Optimization in coordination

Contents

Main project: Optimization in coordination

1.0. Summary

When human listeners hear a sentence, they not only pay attention to the words in the sentence and their order, but also take into account the linguistic and extra-linguistic context of the sentence, the way the sentence is uttered, and general knowledge bearing on the words in the sentence. If someone utters the sentence *Kim brought the shuttles to practice and Chris to the game*, it depends on the structure of the context, the placement of sentential stress, and the ease with which elements in the sentence can be contrasted, which interpretation this coordinate construction receives. One reading is that Kim brought Chris to the game. Another reading is that Chris brought the shuttles to the game. One might assume that the function of contextual, prosodic and semantic information is to merely provide extra clues for the listener to help her/him in finding the correct

interpretation. However, the different types of linguistic information do not always point to the same interpretation. This project proceeds from the assumption that natural language interpretation is a process of optimization. Because language is subject to constraints which are potentially conflicting and hence cannot be satisfied simultaneously, the interpretation that satisfies the total set of constraints best is the optimal interpretation. This interpretation will then be chosen. Because optimization is assumed to be a leading principle in other domains of cognition as well, this view on natural language interpretation strengthens the connections between linguistic theory and other disciplines of cognitive science.

1.1. Incomplete coordinate constructions

A major challenge to linguistic theory is the observation that incomplete sentences do not receive an incomplete interpretation. Consider sentence 1:

1. *Kim ate rice and Chris beans.*

Although the second conjunct of this coordinate construction does not contain a finite verb, it is immediately clear what Chris did with the beans, namely eat them. It is impossible to interpret this sentence as meaning that Chris *bought* beans. Apparently, the meaning of the finite verb *ate* in the first conjunct must be reused in the second conjunct. This would also explain the interpretation of sentence 2.

2. *Kim brought Pat to practice and Chris to the game.*

Again, the second conjunct is incomplete. The preferred interpretation of this second conjunct is that Kim brought Chris to the game. So again meanings from the first conjunct (of *Kim* and *brought*) are reused in the second conjunct. However, if prosodic information is added, another interpretation emerges.

3. *KIM brought Pat to practice and CHRIS to the game.*

Here, capitals indicate sentential stress. Sentence 3 can be interpreted as meaning that Chris brought Pat to the game. In this case, *brought* and *Pat* are reused, rather than *Kim* and *brought*. Apparently, there is a choice with respect to which elements from the first conjunct are reused, and this choice is influenced by prosodic cues. However, prosody is not the only factor influencing the choice of the material being reused. The semantic notion of contrast also plays a role. Because *some people* and *others* form a natural contrast, it seems easier to interpret these elements as having the same function in sentence 4, namely as the subject of the verb *brought*.

4. *Some people brought Pat to practice and others to the game.*

Another factor playing a role is context. Consider the following dialogue:

5. *Question: Where did Kim and Chris bring Pat to?*
   Answer: Kim brought Pat to practice and Chris to the game.

The answer to the question in 5 is identical to sentence 2. However, the preferred interpretation of this answer is that Chris brought Pat to the game, whereas the preferred interpretation of sentence 2 was that Kim brought Chris to the game. This change in the interpretation of sentence 2 is a consequence of the explicit context in the form of a preceding question.

These examples show that there is a preferred interpretation for sentences like 2, the cause of which is subject to debate in the literature on coordination, but which can be overruled by prosodic, semantic and pragmatic (contextual) information. An interesting question is what happens if these different types of information are combined. And even more interestingly, what happens if these different types of information are in conflict and do not point to the same interpretation? This will be the topic of investigation of this project.

1.2. Theoretical framework

The theoretical framework that is adopted for this research is the framework of Optimality Theory (Prince & Smolensky, 1993). In Optimality Theory (henceforth OT), a grammar is assumed to consist of a set of constraints on the output. The output to the grammar can be formed by a string of speech sounds, a sentence or an interpretation. Constraints on the output are not hard and inviolable, as is usually assumed in linguistics, but soft and violable. A constraint may be violated in OT, but only if the effect is that another, stronger, constraint will be satisfied. Thus, constraints in OT are potentially conflicting and differ in strength. The constraints are ordered in a hierarchy of relative strength. Differences between languages are the result of a different ordering of the constraints. Possible output candidates (i.e., possible strings of speech sounds, possible sentences or possible interpretations) are evaluated with respect to this hierarchy of constraints. The output candidate which satisfies the hierarchy of constraints best is the optimal candidate and will be chosen.

To date, OT has been applied mainly to phonological, morphological and syntactic phenomena. Only recently there have been a few attempts to apply OT to semantic and pragmatic phenomena (see, e.g., Blutner, 2000; Hendriks & de Hoop, 1997, 2001; de Hoop & de Swart, 2000; ter Meulen, 2000; Zeevat, 2000). It appears that OT is ideal for the integration of soft pragmatic principles (such as the Gricean maximes) into the grammar, since all constraints are assumed to be soft in OT. In addition, OT is able to model the interaction of linguistic constraints from different components of the grammar in a rather straightforward way. Proposals have already been put forward with respect to the interaction between phonological and morphological constraints, but such interaction also seems possible among syntactic, semantic, prosodic and pragmatic constraints.

1.3. Initial coordination

In section 1.1, it was shown that the construction of a complete interpretation for an incomplete sentence is subject to constraints from different components of the grammar. Interestingly, this is not only true for incomplete sentences. As will be shown in this section, the interpretation of complete sentences can be subject to different types of constraints as well. This suggests that constraint interaction not only occurs at the final stage of interpretation but is a more fundamental aspect of interpretation. Thus, syntactic,

semantic, pragmatic and prosodic factors appear to play an equally important role in interpretation and seem to be in constant interaction with each other. This contrasts with the standard assumption that the components of grammar are modular and only interact at the interfaces between two components (e.g., the syntax-phonology interface and the syntax-semantics interface).

That the interpretation of complete sentences also involves the interaction between constraints from several components of the grammar can be illustrated by the phenomenon of initial coordination. Initial coordination is coordination involving pairs of elements such as *either-or*, *both-and* and *neither-nor* in English and *of-of*, *zowel-als* and *noch-noch* in Dutch. The first element of these pairs, i.e. the initial coordinator, can appear in different adverbial positions in the sentence. Also with respect to other features initial coordinators behave like focus adverbs. For example, the focused element (i.e., the element carrying contrastive stress) must be in the syntactic domain of the focus adverb. This explains why 6 is infelicitous under the given prosodic pattern (infelicity is indicated by the hash mark), whereas 7 is perfectly acceptable.

6. # *KIM ate either rice or PAT ate rice.*
7. *Either KIM ate rice or PAT ate rice.*

These sentences show the same pattern of acceptability as the following sentences with the focus adverb *only*:

8. # *KIM ate only rice.*
9. *Only KIM ate rice.*

The focused element *Kim* occurs in the syntactic domain of *either* and *only* in 7 and 9, but not in 6 and 8. These examples show that initial coordinators behave exactly like focus adverbs with respect to the interaction between their distribution and the placement of contrastive stress. From the perspective of the speaker, the placement of stress limits the position of the focus adverb. From the hearer's perspective, the position of the focus adverb limits the placement of stress and hence adds to the predictablity of the sentence.

In addition to stress, linguistic context is also a determining factor in the distribution of focus adverbs. This seems to account for the definiteness effect in the following Dutch sentence:

10. *Ik dacht dat zij de rozen /? twee rozen of geplant heeft of gesnoeid heeft.*
I thought that she the roses / two roses either planted has or pruned has
'I thought that she either planted or pruned the roses / two roses'

In this position and under an existential (i.e., non-specific) reading, the indefinite noun phrase *twee rozen* is worse than the definite noun phrase *de rozen*. However, this definiteness effect disappears if *of* ('either') precedes the direct object. Because definite noun phrases generally refer to familiar objects which have already been mentioned in the discourse while indefinite noun phrases generally introduce new objects into the discourse, the linguistic context partly determines whether *of* appears to the left or to the right of the direct object. From a hearer's perspective, the position of *of* determines how

the direct object is interpreted if it is an indefinite. Note that this effect is absent in English. Thus, prosodic factors (contrastive stress) and pragmatic factors (contextual cues) play an important role in the generation and interpretation of incomplete as well as complete coordinate constructions.

1.4. Central research question

The central research question of this project is whether natural language interpretation is a cross-modular process of optimization. The relevant constraints will be identified that play a role in the interpretation of coordination, as well as their ordering. An additional consequence of the proposed research is that an explanation might be provided for a number of unexplained observations with respect to coordination. Differences between English and Dutch might help to explain these observations. These cross-linguistic differences are assumed to arise from differences in the ordering of the constraints involved.

1.5. Methodology

In the first phase of the project (year 1), data will be collected mainly from electronic corpora of English and Dutch using software that already is available in Groningen, such as Wordsmith. The use of electronic corpora will allow for a detailed investigation of contextual cues in sentence interpretation, in addition to the syntactic and semantic cues provided by the sentences themselves.

Using qualitative analysis, a number of features will be investigated which incomplete coordinate constructions and initial coordination have in common but which are as yet unexplained. For example, the remaining material in incomplete second conjuncts must sometimes be larger than merely the elements carrying contrastive stress. Similarly, the syntactic domain of an initial coordinator or other focus adverb must sometimes be larger than the element carrying stress. An important discussion in the literature is how the size of the syntactic domain relates to the semantic scope of the focus particle, since focus particles but also *either-or* disjunctions are not always interpreted in the position in which they appear in the sentence. This aspect of their interpretation might be caused by their quantificational properties. However, these quantificational properties differ from the properties of ordinary quantificational determiners, perhaps due to the effects of focus (i.e., the distinction between new and familiar information). This will be investigated in detail by taking into account the linguistic context of the sentence.

Quantitative analysis will be applied to investigate the preference for focus particles to precede rather than to follow prepositions (cf. Hoeksema & Zwarts, 1991):

11. ? *John spoke to only Mary.*
12. *John spoke only to Mary.*

Although this preference is as yet unexplained, the same preference seems to play a role in initial coordination. Strikingly, this preference appears to be much stronger in languages such as Dutch and German than in English, although it is not an unviolable rule in these languages either. Through corpus analysis, the existence and strength of this preference will be determined in English and in Dutch. This preference might be related to an also unexplained preference in incomplete sentences, namely that the elements in

the incomplete second conjunct must be major constituents, i.e., arguments of the main verb. This latter preference can be overruled in English, as the non-major constituent *Monet* in sentence 13 shows. Its Dutch counterpart in sentence 14 is much worse (as is indicated by the asterisk).

13. ? *Mary talked about Manet and John Monet.*
14. * *Mary sprak over Manet en John Monet.*

Note that sentences like 13 deteriorate if the names of the painters are replaced by ordinary proper names such as *Jane* and *Jill*. This suggests that also semantic factors such as the ease with which a contrast can be established play an important role in the interpretation of these constructions. Therefore, the nature of semantic contrast and its effects on interpretation will also be studied in this project. In general, the main project investigates contextual, syntactic and semantic constraints on interpretation and their interaction through formal analysis of the data, whereas the related PhD project focuses on the role of prosodic constraints using psycholinguistic experimentation.

The second phase of the project (year 2) consists of formulating hypotheses with respect to the soft constraints playing a role in the interpretation of coordination, and their relative ordering. If the constraints are not ordered in a modular way, natural language interpretation must be a cross-modular process. The hypothesized constraints will be tested against new data in year 3 and 4, also taking into account any intermediate results from the PhD project. In the final phase of the project (year 5), the results of the main project and the PhD project will be integrated and interpreted in the light of the central research question.

1.6. Significance and impact of the proposed research

The first application of OT to the field of semantics was Hendriks & de Hoop (1997). This paper, a more elaborate version of which appeared in *Linguistics and Philosophy*, aroused a lot of interest from semanticists as well as pragmaticians in the possibility of explaining certain interpretational phenomena by using soft constraints. This interest was increased even more by two conferences in 2000 at Utrecht University on the topic of optimality theoretic interpretation, which were organized by dr. Helen de Hoop and the applicant in collaboration with a number of other researchers at Utrecht University. Invited speakers at these conferences were prof.dr. Paul Smolensky (Baltimore), dr. Reinhard Blutner (Berlin), prof.dr. Gisbert Fanselow (Potsdam), prof.dr. Terence Langendoen (Tucson), dr. Miriam Butt (Konstanz) and dr. Henk Zeevat (Amsterdam). These two conferences resulted in a special issue of *Journal of Semantics* on optimality theoretic interpretation. Recently, a number of groups have emerged internationally which have started to investigate semantic and pragmatic issues within OT: in Berlin (prof.dr. Manfred Krifka, dr. Reinhard Blutner, dr. Bart Geurts, dr. Gerhard Jäger), in Stanford and Santa Cruz (prof.dr. David Beaver, prof.dr. Daniel Büring) and in Amsterdam (dr. Henk Zeevat, dr. Paul Dekker, dr. Robert van Rooy). Evidently, OT semantics is a new and exciting field within linguistics which offers a completely different perspective on compositionality and modularity. This allows us to test one of the basic assumptions within linguistics, namely the assumption that the components of the grammar are modular and only interact at the interfaces. In addition, OT semantics

promises to shed more light on a number of linguistic phenomena that have resisted any satisfactory explanation before.

1.7. Relation with the proposed PhD project

The PhD project investigates a particular aspect of the central research question of the main project, namely the role of prosodic information in the interpretation of coordination. This aspect of the central research question, which is related to the physical speech signal, requires methods of investigation which differ from the methods that will be used in the main project to investigate other, more abstract, factors involved in the interpretation of coordinate constructions. Thematically, however, the research of the PhD project is closely tied to the main project. The PhD project is driven by hypotheses which are partly derived from the main project, and the results from the PhD project will again be integrated in the results of the main project.

1.8. Institutional and scientific embedding

The proposed research falls within the Research School Behavioral and Cognitive Neurosciences (BCN) at the University of Groningen and the Research Institute Center for Language and Cognition Groningen (CLCG) at the Faculty of Arts of the University of Groningen. Within the University of Groningen, the proposed research connects to ongoing and previous research on natural language semantics and information structure by prof.dr. Frans Zwarts, prof.dr. Alice ter Meulen and dr. Jack Hoeksema, to ongoing work on OT phonology by dr. Dicky Gilbers, to work on the syntax of coordination by dr. Jan-Wouter Zwart and dr. Ron van Zonneveld, and to research on cognitive modeling, multi-agent communication and speech processing at the department of Artificial Intelligence (prof.dr. Lambert Schomaker, dr. Niels Taatgen, dr. Rineke Verbrugge, dr. Esther Wiersinga-Post). The research of the PhD project is strongly connected to the PIONIER group of dr. Laurie Stowe. At the national level, there is ongoing collaboration with dr. Helen de Hoop (Nijmegen) and prof.dr. Henriëtte de Swart (Utrecht) on OT semantics. Also, there are close connections with the Institute for Logic, Language and Computation in Amsterdam (dr. Henk Zeevat, dr. Paul Dekker, dr. Robert van Rooy). Internationally, the applicant is engaged in a project on OT semantics and OT pragmatics in collaboration with dr. Helen de Hoop (Nijmegen) and dr. Reinhard Blutner (Berlin). Furthermore, the applicant is involved in a project at Carnegie Mellon University (Pittsburgh) in the ACT-R group of prof.dr. John Anderson which is financed by Carnegie Mellon University and which investigates the possibility of integrating an OT view on language with an ACT-R architecture of cognition. Finally, the applicant has close connections to researchers in OT syntax, such as prof.dr. Joan Bresnan and her group at Stanford University, and researchers into the foundations of OT, such as prof.dr. Paul Smolensky and his group at Johns Hopkins University in Baltimore.

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PhD project: The effects of sentential stress on the interpretation of coordination

2.0. Summary

The aim of this PhD project is to study the role of prosodic information in sentence comprehension. The project concentrates on the role of sentential stress in the comprehension of incomplete coordinate constructions and initial coordination in English and Dutch. Other factors playing a role in the comprehension of these constructions are investigated in the main project. Sentential stress plays an important role in coordinate constructions and is able to disambiguate potentially ambiguous sentences. The central question of this project is whether prosodic information, such as sentential stress, is only relevant for distinguishing between two possible interpretations or whether prosodic information can already at an earlier stage contribute to the interpretation of a sentence. It is hypothesized that prosodic constraints are as important as other linguistic constraints in sentence comprehension and contribute to the interpretation of the sentence in a similar way. The role of prosodic information in the interpretation of coordination will be studied from the perspective of Optimality Theory. In OT, the use of the grammar is assumed to reflect the knowledge of the grammar directly. If prosodic information is as important as other linguistic factors in comprehension, this will be directly reflected in the effects of prosodic information during sentence comprehension. The comprehension of coordination will be investigated using psycholinguistic methods of investigation.

2.1. Sentential stress and sentence comprehension

In spoken language, sentential stress provides a lot of information about the meaning of an utterance. It can mark newly introduced material in the sentence, it can mark the contrastive relation beween a word or phrase and another word or phrase (in these cases, it is refered to as contrastive stress), and it can mark phrasal boundaries. In the literature on sentence comprehension, there is extensive debate as to when exactly in the process of sentence comprehension non-syntactic factors such as prosodic information come into

play. According to structure-based models of sentence comprehension, in which a modular view of grammar is adopted, prosodic information can only be taken into account before or after syntactic processing, but never during syntactic processing (cf. the work of Lyn Frazier and Charles Clifton). Constraint-based models, on the other hand, assume all factors to be relevant from the beginning (cf. MacDonald, Pearlmutter & Seidenberg, 1994; Tanenhaus & Trueswell, 1995). It appears to be difficult to decide between these two models on the basis of on-line experiments of sentence comprehension because of the speed of integration of the different factors in comprehension. In this PhD project, the role of prosodic information will be studied from the perspective of a theory of grammar which assumes the knowledge of the grammar to be directly reflected in the use of the grammar. If prosodic information is as important as other linguistic factors in comprehension, it will interact with these other factors and contribute to the interpretation already from the start.

2.2. Theoretical framework

The theoretical framework that is adopted for this research is the framework of Optimality Theory (cf. Prince & Smolensky, 1993). In OT, a grammar is assumed to consist of a set of soft (i.e., violable) constraints on the output. The fundamentals of the linguistic framework of OT stem from research in neural network modeling. An artificial neural network can be seen as trying to optimize the harmony of the pattern of activation over the units in the network. The framework of OT arose as a result of the realization that this notion of harmony in a neural network can be identified with the linguistic notion of wellformedness. Under this view, a grammatical or wellformed expression is the expression that results in the greatest harmony of the pattern of activation in the network, i.e., the expression that optimally satisfies the conflicting constraints which are represented in the connections between the units in the network.

Such an optimization perspective allows for a clear view on the relation between knowledge of grammar versus the use of this grammar. Rather than assuming that there need not be a direct correspondence between the two, the use of the grammar is assumed to reflect the knowledge of the grammar directly. This is an immediate consequence of the foundations of OT in neural network modeling. In an artificial neural network, the same system is responsible for representation as well as for processing. Similarly, the same linguistic constraints are responsible for knowledge of language as well as for language processing. These constraints are assumed to play a role already from the start during sentence comprehension, thus abolishing the need for a separate parser (see Fanselow et al., 1999, for an investigation of the application of soft constraints in parsing, and Kaan & Wijnen, 2001, for experimental confirmation of the interaction between soft constraints during parsing as was predicted by Hendriks & de Hoop, 2001).

2.3. The comprehension of incomplete coordinate constructions

With respect to incomplete coordinate constructions, the interaction will be investigated between prosodic constraints and semantic constraints. Carlson (2001) already studied the effects of semantic parallelism on the comprehension of incomplete coordinate constructions, both in a written and auditory questionnaire study.

1. *Josh visited Marjorie during the vacation and Sarah during the week.*
2. *Josh visited the office during the vacation and Sarah during the week.*

The second conjunct in these sentences is in principle ambiguous between two readings:

Reading A: *Josh visited Sarah*
Reading B: *Sarah visited Marjorie/the office*

Under reading A, there is parallelism in animacy in sentence 1, where the animate object *Sarah* is contrasted with the animate object *Marjorie*. There is no parallelism in sentence 2, where the animate object *Sarah* is contrasted with the inanimate object *the office*. In Carlson's study, reading A was preferred overall, but sentential stress on *Josh* and *Sarah* significantly increased the choice for reading B.

Carlson explains her results in terms of a preference for parallelism (cf. Frazier et al., 1984) in combination with a parsing preference for minimal syntactic structure. Indeed, parallelism has already been shown to be a soft constraint on the interpretation of elliptical quantified constructions (Hendriks & de Hoop, 2001). The preference for minimal syntactic structure might turn out to be an instantiation of a general tendency to present old information first and new information last.

Carlson only looked at cases where prosodic parallelism and semantic parallelism would pick out the same pair of elements. The proposed research will look at instances where prosodic parallelism and semantic parallelism do not pick out the same pair of elements, i.e., where prosodic constraints and semantic constraints are in conflict. These are sentences like the following:

3. *Josh visited the OFFICE during the vacation and SARAH during the week.*

If reading A is preferred, prosodic parallelism is stronger than semantic parallelism. If reading B is preferred, the ordering of the constraints is the other way around.

2.4. The comprehension of initial coordination

According to Frazier and Clifton (2001), the comprehension of initial coordination is guided by different principles than the comprehension of incomplete coordinate constructions. They claim that, in addition to the parsing mechanism involved in building syntactic structure, another parsing mechanism must be available for unambiguous sentences, which allows material from the first conjunct to be copied into the second conjunct essentially cost-free.

Frazier and Clifton carried out a self-paced reading study of *either-or* constructions such as sentence 4 which proceeded from the assumption that *either* marks the syntactic domain of the disjunction explicitly.

4. *Mary is looking for either a maid or a cook.*

That is, Frazier and Clifton assume that sentence 4 only has reading A and does not have reading B.

Reading A: *Mary is looking for a servant and will be satisfied with a maid or a cook.*
Reading B: *There is doubt as to whether Mary is looking for a maid or Mary is looking for a cook.*

If is assumed that *either* marks the syntactic domain explicitly, sentence 5 also is unambiguous, whereas sentence 6, which lacks *either*, is ambiguous.

5. *Mary is looking either for a maid or a cook.*
6. *Mary is looking for a maid or a cook.*

Frazier and Clifton found no difference in reading times for sentence 4 (where *either* introduces a noun phrase) and sentence 5 (where *either* introduces a prepositional phrase). Reading time for sentence 6 (where no *either* is present) was significantly longer than for the other two sentence. Now if comprehension involves constructing the second conjunct, and if more complex phrases take more time to construct, then the more complex prepositional disjunction of sentence 5 should have taken longer to read than the simpler noun phrase disjunction of sentence 4. However, this was not the case. Therefore, Frazier and Clifton conclude that another parsing mechanism must be at work here, which provides a copy of the syntactic structure of the first conjunct without much processing cost and which is only available for systematically unambiguous sentences.

However, there are a number of problems with the purely syntax-based explanation of Frazier and Clifton. For example, it has been argued that sentences like 4 are in fact ambiguous and also have reading B (Larson, 1985; Rooth & Partee, 1982). The presence of reading B might be explained as a general scope ambiguity arising when a focus particle is attached to a noun phrase but not present when the focus particle is attached to other phrases (in which cases these scope ambiguities exactly arise is not the topic of this PhD project but will be investigated in the main project). If sentence 4 indeed is ambiguous, the explanation by Frazier and Clifton cannot be correct. Thus, their motivation for two different parsing mechanisms is rather weak.

In this PhD project, an alternative explanation will be investigated in which prosodic information plays a crucial role. What seems to be the case here is that the presence of *either*, as a focus particle, limits the placement of sentential stress and hence increases the predictability of the structure of the second conjunct. This alternative explanation will be tested in the PhD project by presenting Frazier and Clifton's sentences in auditory form.

Another weakness of Frazier and Clifton's study concerns the reading times for the following two sentences:

7. *John either ate rice or beans.*
8. *Either John ate rice or beans.*

Sentence 8 was read numerically more quickly than sentence 7 (significant by subjects but not by items). This difference cannot be explained by the complexity involved in constructing the second conjunct since the second conjunct is more complex in 8 than in 7. However, it can not be explained by Frazier and Clifton's copying mechanism either.

2.5. Central research question

The central research question of this PhD project is whether sentential stress constrains interpretation in an OT-like fashion. Thus, it will be investigated whether constraints with respect to sentential stress can be violated, as is characteristic of constraints in OT. At the same time it will be determined whether these constraints with respect to sentential stress are able to overrule other constraints on natural language interpretation, i.e., syntactic, semantic or pragmatic constraints. The proposed research will focus on coordination in English and Dutch.

2.6. Methodology

The comprehension of coordinate constructions will be investigated in 5-6 psycholinguistic experiments using auditory presentation. The presented sentences will vary in their prosodic structure by the placement of prominent pitch accents. The placement of pitch accent in the speech signal can be manipulated using the computer program Praat, which has been developed by dr. Paul Boersma and drs. David Weenink at the University of Amsterdam. Subjects will be asked to listen to a prosodically structured sentence, and then to choose among paraphrases, to rate the difficulty of the sentence, and to indicate if they notice another interpretation of the sentence.

Experiment 1 will study the interaction between prosodic and semantic information with Dutch subjects using the Dutch counterparts of sentences such as 3. The effects of different types of semantic parallelism will be studied by replacing the proper names in these sentences by elements that invoke a stronger contrast (for example, *some people* versus *others*). The factors that might be involved in semantic contrast will be derived from the main project.

Experiment 2 will study the interaction between prosodic and syntactic information with English subjects. Sentences such as 4, 5 and 6 will be presented in auditory form. In addition, *both-and* constructions will be presented. If sentential stress is provided explicitly, the predictability of the second conjunct is assumed to also increase in the absense of an initial coordinator. Moreover, no difference is expected between *either-or* constructions and *both-and* constructions since *both* also behaves like a focus particle and therefore should increase the predictability of the second conjunct in the same way *either* does. Frazier and Clifton (2001), on the other hand, would predict these latter constructions to be read faster across the board because *both* does not give rise to scope ambiguities (cf. Larson, 1985).

Experiment 3 will study the interaction between prosodic information and context with English subjects. Sentences such as 7 and 8 will be presented in auditory form to determine whether the difference in processing that Frazier and Clifton observed also emerges if prosodic information is added. If so, this difference in processing might be explained by the fact that if material is stressed, other material must be destressed. Destressing must be licensed by the context. Thus, any differences between 7 and 8 might lie in the different contexts they require. This will be studied by adding different context sentences (for example, *What did John do?* versus *What happened?*) while manipulating the prosodic structure.

Experiments 4 and 5 are identical to 2 and 3 but with Dutch subjects and Dutch sentences. Note that Dutch *of* is not possible in the position of *either* in sentence 7 for syntactic reasons (these syntactic factors are studied in the main project; see also

Hendriks & Zwart, to appear). Hence, contextual effects are expected to be slightly different in Dutch. Also, in Dutch the relation between context and stressing seems to be rather strong (e.g., Terken & Nooteboom, 1987; Van Donselaar, 1995), perhaps stronger than in English.

If necessary, one more experiment will be carried out to resolve remaining issues.

2.7. Schedule and promotors

In the first year of the PhD project, data will be collected and hypotheses will be formulated with respect to the constraints pertaining to the effects of sentential stress on interpretation. In the second year, the auditive material will be prepared and the first series of experiments will be carried out. Preparation of the auditive material is expected to be time consuming. In the third year, the remaining experiments will be carried out and the results of the experiments will be interpreted. Possibly, one more experiment will be carried out to resolve remaining issues. The fourth year is dedicated to interpretation of the final results and to writing the dissertation. The intended promotor is prof.dr. Frans Zwarts (Dutch, University of Groningen) and the intended co-promotor dr. Laurie Stowe (Linguistics, University of Groningen).

2.8. Relation with the main project

The PhD project investigates one particular aspect of the central research question of the main project, namely the role of prosodic information in the interpretation of coordination. The main project investigates other factors involved in the interpretation of coordinate constructions. Thematically, therefore, the research of the PhD project is closely tied to the main project. The PhD project is driven by hypotheses which are partly derived from the main project, and the results from the PhD project will again be integrated in the results of the main project.

2.9. Significance and impact of the proposed research

The proposed research proceeds from an entirely new perspective on human sentence processing. Given the assumptions that are adopted within the linguistic framework of OT, the experimental results bear on the grammar directly, rather than on the properties of a hypothesized separate parser. Two important results are to be expected: (1) the research will provide more insight into the structure of the grammar, in particular into the prosodic constraints involved in interpretation, and (2) the research will shed more light on human sentence processing and the mechanisms involved.

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