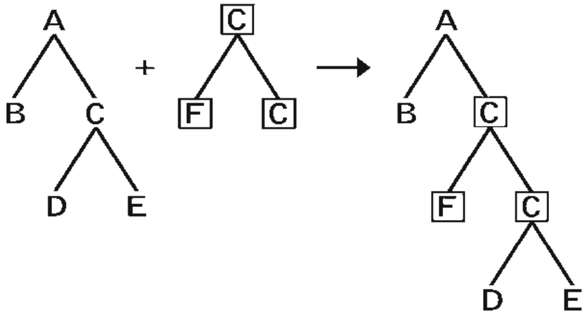

Fig. 2 Adjoining operation in Tree-Adjoining Grammar

lexical head. These are the basic types of tree structures which can be combined to make longer utterances. While the head of a frame projects its arguments, the positions remain empty, as the projection contains no other semantic content and must be filled through tree combining operations.

Trees can be combined through two types of operations: 'substitution' and 'adjoining'. In the substitution operation, one elementary tree is attached to the bottom node of another elementary tree. In the adjoining operation, one tree is inserted into another tree. In order for either operation to take place, certain conditions must be fulfilled. During substitution, the root node of the tree which is to be inserted must be of the same type as the node which it will connect to at the insertion site (see Fig. 1).

For example, a DP tree may be attached to an available DP node. In this way, a set of argument positions licensed by a head can be filled to produce the complete intended utterance. As the adjoining operation involves inserting one tree structure within another, its requirements are slightly more specific. Again, the root node of the tree being inserted needs to be of the same type as the node at the place of insertion. But in addition, the structure which is inserted must license the continuation of the rest of the structure. For example, a structure that is inserted at the C′ complementiser position needs itself to license a C′ to fit into the original structure (see Fig. 2). F. Ferreira (2000) suggests that this operation minimizes the number of empty categories that need be created, and that this procedure can provide an account of phenomena such as wh-movement and inclusion of adjunct phrases. This allows for different types of structures and more complex structures.

In the processing model of language production proposed by F. Ferreira (2000), a message is translated to a propositional representation. This is a formal representation of the utterance's meaning. This proposition specifies whether the utterance describes a state or an event. This is then realized as a function-argument structure, where typically the main verb is the function and the rest of the structure consists of its arguments including tense and aspect. The information for which argument is topic is also provided and nominals are specified for definiteness, number and thematic role. Once the concept is activated, its lemma is also activated. A lemma is the abstract representation of a word (Kempen and Huijbers 1983). The lemma corresponds to a syntactic head and the accompanying tree structure is accessed. It is the thematic role of an activated nominal concept that determines which possible tree structure is selected. The outcome of accessing the verb is the activation of the syntactic structure for the whole clause. Any already constructed argument will be inserted at the earliest possible point. Overall sentence structure is driven by the arguments and structures licensed by the verb or main predicate and the choice of phrase structure is determined by thematic information and featural information which is available beforehand when the conceptual message is translated into a propositional representation.

Ferreira outlines some features of TAG theory which have implications for language production. Elementary trees are retrieved in one chunk and all dependency relations are specified within this syntactic chunk. The relationship between a wh-phrase and its thematic position is already specified within one structure. There is no need for interim positions for phenomena such as wh-structures, as structures can be inserted directly. Finally, Ferreira also suggests that the operations may differ in processing difficulty when they are being performed, which may account for why some structures are more difficult to process than others.

A fundamental aspect of this account is that the processor works on possible alternate structures in parallel. This may also extend to an overall processing strategy where processing occurs at different levels of language processing simultaneously instead of waiting for a completed final structure to be built at one level before initiating processing at the next level. For example, a phonological representation may start being built for one part of an utterance while other parts of the syntactic structure are still being filled. As trees are retrieved as chunks specifying roles and grammatical requirements, there is less processing work required than if a structure were built anew piece by piece every time during production. Because some grammatical information is already specified with the lexical head, this reduces the number of decisions required when building a syntactic structure.

As verbs are commonly the lexical head of a tree, this means that they play a particularly important role in syntactic processing, licensing structures and providing grammatical information. In fact, an initial noun phrase cannot be assigned until the verb for the structure is known. This is a bold claim and could cause compatibility problems with incremental views of language production. Ferreira presumes that an initial phrase is not produced unless it is combined into an auxiliary tree. It is unclear why this must be the case unless procedures that combine trees must be completed before articulation.

A model where structures are accessed as part of the verb has implications for processing behaviour during language production. If syntactic structure is specified by the verb, one would expect a strong if not exclusive influence from the verb on the production of syntactic structures. Abstract syntactic structures should play a significant role in language processing behaviours (such as syntactic priming), whereas syntactic structures should play a far smaller role in a piecemeal model of language processing. However, the TAG model places strict limitations on the role of abstract syntactic structures in language processing by harnessing them to verbs.

In view of overall planning in production, the elementary tree is necessarily the basic unit in planning production. For example, the lexical head *give* licenses the prepositional object and double object ditransitive structures for a possible elementary tree. Structures are built in parallel and some may be in competition as all structures, licensed by a head or lemma, are activated at the same time. Structures are then combined to create full utterances. This creates an incremental and lexically driven model of language production where choice of verb has a strong influence on choice of structure.

3.2 Incremental Procedural Grammars

A fundamental assumption of Incremental Procedural Grammar (IPG), developed by Kempen and Hoenkamp (1987), is that language production involves different stages of language processing occurring in parallel. If production were serial there would be inefficient use of resources as the processor would experience periods of idling and then periods of intense activity, because each level of processing would be required to wait for information from a previous process in the system. Focusing on syntactic processing, Kempen and Hoenkamp (1987) proposed that syntactic structures are built incrementally and that these fragments are then connected together to form a final utterance. Additionally, they assumed that syntactic knowledge is not stored but that this knowledge is contained within a set of syntactic procedures. For instance, Noun Phrases are built by calling on a NP procedure, whose function is to build Noun Phrases, and Subjects are assigned by another procedure. A procedure may call upon other procedures as subprocedures. These syntactic procedures draw upon conceptual and semantic information in a Lexico-Syntactic phase and then the processor enters a Morpho-Phonological stage. It is assumed that the order of conceptual fragments does not necessarily correspond with the order of syntactic fragments which are built separately and then placed into a final order. This would indicate that building syntactic trees and assigning word order are to some extent separate processes.

The Incremental Parallel Formulator (IPF) developed by De Smedt (1990) builds upon the basic ideas of the IPG, but makes significantly different assumptions. These include building structures upwards from the syntactic processing level as well as downwards from the conceptual level, and assuming that linear order can be specified before function assignment. De Smedt proposed a model where semantic information feeds into syntactic processing, but where structural requirements at the syntactic level inform further processing at the conceptual and syntactic levels.

The model assumes two main components of language generation: a conceptualiser which creates the semantic context of the message, and a formulator which builds the syntactic structures. De Smedt focused on the formulation stage and the constraints under which the syntactic formulator operates and proposed certain fundamental properties of the formulator (Kempen and Hoenkamp 1987). Syntactic structures can be built both downwards from the conceptual information and upwards from syntactic or morpho-phonological information as conceptual information may not necessarily be provided in an order corresponding to articulation output. Individual branches can be attached to already existing syntactic structures as conceptual fragments may not correspond exactly to syntactic fragments. Furthermore, as production of conceptual fragments is not linear, the formulator should be flexible as to how it forms a structure within the permitted structures of the language.

The structures created by the formulator are segments representing one immediate dominance relation. The segments consist of a root, a foot and an arc. The root contains syntactic/semantic information, the foot contains morphological information, and the arc represents the grammatical function. The root unifies with the foot through a process called 'concatenation' and two roots may unify together to build a larger structure in a process called 'furcation'. The syntactic formulator receives semantic information from the conceptual level about thematic roles, events, and feature information such as definiteness and number. The formulator then builds F-structures which contain the syntactic relations between the segments or constituents. Semantic information is encoded as syntactic relations, features, and subcategorised lexical elements.

For the IPF, generation is driven by conceptual and lexical information, so an important aspect of formulation is the subcategorisation preferences specified at the lexical item itself. For example, verbs specify preferences for the structures they permit. It is also possible for subcategorisation preferences to project upwards towards incoming content if the subcategorisation information has been processed earlier, depending on the order that the conceptual information has entered the formulator.

Lexical entries are themselves complex structures. The root of the lexical segment or lemma contains semantic content and subcategorisation frames specifying syntactic information and preferences. Morpho-phonological information is accessed at the foot. The foot is a word form and the arc which specifies the grammatical relation is the head. Thus, a noun structure consists of a foot which is the word itself and then an arc specifying the syntactic category noun which acts as the head. Likewise, a verb structure consists of a foot which is the word itself and an arc specifying for the syntactic category 'verb' which acts as the head.

As syntactic information and preferences are provided by the conceptual and lexical components, the grammar is therefore a part of the lexicon and not distinct from it. De Smedt also proposed a phrasal lexicon where multi-word structures can be stored as part of the lexicon allowing idioms or other frequently used syntactic fragments to be stored for retrieval. It is assumed that the lexical entries are accessed

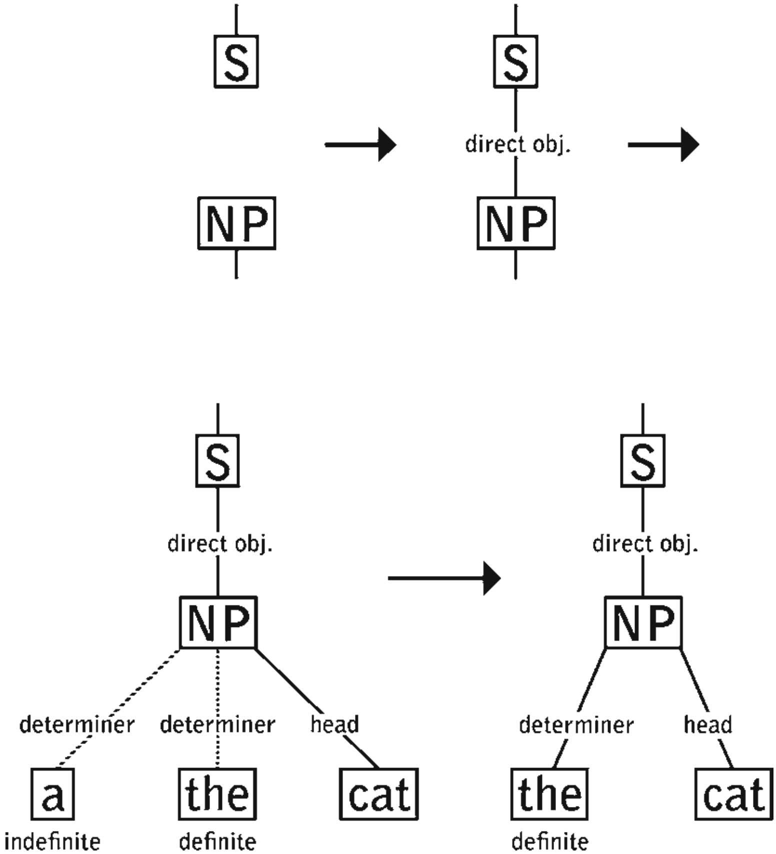

Fig. 3 Forming an NP segment in IPF

in parallel and thus the IPF selects from competing parallel processes. Thus, incoming structures may be rejected if they are incompatible with already selected subcategorisation preferences. For example, passivisation structures are treated as structures stored within the lexicon.

Syntactic roles are assigned using a case frame which attaches to the roots of the lexical segments. In order to create semantic and case relations between the lexical segments, the formulator looks for the semantic information at the case frame and then locates the syntactic relations associated with the semantic role. For example, the formulator may create a segment consisting of the corresponding semantic and syntactic roles subject and NP (see Fig. 3). First the segment is assigned the role of direct object. Having selected the noun *cat,* the possible candidates '*a'* and '*the'* are considered for the determiner role. In the figure, the broken line indicates that these candidates have been activated but that the final selection and association have not yet been made. Finally, we see the completed NP segment.

Features are assigned to nodes before lexicalisation occurs, as they pose constraints on selection. Features guide the functorisation process where function words and inflection are added to an utterance. Features which initiate inflectional change may be shared and those which initiate function words may require the addition of segments which are called functor segments.

While F-structures create the relations and dominance structure of the utterance, the actual word order for articulation is built in the C-structure. This process occurs after all segments have been incorporated and their values validated, and after functorisation has occurred. The procedure works from the bottom upwards, assigning the feet to a destination slot in the C-structure. This position is determined by the root in the F-structure which contains the dominance and relational information.

As information and constituents become available at differing times, once a node has been lexicalised it can be assigned to a holder. The holder consists of a series of numbered positions or slots that the segments are assigned to. The foot node has the feature positions which detail all the possible positions the foot can occupy as its destination. This allows for language-specific constraints on word order. The final slots in the holder may be used as a place to store constituents which cannot yet be assigned, something which for instance may occur during production of relative clauses. As relative clauses can be embedded within a main clause, a situation may arise where the processor has built the main-clause elements but needs to finish building the relative clause structure before allocating the remaining main-clause elements.

Finally, topic and focus are not assigned specific features in the representation, but are instead reflected in the order in which the conceptualiser produces segments. It is assumed that something which is recently activated or is an important piece of information should be highly accessible and thus more likely to be passed onto the formulator earlier. This therefore increases the likelihood that it will claim a prominent position in the syntactic structure. This would link well with the phenomenon of fronting prominent items found in some languages. Furthermore, during parallel processing, it may be possible to allocate resources to differing degrees among the processes. A highly salient or important item may have more resources allocated to its processing. Discourse-relevant information and context can be reflected in syntactic processing even though the procedures themselves do not process non-syntactic information.

3.3 Construction Grammar

While TAG and IPG place considerable focus on the processes involved when building a syntactic structure, Construction grammar as proposed by Goldberg (1995, 2006) focuses on the role of syntactic structures themselves in language processing as a whole. In this way, Construction Grammar represents an attempt to reconcile current thinking in theoretical linguistics with contemporary psycholinguistic research. Goldberg draws upon psycholinguistic data on syntactic processing as well as first language acquisition data in the developmental field (e.g. Tomasello 2003).

Construction grammar is based upon the principle of pairing form with meaning; these pairings are referred to as constructions. Constructions occur on a scale from the level of individual words, referred to as morphemes, to set idioms, e.g. ‘to kick the bucket’. This idiomaticity continuum (Goldberg 2002) includes many different types of phrases varying in degrees of size, complexity, and predetermined specified elements. A determiner phrase represents a smaller, partially specified construction in which elements (i.e., specific words) can be substituted in as appropriate.

Constructions are considered separate entities with unique intrinsic semantic meanings which cannot always be derived from the separate entities within the utterance. This is especially relevant for English where there is very little inflection and overt case marking, and changes in word order can result in very different meanings. In one example, Bencini and Goldberg (2000) classify ditransitive double object utterances such as *The nun is giving the monk the jug* as associated with transfer. In this case, the syntactic form ‘Subject Verb Object1 Object2’ is linked to the structural mean ‘X causes Y to receive Z’. The verb and the nouns in this utterance may all be varied but as long as the actual words or morphemes used allow a literal or figuratively relevant interpretation, this structure carries a cause-receive meaning of transfer.

Instead of proposing an underlying hierarchy of syntactic dominance which is then manipulated to achieve non canonical word orders, construction grammar proposes that what would traditionally be considered non-canonical structures exist as independent constructions with the same status as canonical constructions. These constructions specify particular syntactic properties and meanings. For example, the passive voice can be represented by the construction ‘Subj aux VPpp (PP*by*)’, as in *The boy was kissed by the girl*, (Goldberg 2006). At the other end of the spectrum, entire phrases can be stored in the lexicon with specific meanings.

In terms of production, this means that as well as accessing a specific verb for an utterance, it is assumed that the speaker also accesses a construction that is semantically congruent for the message being expressed. Syntactic structures are a part of the lexicon, so therefore grammatical knowledge is treated as part of the lexicon, and there is no distinction between abstract grammar and lexical knowledge. During processing, meaning and preferences stored with the verb (e.g. verb subcategorisation), are important, but are not the only means of selecting the final structures in which a verb appears. There is interplay between verb preferences and constructions that can express the relevant meaning. This can be seen in the novel use of verbs in structures which are not typically licensed by the verb in common usage.

For example, the verb *sneeze* is considered an intransitive verb but in *He sneezed his tooth right across the town* (Munsch 2002), the verb is used with multiple arguments. This usage fits, however, into a ‘caused motion’ construction such as *The footballer kicked the ball into the net*. An action (sneezing) causes an object (a tooth) to be transferred to a new location (across the town). The interlocutor is able to understand this utterance by recognising and accessing the appropriate construction and understanding the novel verb use within this context.

Information about preferred structures and typical language use is stored with the verb in the lexicon. By storing constructions that have their own meanings, the language user is able to create and comprehend novel utterances as the need arises. This allows for a certain degree of innovation and productivity in the language. Novel utterances can be understood by analogy to already existing structures and context. By storing grammatical information in the lexicon and allowing retrieval of both verb-subcategorisation preferences and larger constructions as distinct entities, construction grammar has implications for language processing.

A possible construction grammar account of language production may involve the following processes. A message is formulated at the conceptual level; for example, the speaker might wants to describe the act of a nun giving a jug to a monk. These concepts activate lemmas, and possible constructions at the lexical level will be activated, such as 'nun', 'jug', 'monk' and 'give'. Constructions representing the meaning in terms of thematic structure will also be activated, for example both 'cause X to receive Y' or 'provide with' may both be activated. Subcategorisation preferences at the verb may only license one of these structures or strongly select for one structure more than the other. Other factors may influence this decision such as the availability of completed component structures; this may reflect activation levels.

Chang et al. (2006) discussed a possible model for mapping form to meaning using a connectionist model of language processing. In the model, the processor builds all these constructions in parallel: phrase-based meaning constructions are accessed at the same time that the processor is building less complex constructions such as determiner phrases (e.g. *the nun*). Depending on the degree to which the desired phrase construction is lexicalized (i.e. idiomatic), the less complex constructions are integrated into the larger construction. In the case of an idiomatic expression, the entire phrase may be stored as a single lexical item, such as *pushing up daisies*. This process of integrating smaller structures into larger phrases with meaning also allows novel constructions to be built and understood in a systematic fashion.

Construction grammar predicts a definite lexical influence on processing. Verbs are assumed to demonstrate argument preferences, although not inflexibly so, and verbs which are similar in meaning can be expected to follow similar syntactic patterns. Also, a verb which is used in a novel context may adopt the syntactic structure typical of verbs used with that meaning. However, as syntactic structures themselves are stored in the lexicon, there could also be an element of syntactic processing which is not necessarily dependent on the preferences of individual lexical items. Constructions vary in size from words to phrases to entire sentences, so the processor may also draw upon grammatical knowledge of complex sentence structures during processing.

3.4 Discussion of Grammatical Theories

Although Tree-Adjoining Grammar (TAG), the Incremental Parallel Grammar and Formulator (IPG/IPF) and Construction Grammar emphasise different aspects of grammar and processing, they share many features and fundamental principles.

This leads to some shared predictions about language production. They all assume parallel processing and that the production system is able to process, and actively engages in processing, multiple structures and different levels of processing (i.e. conceptual, lexical/syntactic and morpho-phonological levels). Furthermore, the processor builds multiple, competing structures in parallel; the first available structure which does not violate the constraints of the target language is the structure which will be produced and articulated in full.

In all the models, the processor builds structures which vary in size. The processor may build smaller structures such as a determiner phrase which consists of a noun and an article only (e.g. *the jug*), or a structure for a much larger unit, such as a ditransitive structure (e.g. *The nun is giving the jug to a monk*). Smaller structures are then integrated into larger structures to form longer utterances and complete sentences. This strategy is extremely efficient in a processor which works on structures in parallel. Having smaller constructions and larger constructions activated in parallel allows the processor to be more flexible in the production of utterances while operating within the constraints of a specified language.

Another assumption underlying this style of processing is that the processor works in an incremental fashion, working on structures as soon as the information becomes available, whether this is conceptual information or phrase structure level information. Thus, processing order may not reflect the final order in articulation. The processor will attempt to build whichever structures it can and will try to integrate these into a larger structure as soon as it can.

All three approaches posit that syntactic/grammatical information does not exist separately but as part of the information stored in the lexicon and is reflected in the processing that builds syntactic structures. Incremental Procedural Grammar suggests that grammatical rules exist as procedures which are called, but the Incremental Parallel Formulator presents a more detailed approach where information is provided from the conceptual specifications at the root and from information provided at the lemma. More abstract syntactic information such as phrase structure is attributed to information accessed at the lemma. In particular, individual verbs will specify the structures which they license and degrees of preference for different structures.

Verb-subcategorisation is a core element for the production of phrases according to all the models mentioned. The ability to store larger structures in the lexicon is a shared property in all three types of grammar mentioned, although the extent to which this occurs varies among the models. For example, in the Incremental Parallel Formulator, Ferreira's Tree-Adjoining Grammar, and Construction Grammar, it is suggested that the passive voice is a specifically selected structure stored at the lexicon and chosen using meaning information provided at the conceptual level.

The grammars all advocate the existence of larger structures bridging the conceptual and lexical-syntactic processes, which represent the thematic roles and meaning structures specified by the conceptual message. Tree-Adjoining Grammar calls upon a propositional representation, the Incremental Parallel Formulator includes a case frame specifying roles, and the idea of meaning structures is integral to the Construction Grammar account of language production. All these structures specify thematic relations but not any syntactic structural information. Finally, a parallel approach to processing and building structures opens up the possibility that semantic and lexical processing may be ongoing during syntactic processing and may interact with this process.

As highlighted above, Tree-Adjoining Grammar, the Incremental Procedural Formulator and Construction Grammar are closely related in their approach to language production and share many fundamental assumptions and principles of processing. However, they still vary in how they choose to incorporate and implement these ideas as processing strategies. Tree-Adjoining Grammar presents the basic levels of structures as trees which reflect dependencies and hierarchies. Ferreira (2000) also specifies that verb-subcategorisation is crucial to the building of a structure. IPF presents a very technical computational account of how syntactic structures are built and integrated with morpho-phonological information using rules and procedures. Structural information is found at the lemma level and particularly at verbs. A frame designating case is proposed but it is unclear how this fits into the overall picture of syntactic processing. The main emphasis of Construction Grammar lies with the pairing of form and meaning. Construction Grammar proposes a whole vocabulary of meaning structures stored in the lexicon which are then realised as actual syntactic structures. These three grammars make similar predictions but using distinctly different mechanisms. In order to try to distinguish between these mechanisms closer examination of the interaction between lexical and structural influences on syntactic processing is needed. In the following section, a series of studies look at lexical and structural influences on choice of phrase structure.

4 Huxley (2009): Lexical Preference vs. Global Syntactic Preference

Recent evidence suggests that the overall global complexity of a sentence affects the selection of individual structures at the local level. Using a sentence recall task, Huxley (2009) found that speakers produced different local syntactic structures (grammatical voice) depending on whether they were producing simple matrix clauses or complex utterances with relative clauses. In English, passive structures occur less frequently than actives (Svartvik 1966) and evidence shows that people make more errors in comprehension of passive voice in comparison to equivalent sentences in the canonical active voice (Ferreira 2003). For example, V.S. Ferreira found that participants were more likely to incorrectly identify *the man* as the agent of the action in a passive sentence like *The man was visited by the woman* than in an active sentence like *The woman visited the man.* People also show difficulty processing object relative clauses, in which the head of the relative clause functions as the direct object of the embedded verb, compared to subject relative clauses, in which the head functions as the subject of the embedded verb. For example, participants took longer to read sentences like *The athlete whom coaches advised ate health foods*, where *athlete* is the direct object of *advised* compared to sentences involving subject relative clauses such as *The athlete who advised coaches ate health foods*, where *athlete* is the subject of *advised* (Wanner and Maratsos 1978).

However, Gennari and MacDonald (2008) showed that animacy interacts with preferences for grammatical voice structure in the processing of object relatives. Reading times were longer for active object relatives when the head noun was animate (e.g., *The musician that the accident terrified was in the headlines the next day*) than when the head noun was inanimate (e.g. *The accident that the musician caused was in the headlines the next day*); active object relatives were more difficult than passive subject relatives (e.g., *The musician that was terrified by the accident was in the headlines the next day*), irrespective of animacy.

Speakers can choose to avoid producing an object relative clause such as *whom the girl kissed*. If the speaker chooses to use the passive voice, then they can produce a passive subject relative clause like *who was kissed by the girl*. In this way, the speaker can choose to produce a subject relative clause, which is easier to produce than an object relative clause. However, in doing this, the speaker is selecting the passive grammatical voice, which causes more processing difficulties than the active voice. Whether the speaker produces an active object relative clause or a passive subject relative clause depends on whether preference for grammatical voice or preference for ease of structural processing is stronger.

Huxley (2009) used a recall task to examine production of subject and object relative sentences which occurred in either active or passive voice as well as simple matrix clauses. In her experiment, participants heard sentences such as (1a–d).

(1)	a. The boy who was kissed by the girl was embarrassed.	(relative, passive)
	b. The boy who the girl kissed was embarrassed.	(relative, active)
	c. The boy was kissed by the girl.	(matrix, passive)
	d. The girl kissed the boy.	(matrix, active)

Participants heard six sentences in a block, and then orally recalled them in response to prompts (the initial adverbial phrases, e.g. *Before the lesson*) that were presented in a different order. Previous research shows that messages are regenerated anew from the conceptual level during recall (Potter and Lombardi 1990). That is, when participants recall sentences, they do so by recalling the conceptual message and then initiating the normal processes of language production. For example, they must retrieve appropriate lexical items and then arrange them in an appropriate syntactic structure to convey the desired meaning. For this reason, the sentence recall paradigm provides a means for specifying the content of an utterance but still allowing choice of syntactic structure in production.

Huxley (2009) was concerned with whether choice of syntactic structure is affected by processing preferences associated with a larger syntactic structure, or whether choice of structure is dictated by lexical preferences at the verb. She predicted that if structural choice is driven entirely by preferences associated with the verb, then a structure should occur in the same grammatical voice regardless of its location in a larger, complex structure but in accordance with the preference of the verb used. If global syntactic constraints affect choice of syntactic structure, then the grammatical voice should depend on where the structure occurs in regards to a larger syntactic structure. If both lexical and syntactic factors influence choice of structure, there would be an interaction between the two factors: choice of structure

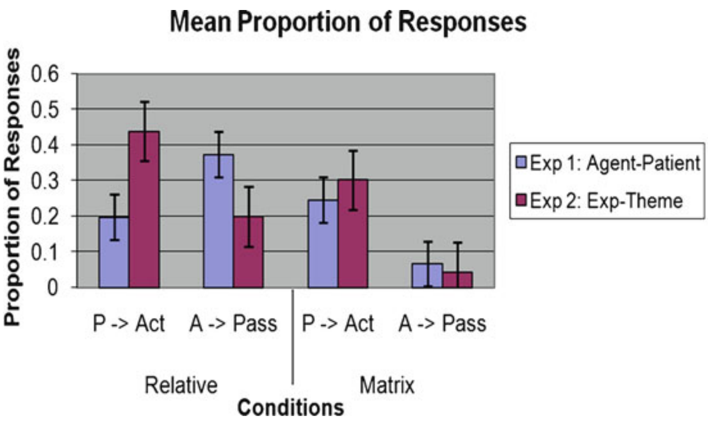

Fig. 4 Proportion of inverted responses for Experiment 1 (agent-patient verbs) and Experiment 2 (experiencer-theme verbs)

may vary according to its position in a larger structure but may also according to preferences specified by the verb.

Experiment 1 showed that choice of syntactic structure in recall varied according to global syntactic complexity (see Fig. 4 for results from Experiments 1 and 2). For relative clauses, speakers recalled significantly more active structures as passive (e.g., recalling *The boy who the girl kissed* as *The boy who was kissed by the girl)* than passive structures as actives (e.g., recalling *The boy who was kissed by the girl* as *The boy who the girl kissed*; 37% vs. 20%). For matrix clauses, speakers recalled significantly more passive structures as active (25%) than they recalled active structures as passive (7%). Speakers tended to choose the dispreferred passive voice structure and produce the preferred global structure subject relative clause rather than an active object relative clause. Choice of structure is clearly influenced by complexity of the global syntactic structure.

In Experiment 2, Huxley found that strong verb-subcategorisation preferences can counter selection preferences shown by a complex utterance. Using the same recall task, Huxley replaced the agent-patient transitive verbs used previously with experiencer-theme verbs, which have a strong preference for the active voice (Cupples 2002). In a short norming study, Huxley presented a verb onscreen and asked participants to produce transitive sentences with two characters interacting. The study used theme-experiencer verbs with a relative preference for the passive, active preferring experiencer-theme verbs and agent-patient verbs which usually occur in the active voice. Speakers produced actives to the same degree for both experiencer-theme verbs (99%) and agent-patient verbs (97%) but produced a significantly reduced number of active voice utterances for theme-experiencer verbs (80%). This confirms the finding by Ferreira (1994) that theme-experiencer verbs show a preference for the passive voice as the experiencer is the entity actively experiencing the emotion, e.g. *worry*. As expected the experiencer-theme verbs show the reverse, a preference for active voice as the experiencer is already the subject of the utterance, e.g. *adore*. When Huxley used the active preferring experiencer-theme verbs in the recall task, speakers showed a significantly greater tendency to recall passives as active voice structures overall. In relative clauses, speakers were more likely to recall passive voice utterances as active (44%) than to recall active voice as passive (20%). When recalling matrix clauses, speakers again recalled more passives as actives (30%) than they recalled actives as passives (4%). The verb-subcategorisation preference for active voice changed the choice of syntactic voice structures from the previous preference shown for passive voice structures when recalling relative clauses. Choice of syntactic structure involves an interaction between lexical preferences and the structural preferences exhibited in the overall global syntactic structure.

A comparison of the two experiments showed that fewer passives were produced in recall with experiencer-theme verbs (23%) than agent-patient transitive verbs (34%). Verb-subcategorisation preferences affected choice of syntactic voice. However, the global complexity of an utterance also appeared to have a large influence on whether to choose a passive structure. More actives were recalled as passives in relative clauses (28%) than in matrix clauses (6%) over the two experiments. Focusing on relative clauses, more active structures were recalled as passives in Experiment 1 using common agent-patient verbs (37%) than in Experiment 2 using active preferring experiencer-theme verbs (19%). Similarly, significantly more passive structures were recalled as actives in relative clauses with experiencer-theme verbs (43%) than with agent-patient verbs (20%). There was relatively little change in syntactic structure preferences for matrix clauses depending on the type of verb used. This is shown in recall of actives as passives (7% vs. 5%) and recall of passives as actives (25% vs. 30%) for agent-passive verbs and experiencer-theme verbs respectively. Verb-subcategorisation preferences clearly influence choice of syntactic structure. However, there is also a clear influence of global syntactic structure which affects choice of local syntactic structures and interacts with lexical preferences.

5 Discussion

In this chapter, we have discussed whether lexical or structural factors influence choice of syntactic structure. We have considered different grammars which offer accounts of how syntactic structure is built, examined psycholinguistic evidence for lexical and structural influences on structure choice, and discussed a study which compared lexical and global syntactic influences on choice of syntactic structure.

The grammars that we discussed are fully compatible with both lexical and structural influences on choice of syntactic structure. While the grammars differ in detail, they share certain fundamental underlying assumptions. It is assumed that during language production, the language processor uses parallel processing to build several possible structures at approximately the same time. This parallel processing can occur at different levels of processing, such as those concerned with message formulation and syntactic encoding. The processor builds structures incrementally and the final structure is selected through competition, so that whichever structure is completed first is selected. Smaller structures are built and then integrated into larger structures. Finally, it is assumed that grammatical information is stored in the lexicon.

This proposed framework for language production is highly compatible with the findings that lexical and structural factors influence language processing. If the processor can work in parallel on structures at various levels of processing, it is possible for factors at any of these levels to increase or inhibit activation of individual words or structures within that processing level which will affect how quickly that structure is built at the syntactic level. In this way, information which is not purely syntactic can have consequences for syntactic processing.

But even at the level of syntactic encoding, there are still immediate effects of lexical information upon processing. Lexical items, such as verbs, can have strong preferences for specific syntactic structures and this information is stored with them in the lexicon. Thus, when a verb is accessed, its syntactic preferences are also accessed. We propose that syntactic structures themselves are stored in the lexicon, independently of any specific lexical entry. Therefore, syntactic structures may be accessed as one would access a lexical item. Like lexical items, syntactic structures can receive activation and inhibition in a way that affects their current selection or subsequent use. Because both forms of information exist in the lexicon (lexical and syntactic) and because structures are built in parallel and selected through competition, it is possible that, when lexical and structural preferences favour different structures, these two structures compete.

Psycholinguistic evidence for lexical and structural influences on choice of syntactic structure in production shows that both factors play a role in this. A range of studies show that there is a clear lexical influence on the choice of syntactic structure. Verb-subcategorisation effects, where individual verbs influence choice of structure, have been found in production and comprehension studies in various languages: Verb-subcategorisation demonstrates specific preferences as to which structures it permits or prefers (e.g., Ferreira 1994), and individual verbs vary in their degree of preference for particular structures (e.g., Gries 2005). Finally, repetition of a verb can increase the tendency to repeat a syntactic structure, in comparison to when the verb is not repeated between the two structures (Pickering and Branigan 1998).

We have noted that there is also strong evidence that choice of syntactic structure can be affected by structural information that exists independently of lexical items. This has been established through the use of syntactic priming (see Pickering and Ferreira 2008). Syntactic priming occurs for a variety of structures and in various languages. Priming can also occur between different languages (e.g. Spanish to English in Hartsuiker et al. 2004). It has been shown that syntactic priming is not simply an artefact of short term memory, but may even be a long term learning strategy (see Bock and Griffin 2000). It occurs in dialogue in both natural and experimental environments. Priming occurs for individual structures at the level of word order and not just for shared syntactic dominance hierarchies. However, evidence is mixed as to whether structural priming applies to the extent of global syntactic structures (Branigan et al. 2006; Scheepers 2003).

Finally, Huxley (2009) directly compared lexical and global syntactic influences on choice of a local syntactic structure using a sentence recall paradigm, and found both lexical and syntactic influences on structure choice, and an interaction between the two. In an experiment manipulating grammatical voice and global syntactic structure, speakers recalled more utterances using passive voice than active voice, when using active voice meant producing a relative clause structure that was hard to process. A second experiment used verbs with a strong preference for the active voice, and speakers no longer produced passives to avoid the awkward relative clause structure, but tended to produce active voice relative clauses in accordance with the verb preference. Choice of structure in a relative clause varied according to syntactic constraints and lexical preferences suggesting that the two structure preferences could be in competition.

6 Conclusion

In conclusion, psycholinguistic evidence shows that both lexical and syntactic constraints affect choice of syntactic structure. This finding is compatible with existing lexical based grammars. Models of language processing need to address the issue of how to incorporate information from both lexical and structural considerations if they are to accurately reflect how language is processed and used. Lexical grammars suggest that some syntactic structures may be stored in the lexicon, but it is not clear precisely what is stored. Another question is the extent to which lexical structure preferences and other structure preferences compete. Finally, we do not know which kinds of information affect this process or how they might do it. Psycholinguistic research has tended to focus on smaller local structures, with less research investigating how clauses and phrases are integrated into larger structures with complex syntactic dominance hierarchies. One possible strategy arising from the grammars already discussed is the idea that syntactic structures of any size may be stored in the lexicon, which would predict that it should be possible to prime global as well as local syntactic relations. Scheepers (2003) suggests another possible strategy, where the order in which syntactic rules or structures are processed may be retained, and may be recalled during subsequent production. The evidence that global syntactic structure plays a role in structure choice in addition to lexical and local structural preferences provides great opportunities for further research on use of syntactic information on both a local and a global scale during language production.

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