Conceptual Accessibility and Serial Order in Greek Speech Production

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Abstract

Current theories of language production disagree about the way in which conceptual accessibility influences syntactic processing (e.g. Bock, 1987; De Smedt, 1990). We present theoretical arguments that the assumption of highly incremental processing can only be reconciled with theories in which conceptual accessibility influences word order. We report a sentence recall experiment in Modern Greek that provides empirical support for this position. Our results demonstrate that Greek speakers prefer to place conceptually accessible entities in early word order positions, irrespective of grammatical function, contrary to previous findings for English (Bock & Warren, 1985; McDonald, Bock & Kelly, 1993). We interpret our results as evidence for highly incremental processing.

Introduction

Speakers are faced with the task of producing fluent, well-formed speech under time constraints. Many researchers have suggested that speakers achieve this by processing different aspects of the utterance incrementally and in parallel (e.g., De Smedt, 1990; Ferreira, 1996; Kempen & Hoenkamp, 1987; Levelt, 1989). In this way speakers can start generating an utterance as soon as a minimal amount of input is available, rather than having to wait until all elements of the utterance have been retrieved; and can begin to articulate an utterance before all aspects of its structure have been processed. If the human production system were not incremental, conversation would consist of bursts of speech punctuated by silences as the speaker planned the next utterance. This emphasis on processing partial information represents an important point of contact between language production and other aspects of human cognition (e.g. Marslen-Wilson, 1973).

Incremental accounts of language production predict an important role for information accessibility: Readily accessible information will undergo processing more quickly than less readily accessible information. Thus variations in information accessibility are hypothesized to play an important part in determining the characteristics of the utterance that is ultimately produced (Bock, 1982; De Smedt, 1990; Levelt, 1989). This paper examines that hypothesis with reference to syntactic structure. We begin by examining evidence that the conceptual features of a message influence its eventual syntactic realization. We then assess critically how current models of production account for such effects. We will argue that models in which conceptual accessibility is primarily associated with the assignment of grammatical functions are incompatible with the assumption of highly incremental processing. Instead we argue for models in which conceptual accessibility has a direct influence on word order. In the remainder of the paper, we report an experimental investigation of Modern Greek that provides empirical support for a link between word order and conceptual accessibility, contrary to previous findings for English (Bock & Warren, 1985; McDonald, Bock & Kelly, 1993). We interpret our results as support for highly incremental models of language production.

Determinants of Syntactic Processing in Production

It is generally accepted that language production begins with the speaker deciding to express a meaning. This prelinguistic message triggers the retrieval of appropriate lexical concepts and their associated lemmas (the syntactic component of lexical entries; Levelt, Meyer & Roelofs, in press; see also Kempen & Huijbers, 1983). Syntactic structure is then generated from the syntactic information contained within the lemmas (Kempen & Hoenkamp, 1987). Under these assumptions, syntactic processing should be affected by two factors: the relative accessibility of the lemmas themselves; and the relative accessibility of the syntactic information contained within them. Evidence from syntactic priming effects in production (Bock, 1986; Bock & Loebell, 1990; Hartsuiker & Kolk, 1998; Pickering & Branigan, 1998) supports the second hypothesis; what evidence is there to support the first?

In fact, there is considerable evidence that syntactic processing is influenced by conceptual features that are plausibly associated with lemma accessibility. For example, many researchers have found a tendency for speakers of English to produce passive sentences when the patient of an action is animate and/or human (Cooper & Ross, 1975; Ferreira, 1994; McDonald et al, 1993; Sridhar, 1988). Bock and Warren (1985) (see also Bock, 1987) proposed an explicit link between variations in syntactic structure and variations in what they termed conceptual accessibility, or 'the ease with which the mental representation of some potential referent can be activated in or retrieved from memory' (p.50). We interpret this as the accessibility

of a lexical concept and its associated lemma. Bock and Warren suggested that some entities are conceptually more accessible than others because they take part in more conceptual relations, and hence can be retrieved through more routes. For example, entities that are animate, concrete or prototypical are more predicable than items that are inanimate, abstract or non-prototypical (Keil, 1979).

How are variations in conceptual accessibility realized as variations in syntactic structure? We can identify two possibilities. First, conceptually accessible items might be associated with higher grammatical functions, such that easily retrieved items tend to become subjects. In that case, the preference for passive structures with animate patients would reflect an association between animacy and subjecthood. Alternatively, conceptually accessible items might be associated with early word order positions, such that easily retrieved items tend to precede less easily retrieved items. In that case, the preference for passive structures with animate patients would reflect an association between animacy and first position in the sentence.

Conceptual Accessibility and Grammatical Function Assignment

Bock (1987; see also Bock & Warren, 1985) argued for the first of these alternatives. She proposed that conceptual accessibility influences an initial stage of syntactic processing. During this stage, grammatical functions are assigned following Keenan and Comrie's (1977) NP accessibility hierarchy. The subject function is assigned first, then the direct object function, and so on. Because the lemmas associated with conceptually accessible items are retrieved more quickly, they tend to claim higher grammatical functions. Thus conceptually accessible items prefer to appear as subjects. However, conceptual accessibility does not directly influence word order. Instead, word order is determined at a subsequent stage of processing, and is influenced by the accessibility of the relevant wordforms (morpho-phonological content of a lexical entry). Bock suggested that any apparent link between conceptual accessibility and word order arises from the fact that - in English at least - higher grammatical functions tend to precede lower grammatical functions. For example, the subject of an English sentence appears at the beginning of the sentence, preceding the direct object. This means that grammatical function effects can easily be misinterpreted as word order effects. Bock argued that when the effects of grammatical function are excluded, there is no independent preference to place conceptually accessible items in early word order positions. We will term Bock's (1987) model the grammatical function model.

Two sentence recall studies provided empirical support for the grammatical function model. In this task, participants are presented with sentences that they subsequently attempt to recall. Many studies have shown that the form in which participants recall the original sentences reflects the normal biases of production (see Bock & Irwin, 1980). By manipulating the features of the sentences that are presented, and examining how this affects participants' recall of the sentences, it is possible to draw inferences about the nature of the production system. In both of the relevant studies, the experimental manipulation was to present sentences containing pairs of nouns that varied in conceptual accessibility. Bock and Warren (1985) employed concreteness as an index of conceptual accessibility, whilst McDonald et al (1993) employed animacy. Both studies found that participants tended to recall sentences in a form that allowed the more conceptually accessible entity to appear in a higher grammatical function than the less accessible entity. For example, participants recalled an active sentence as a passive sentence when the patient was the more accessible entity, thereby promoting the accessible entity to subject. However, in NP conjunctions, where both nouns had the same grammatical function, there was no tendency for recall in a form that allowed the more accessible entity to precede the less accessible entity. These findings appear to support the hypothesis that variations in conceptual accessibility are associated with variations in grammatical function assignment but do not influence word order.

The Grammatical Function Model: Restricted Incrementality

However, both the grammatical function model and the empirical findings on which it is based appear to sit uneasily with the assumption of highly incremental processing. First, it is unclear how the model can account for the systematic variations in word order found in many languages, in which lower grammatical functions may precede higher grammatical functions. For example, Modern Greek allows an Object-Verb-Subject (OVS) ordering. Under the grammatical function model, a phrase must receive a grammatical function before it receives a serial position, and the first function to be assigned is always the subject function. There are thus only two ways in this model to account for an object's appearance preceding the subject. First, the subject's wordform might be less accessible than that of the object; in that case, the object might 'overtake' the subject at this stage of processing. But in an extensive series of studies, McDonald et al (1993) found no evidence that wordform accessibility influences serial ordering. The alternative is to sacrifice incrementality, so that in some circumstances the processor assigns the subject function but does not then place the subject in the earliest serial position. Instead, it waits until the object function has been assigned; it then assigns the object phrase the earliest position instead. Such a position is certainly possible. But it would mean that the speaker, despite having the subject phrase ready to articulate, would have to buffer it until the object phrase subsequently became ready. Thus there is no way in the grammatical function model for speakers to promote fluency by exploiting the word order variations available in their language to produce an accessible item while they are retrieving or processing a less accessible item. Rather, the production of such non-canonical sentences would seem in the grammatical function model to inherently entail disfluency.

So far, we have argued that the actual architecture of the

grammatical function model entails restricted incrementality under some circumstances. In addition, one aspect of the empirical findings that underpin the model implies restricted incrementality. This is the failure to find serial ordering effects associated with conceptual accessibility in NP conjunctions. Recall that the absence of such effects was the crucial evidence for the model's linkage between conceptual accessibility and grammatical function. This finding poses a problem for incrementality because, in an incremental processor, the first element to complete processing at one level should be the first to undergo processing at the next stage. Hence, in an NP conjunction, the conceptually more accessible entity should undergo lemma retrieval before the less accessible entity. It should therefore also undergo and complete wordform processing first (assuming that both conjuncts are of equal wordform accessibility, which was controlled for in the experiments under discussion). Under the grammatical function model, it should therefore consistently claim the earliest serial position. The failure to find such ordering effects can only be explained by assuming restricted incrementality, in which order of access does not determine order of processing.

From this conclusion, we can draw one of two alternative implications for the grammatical function model. NP conjunctions could be 'normal' structures that are processed like any other structure. In that case, evidence about the way in which they are processed is good evidence about the normal processes of production, but we must conclude that the production system is only restrictively incremental. Alternatively, NP conjunctions might be abnormal structures that are processed quite differently from other structures. In that case, failure to find serial ordering effects in these structures does not necessarily mean that the production system is restrictively incremental under normal circumstances, merely that it is restrictively incremental when processing NP conjunctions; but then evidence from such unusual structures cannot be taken as evidence about the normal workings of the system.

Conceptual Accessibility, Serial Order and Incremental Processing

Although we are not aware that the specific problems described in the previous section have been previously identified, a number of researchers have proposed alternative models of production which avoid the restricted incrementality entailed by the grammatical function model. These models differ in details; however, they all allow conceptually more accessible entities to claim early serial positions, irrespective of grammatical function (e.g. De Smedt, 1990; Kempen & Hoenkamp, 1987; Levelt, 1989). For example, in Kempen and Hoenkamp's (1987) model, lemmas are assigned grammatical functions before they claim a serial position; but functions are not necessarily assigned according to a hierarchy, and whichever lemma receives a grammatical function first claims the earliest available position. Thus an object can claim an early serial position before the subject function has been assigned. In this model, early serial positions are thus mediated via an initial stage of grammatical function assignment. By contrast, De Smedt (1996) discussed a model in which a lemma can claim a serial position before it has been assigned a grammatical function. For example, the first lemma to be retrieved can claim the earliest serial position before the processor has committed to which grammatical function it will fulfil in the utterance. As in Kempen and Hoenkamp's model, an object can thus claim an early serial position before the subject function has been assigned. But in this model, early serial positions are directly associated with conceptual accessibility. Although these models differ in their architectural details, the important point is that they all propose that conceptual accessibility influences serial order. We therefore term them serial order models. In these models, variant word orders such as OVS promote fluency through incremental production, by allowing speakers to encode a readily accessible object while they are retrieving a less accessible subject. This contrasts sharply with the grammatical function model, where such variant word orders promote disfluency.

Conceptual Accessibility Effects on Syntactic Structure in Greek

Clearly, there are theoretical reasons for preferring the serial order models: They allow highly incremental processing, which we have argued to be greatly advantageous for speakers. In particular, they provide an account of how speakers of languages with flexible word orders might exploit variant orders as a means of promoting fluency. But there is limited empirical evidence to support the serial order models. Kelly, Bock and Keil (1985) found evidence in English for a link between prototypicality and serial order, using the same recall task as Bock and Warren (1985) and McDonald et al (1993). Sridhar (1988) found cross-linguistic evidence using a `simply describe' paradigm (cf. Osgood, 1971) of a tendency to produce word orders that allowed conceptually accessible entities (in his terms, more salient entities) to appear first. Prat-Sala (1997) employed a picture description task and found a tendency in Spanish and Catalan for conceptually accessible entities to precede less accessible entities. However, these experiments have other possible explanations (e.g. lexical confounds).

We therefore set out to examine whether there is evidence for a link between conceptual accessibility and word order when such alternative explanations can be excluded. Our experiment employed Modern Greek, a language allowing a wide range of structures that separate serial order from grammatical function. Bock and her colleagues' work relied crucially on NP conjunctions, since these are almost the only structure in English where grammatical function and serial order are separable. However, conjunctions are unusual structures (e.g. Chomsky, 1965). For example, they may be multiply-headed structures (Gazdar, Klein, Pullum & Sag, 1985). Thus it is possible that they are processed in unusual ways. In Modern Greek, by contrast, word order variations can be found for normal declarative sentences. For example, the subject of a sentence can appear preceding or following the verb, and preceding or following the direct object. Our experiment focused on the subject-verb-object (SVO) and object-verb-subject (OVS)

orders. As in Bock and colleagues' experiments, participants heard and attempted to recall sentences like those in (1) in which the animacy of the two nouns fulfilling the subject and direct object functions was systematically manipulated:

(1a) Sta dimokratika politevmata, o politis sevete to sindagma.
in democratic regimes the citizen$_{NOM}$ respects the law$_{ACC}$
'In democratic regimes, the citizen respects the law'

(1b) Sta dimokratika politevmata, to sindagma sevete o politis.
in democratic regimes the law$_{ACC}$ respects the citizen $_{NOM}$
'In democratic regimes, the citizen respects the law'

(1c) Sta dimokratika politevmata, to sindagma sevete ton politi.
in democratic regimes the law $_{NOM}$ respects the citizen$_{ACC}$
'In democratic regimes, the law respects the citizen'

(1d) Sta dimokratika politevmata, ton politi sevete to sindagma.
in democratic regimes the citizen$_{ACC}$ respects the law$_{NOM}$
'In democratic regimes, the law respects the citizen'

The logic of the experiment was simple: If conceptual accessibility affects serial order, then we would expect participants to recall sentences in a form that allowed the conceptually more accessible entity to appear first, irrespective of grammatical function. Thus sentences like (1b) should be recalled as (1a), and sentences like (1c) should be recalled as (1d).

Method

Participants and Materials Our participants were thirty-two native Greek speakers. We constructed thirty-two items like those in (1a-d), each comprising a preposed adverbial phrase and a main clause that contained a transitive verb, an animate noun and an inanimate noun. The animate and inanimate nouns were matched for frequency over the item set as a whole. (Because frequency tables are unavailable for Modern Greek, we compared frequencies for the English translation equivalents of the target nouns, using the CELEX database [Baayen, Piepenbronck & Gulliver, 1995].) For animate nouns, the mean frequency was 39.22 per million words; for inanimate nouns, it was 38.66 per million words. There was no significant difference in frequency on a paired samples T-test ($t(31) = 0.054$, $p = .95$).

Each item had four versions, each containing the same adverbial phrase, verb and noun phrases, as in (1a-d). The four versions of each item were constructed by crossing Subjecthood (animate vs. inanimate subject) with Word Order (SVO vs. OVS). Hence the animate noun appeared as the subject in two versions (1a and 1b), and as the direct object in two versions (1c and 1d); and in sentence-initial position in two versions (1a and 1d), and in sentence-final position in two versions (1b and 1c). In addition we constructed 16 filler sentences, comprising a preposed adverbial phrase and a main clause of various types.

Procedure The sentences were presented on audiotape in eight blocks, each containing four experimental sentences and two filler sentences. The order of sentences within each block was randomized; the resulting order was held constant across all four lists. A three-second pause separated each recorded sentence in each block. The number of sentences presented in each block, and the duration of the pause between each sentence, were determined on the basis of a pilot study involving eight participants who did not take part in the main study. After each block of sentences, participants were prompted for oral recall using the introductory adverbial phrases; within each prompt block, the prompts appeared in a different order from the corresponding sentences in the sentence block. A block of six practice sentences was presented before the main experiment.

Scoring Participants' responses were recorded on audiotape. This represents a minor methodological change from previous sentence recall experiments, where participants wrote their responses. We asked participants to recall sentences orally because we felt that this would be more informative about spoken language production. Participants' responses were scored as correct (same function assignment and word order as the original sentence); inversion (same function assignment as the original sentence but the alternative word order); or error (anything else). As in Bock and colleagues' experiments, we used a measure that expressed the strength of the tendency to recall a sentence in a different form to that presented, when the semantic content was correctly remembered. Thus we performed analyses of variance on proportions representing the number of inversions, i.e. sentences recalled in their alternative form ((1a) recalled as (1b) and vice versa, (1c) recalled as (1d) and vice versa), relative to the total number of corrects plus inversions in each condition for each subject and item.

Results

The mean proportion of inversions in each condition is shown in Figure 1. Analyses of variance treating both participants and items as random effects revealed a main effect of Word Order ($F_1(1,31) = 40.92$, $p < .001$; $F_2(1,31) = 96.87$, $p < .001$): Participants were more likely to recall sentences in the alternative form to that originally presented when this resulted in the preferred SVO order than when it resulted in OVS order (41% vs. 6%).

More importantly, however, this tendency interacted with Subjecthood ($F_1(1,31) = 8.75$, $p < .006$; $F_2(1,31) = 7.38$, $p < .01$). Inspection of the results showed that participants were more likely to recall SVO sentences as OVS sentences when the subject was inanimate and such an inversion would result in the animate entity appearing first, than when the subject was animate and such an inversion would result in the inanimate entity appearing first (10% vs. 2%). Equally, participants were more likely to recall OVS sentences as SVO sentences when the subject was animate and such an inversion would result in the animate entity appearing first, than when the subject was inanimate

and such an inversion would result in the inanimate entity appearing first (47% vs. 36%). Planned comparisons confirmed that there were significant effects for both SVO and OVS sentences (all $p < .001$). No other effects achieved significance.

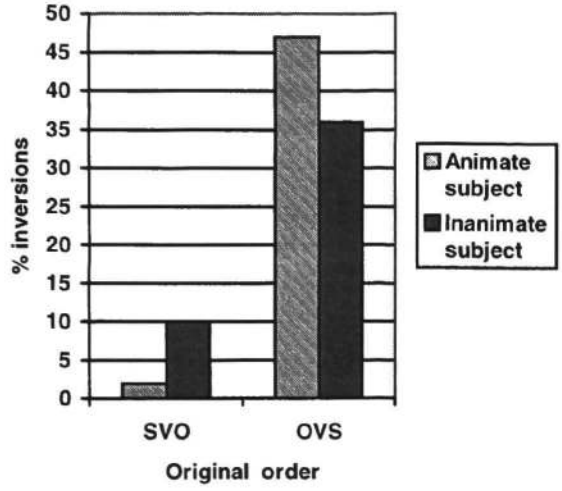

Figure 1: Percentage of sentences recalled with inverted word order, by condition.
(Columns represent original [uninverted] word order)

Discussion

These results provide strong evidence that conceptual accessibility can affect word order: Participants preferred to recall sentences in a form that allowed the conceptually more accessible entity to precede the less accessible entity, irrespective of grammatical function. This tendency was found both for the preferred SVO order and for the dispreferred OVS order. Thus animate entities tended to appear first even when they fulfilled the grammatical function of object. These results argue against the grammatical function model of conceptual influences on syntactic processing, which predicted that participants should prefer to recall animate entities as subjects but that animate entities should exhibit no independent tendency to appear in early serial positions. Instead, they provide strong support for what we have termed serial order models, in which the relative accessibility of lemmas exerts a relatively direct influence on word order decisions (e.g. De Smedt, 1990). More importantly, by disconfirming the grammatical function model, our results argue against the restrictive incrementality that we have shown that model to entail. Rather, our results argue for highly incremental syntactic structure generation, in which the processor achieves fluency by working on information as and when it becomes available.

Of course, we cannot be sure from these results whether the influence of conceptual accessibility is mediated by grammatical function in some way. There are two aspects to this point. Firstly, conceptually accessible entities might have an affinity for higher grammatical functions, in addition to early serial positions. Clearly, our experiment excludes the possibility that conceptually accessible entities are advantaged only with respect to grammatical functions; but it cannot determine whether there is a grammatical function effect of some sort. Future work could address this problem by using structures which involve variations in grammatical function that are independent of early word order positions. For example, if there is indeed a preference for conceptually accessible entities to claim higher grammatical functions, independent of serial order, then speakers should prefer to recall a sentence-final oblique object in a passive sentence as a sentence-final subject in a semantically equivalent OVS sentence. Secondly, our experiment does not allow us to distinguish between two possible architectures for syntactic processing in language production, one in which serial order can be assigned immediately a lemma has been retrieved, possibly before it has received a grammatical function, as discussed by De Smedt (1996); versus an architecture in which a lemma must be assigned a grammatical function before it claims a serial position, as in Kempen and Hoenkamp (1987). In the first architecture, conceptual accessibility would have a very direct impact upon serial order; in the second architecture, its impact would be mediated by an initial stage of function assignment. In theory, such an intermediate stage of processing could muddy the ultimate relationship between conceptual accessibility and serial order. However, the very incrementality of the processor makes it difficult to distinguish empirically between the two possibilities, at least using this experimental method. We therefore leave this as a question for future research.

A final important question concerns the differences between our findings and those of Bock and colleagues, who failed to find a link between conceptual accessibility and serial order. Do these differences reflect different processing architectures for English versus Greek, or is there some other explanation? It is obviously possible that strict word order and more flexible word order languages are associated with different processing architectures, and that the latter allow more highly incremental processing; but this seems unlikely. Rather, it seems plausible that the differences can be attributed to the structures studied. Recall that Bock and colleagues' experiments crucially relied upon NP conjunctions. These structures differ in an important way from those that we studied. Specifically, non-conjunctive NPs involve retrieval of a single noun lemma, which controls syntactic elaboration. Hence as soon as the processor has retrieved just the noun lemma, it can commence syntactic processing. In contrast, NP conjunctions require the processor to retrieve two noun lemmas, one for each conjunct. Crucially, the syntactic elaboration of the conjunctive phrase is determined by the syntactic features of both conjuncts. For example, agreement is determined with reference to both conjuncts. In syntactically elaborating an NP conjunction, therefore, the processor needs to make reference to the syntactic information contained in both lemmas. As such, it seems plausible that conjunctions are

not processed incrementally like other phrases. We suggest that when processing a conjunctive phrase, the processor temporarily suspends fully incremental processing, and delays some syntactic processing until the lemmas associated with both conjuncts have been successfully retrieved and the information that they contain can be used to constrain the syntactic structure that is generated. If NP conjunctions are not processed incrementally like other phrases, it is not surprising that they do not exhibit ordering effects related to the accessibility of each conjunct.

To conclude, our results confirm a hypothesized role for conceptual accessibility in determining serial order. We interpret our results as evidence for highly incremental syntactic structure generation, in which information accessibility strongly influences the behavior of the processor.

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References

Bock, J.K. (1982). Toward a cognitive psychology of syntax: Information processing contributions to sentence formulation. *Psychological Review, 89*, 1-47.

Bock, J.K. (1986). Syntactic persistence in language production. *Cognitive Psychology, 18*, 575-586.

Bock, J.K. & Loebell, H. (1990). Framing sentences. Cognitive Psychology, 35, 1-39.

Bock, J.K. (1987). Coordinating words and syntax in speech plans. In A. Ellis (ed) *Progress in the pathology of language.* London: Erlbaum.

Bock, J.K. & Irwin, D. (1980). Syntactic effects of information availability in sentence production. *Journal of Verbal Learning and Verbal Behavior, 19*, 467-484.

Bock, J.K. & Warren, R. (1985). Conceptual accessibility and syntactic structure in sentence formulation. *Cognition, 21*, 47-67.

Baayen, R. H., Piepenbronck, R., & Gulliver, L. (1995). *The CELEX Lexical Database (CD-Rom).* The Linguistic Data Consortium, University of Pennsylvania, Philadelphia.

Chomsky, N. (1965). *Aspects of the structure of syntax.* Cambridge: MIT Press.

Cooper, W.E. & Ross, J.R. (1975). World order. In R.E. Grossmann, L.J. San, and T.J. Vance (eds) *Papers from the parasession on functionalism.* Chicago Linguistic Society.

De Smedt, K. (1990). IPF: An incremental parallel formulator. In R. Dale, C. Mellish, and M. Zock (eds) *Current research in natural language generation.* London: Academic Press.

De Smedt, K. (1996). Computational models of incremental grammatical encoding. In T. Dijkstra and K. De Smedt (eds) *Computational Psycholinguistics.* London: Taylor & Francis.

Ferreira, F. (1994). Choice of passive voice is affected by verb type and animacy. *Journal of Memory and Language, 33*, 715-736.

Ferreira, V.S. (1996). Is it better to give than to donate? Syntactic flexibility in language production. *Journal of Memory and Language, 35*, 724-755.

Gazdar, G., Klein, E., Pullum, G. & Sag, I. *Generalised Phrase Structure Grammar.* Oxford: Blackwell.

Hartsuiker, R. & Kolk, H. (1998). Syntactic persistence in Dutch. *Language and Speech, 41*, 143-184.

Keenan, E. & Comrie, B. Noun phrase accessibility and universal grammar. *Linguistic Inquiry, 8*, 63-99.

Keil, F.C. (1979). *Semantic and conceptual development: An ontological perspective.* Harvard University Press.

Kelly, M.H., Bock, J.K. & Keil, F.C. (1985). Prototypicality in a linguistic context: Effects on sentence structure. *Journal of Memory and Language, 25*, 59-74.

Kempen, G. & Hoenkamp, E. (1987). An incremental procedural grammar for sentence formulation. *Cognitive Science, 11*, 201-288.

Kempen, G. & Huijbers, P. (1983). The lexicalization process in sentence production and naming: Indirect election of words. *Cognition, 14*, 185-209.

Levelt, W.J.M. (1989). *Speaking: From intention to articulation.* Cambridge: MIT Press.

Levelt, W.J.M., Meyer, A. & Roelofs, A.(in press). A theory of lexical access in speech production. *Behavioral and Brain Sciences.*

Marslen-Wilson, W. (1973). Linguistic structure and speech shadowing at very short latencies. *Nature, 244*, 522-523.

McDonald, J., Bock, J.K. & Kelly, M.H. (1993). Word and world order: Semantic, phonological and metrical determinants of serial position. *Cognitive Psychology, 25*, 188-230.

Osgood, C.E. (1971). Where do sentences come from? In D. Steinberg and L. Jakobovits (eds) *Semantics: An interdisciplinary reader in philosophy, linguistics and psychology.* Cambridge: Cambridge University Press.

Pickering, M.J. & Branigan, H.P. (1998). The representation of verbs: Evidence from syntactic priming in written production. *Journal of Memory and Language, 39*, 633-655.

Prat-Sala, M. (1997). *The production of different word orders: A psycholinguistic and developmental approach.* Unpublished PhD thesis, University of Edinburgh.

Sridhar, S.N. (1988). *Cognition and sentence production: A cross-linguistic study.* New York: Springer.