Sentence processing strategies: some preliminary results on the processing of prepositional phrases in Greek

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Abstract

The present study reports on some preliminary results on the processing of ambiguous Prepositional Phrase structures in Greek. The study was conducted in order to investigate the attachment preferences of Greek native speakers in temporarily ambiguous Prepositional Phrase structures in Greek. An off-line sentence completion task introduced temporarily ambiguous sentence fragments in Greek, including four basic Greek prepositions: *me, se, ja, apo*. The verbs in each of the critical sentences were tested for semantic biases in a separate paper-and-pencil plausibility study. The results are discussed on the basis of recent theoretical frameworks in Sentence Processing.

Keywords: structural ambiguity, prepositions, Prepositional Phrases, sentence processing, attachment preferences

1. Introduction

The primary aim of the present study is to investigate Greek native speakers' attachment preferences in ambiguous structures of the V-NP-PP type (i.e. high attachment – the PP modifying the verb or low attachment – the PP modifying the noun phrase). An off-line questionnaire study has been designed in order to check whether there is a change in subjects' attachment preferences when the preceding constituents are thematically biased towards either V or NP attachment. An additional aim of this study is to investigate whether the use of different prepositions affects the overall speakers' attachment preferences.

The findings of the questionnaire will be evaluated and used as a basis for the conduction of an on-line study on Prepositional Phrase attachment ambiguities. The on-line study will allow us to capture subjects' initial attachment preferences between the two attachment sites (high *vs* low attachment) as well as the effect that each preposition may have on the processing of an ambiguous structure.

2. Theoretical background

There is a strong debate in the field of Sentence Processing which mainly focuses on the autonomy of the parser, that is, the amount and the type of information that the parser receives in order to process a given structure. Most of the sentence processing models and theories that have been developed basically aim at providing a complete account of a theory of parsing. These models can be roughly divided into two basic categories: the serial-autonomous and the multiple-constraint satisfaction models.

According to the principles of serial-autonomous models (e.g. Frazier 1978, 1987, 1990; Frazier & Fodor 1978; Frazier & Rayner 1982), the parser initially constructs a syntactic representation of a given structure only on the basis of syntactic information. Other types of information such as lexical, semantic, pragmatic and discourse come at a later stage of processing and after possible re-analysis of the structure. The most well-known serial autonomous model is the Garden-Path model (e.g. Frazier 1987). A basic principle of the Garden Path model is Minimal Attachment, according to which the resolution of a structural ambiguity should be accomplished through the use of the fewest possible nodes in the syntactic structure (e.g. Rayner et al. 1983).

Multiple-constraint satisfaction models (e.g. Taraban & McClelland 1988; Tanenhaus & Carlson 1989; Boland et al. 1990; Trueswell et al. 1993; MacDonald 1994; MacDonald et al. 1994) mainly claim that during the processing of a given structure the processor has access to various types of information (syntactic, lexical, pragmatic, discourse, etc.) from the very initial stage of parsing. The resolution of temporal and global ambiguities is accomplished through the satisfaction of multiple probabilistic constraints which compete with each other until the resolution of the ambiguous structure.

3. Previous studies

Frenck-Mestre & Pynte (1997) examined native French speakers' and late bilinguals' (L1 English / L2 French) attachment preferences in temporarily ambiguous sentences. The critical sentences were presented through an eye-tracking task and had the following form:

VP-attachment Condition
(1)   They accused the ambassador of espionage but nothing came of it.
NP-attachment Condition
(2)   They accused the ambassador of Indonesia but nothing came of it.

On the basis of the assumption that the initial sentence analysis is solely guided by major syntactic category information and general syntactic principles (Rayner et al. 1983; Frazier 1987, 1990; Clifton et al. 1991), Frenck-Mestre & Pynte (1997) predict that native speakers' reading times in the V-attachment condition should be faster than in the NP-attachment condition. They also hypothesise that L2 learners will resolve attachment ambiguities differently from native speakers.

The results showed no statistically significant effects for the native speakers in the analysis of the first pass reading times. The bilingual subjects, on the other hand, appeared to have longer gaze durations in the NP-attachment condition when the preceding verb was ditransitive and shorter gaze durations when the preceding verb was monotransitive. Second pass reading times revealed that it generally took longer for bilinguals than for monolinguals to re-read the critical sentences.

Frenck-Mestre & Pynte (1997) thus argue that although bilinguals had a slight tendency to attach incoming material to the most recent constituent, their results do not strongly support the hypothesis that L2 learners resolve structural ambiguities in a different way from native speakers. Moreover, subcategorisation information affected the initial processing of ambiguous structures regardless of the participant group. However, as this effect was only significant in the second word following the noun of the PP, it can be argued that lexical information became available at a later stage in processing.

Konieczny et al. (1997) conducted an eye-tracking study in order to investigate German native speakers' attachment preferences in Verb-second (V2) and Verb-final constructions of the V-NP-PP structure. In both the V2 and the Verb-final conditions the sentences were either V-biased or NP-biased.

V2 Condition

(3)   Marion beobachtete das Pferd mit dem neuen Fernglas.   *(V-biased)*
       'Marion watched the horse with the new binoculars.'
(4)   Marion beobachtete das Pferd mit dem Weißen Fleck.   *(NP-biased)*
       'Marion watched the horse with the white patch.'

V-final Condition

(5)   Marion das Pferd mit dem neuen Fernglas beobachtete.   *(V-biased)*
       Marion the horse with the new binoculars watched
(6)   Marion das Pferd mit dem Weißen Fleck beobachtete.   *(NP-biased)*
       Marion the horse with the white patch watched.'

The analysis of the subjects' eye movements in the V2 condition indicated longer Regression Path Duration (RPD) in the NP-biased than in the V-biased sentences. In the Verb-final condition, on the other hand, first pass reading times and RPD were shorter for the NP-biased than for the V-biased sentences. Konieczny et al. (1997) conclude that their results are compatible with the principle of 'Parameterised Head Attachment', which postulates that the resolution of attachment ambiguities relies on the linear ordering of lexical heads and their detailed lexical properties.

In Greek, studies in attachment preferences have been conducted by Papadopoulou (2002) and Papadopoulou & Clahsen (2003, 2006). Papadopoulou & Clahsen (2003) conducted off-line and on-line experiments, in which they examined attachment preferences in structurally ambiguous Greek sentences involving relative clauses. Papadopoulou & Clahsen's (2003) study tested three groups of adult L2 learners of Greek and a group of native speakers of Greek. The experimental materials had the following form:

Genitive-high Condition

(7)   Enas kirios fonakse ton fititi tis kathighitrias pou itan apoghoitevmenos apo to neo ekpedheftiko sistima.
       'A man called the student (MASC) of the teacher (FEM) who was disappointed (MASC) by the new educational system.'

Genitive-low Condition

(8)   Enas kirios fonakse ton fititi tis kathighitrias pou itan apoghoitevmeni apo to neo ekpedheftiko sistima.
       'A man called the student (MASC) of the teacher (FEM) who was disappointed (FEM) by the new educational system.'

PP-high Condition

(9)   Enas kirios fonakse ton fititi me tin kathighitria pou itan apoghoitevmenos apo to neo ekpedheftiko sistima.
       'A man called the student (MASC) with the teacher (FEM) who was disappointed (MASC) by the new educational system.'

PP-low Condition

(10)   Enas kirios fonakse ton fititi me tin kathighitria pou itan apoghoitevmeni apo to neo ekpedheftiko sistima.

'A man called the student (MASC) with the teacher (FEM) who was disappointed (FEM) by the new educational system.'

The results of both the on-line and the off-line tasks indicated a high attachment preference for genitive antecedents and a low attachment preference for PP-antecedents in the case of native speakers of Greek. The L2 learners, on the other hand, exhibited a low attachment preference for PP-antecedents (similarly to the natives) but there was no statistically significant attachment preference for the genitive condition.

Papadopoulou & Clahsen (2003) conclude that L2 learners' attachment preferences differ from those of native speakers of Greek. Moreover, the similarity in attachment preferences among the three groups of L2 learners – even though their linguistic backgrounds were totally different (Spanish, German, Russian) – indicated that L2 learners do not directly transfer parsing preferences from their L1.

4. The present study

The aim of the present study is to examine Greek native speakers' attachment preferences in V-NP-PP constructions involving four basic Greek prepositions (*me* 'with', *se* 'in/into', *ja* 'for', *apo* 'from/by').

4.1 The Pre-test

An off-line completion task was conducted in order to test whether the verbs and the nouns used in the experimental sentences of the study were indeed most frequently used with the selected prepositions. Thirty monolingual speakers of Greek were asked to complete the missing preposition in 32 experimental sentences such as "The thief threatened the cashier ………. the gun and took the money". Table 1 presents the percentages of expected preposition selection:

Table 1. Percentages of expected preposition selection per type of preposition

Type of Preposition	Percentage of Expected Preposition Selection
ME	90%
SE	84%
JA	82%
APO	82%

The results of the off-line preposition completion pre-test show very high percentages of expected preposition completion in all the prepositions that were used in the study. Sentence fragments which were completed with a preposition other than the one expected were excluded. Thus, the materials of the main experiment of the present study were constructed on the basis of the expected preposition completions of this pre-test.

4.2 The Sentence Completion Task

4.2.1 Method

A Subjects: Forty undergraduate students (native speakers of Greek, both male and female) of the Aristotle University of Thessaloniki voluntarily participated in the study. The subjects' age ranged from 20 to 24 years old (mean age: 21;4). None of them was

identified either as early or late bilingual and none of them had spent more than six months abroad.

B Materials: A total of twenty four pairs of sentence fragments – six per each preposition – were used in the study. Each preposition was tested in fragments including verbs (cf. 11a, 12a, 13a & 14a) as well as nouns (cf. 11b, 12b, 13b & 14b) which take as complements PPs headed by these prepositions. The experimental sentences were constructed in such a way that the temporal ambiguity could be resolved either through attaching the PP to the verb (high attachment) or by attaching the PP to the preceding NP (low attachment). Each subject saw only one version of each fragment pair, although all subjects were exposed to all conditions. The experimental sentences were thus equally divided into two lists, each of which contained 24 experimental sentences (6 per each type of the 4 prepositions). 48 filler sentences were inserted in each of the two lists.

(11a)   O pektis travmatise tin kiria **me** _____.
        'The player hurt the lady with _____.'
(11b)   O pektis dhiapistose ton travmatismo **me** _____.
        'The player realised the hurt with _____.'
(12a)   O kathighitis eksighise to provlima **s(e)** _____.
        'The professor explained the problem in/to _____.'
(12b)   O kathighitis oloklirose tin eksighisi **s(e)**_____.
        'The professor made [completed] the explanation in/to _____.'
(13a)   O isageleas katadhikase ton odhigho **ja** _____.
        'The prosecutor convicted the driver for _____.'
(13b)   O isageleas apofasise tin katadhiki **ja** _____.
        'The prosecutor decided the conviction for _____.'
(14a)   O dhiktatoras eksorise ton politiko **apo** _____.
        'The dictator expelled the politician from _____.'
(14b)   O dhiktatoras dhietakse tin eksoria **apo** _____.
        'The dictator ordered the expulsion from _____.'

D Procedure: The experiment was a sentence completion task. Each of the participants was presented with one version of the questionnaire in printed form. The participants were instructed to read carefully and complete each of the fragments on the list. The completion procedure lasted about 20 minutes.

4.2.2 Results

The results per each biasing condition (either V or NP) and per each preposition are presented below:
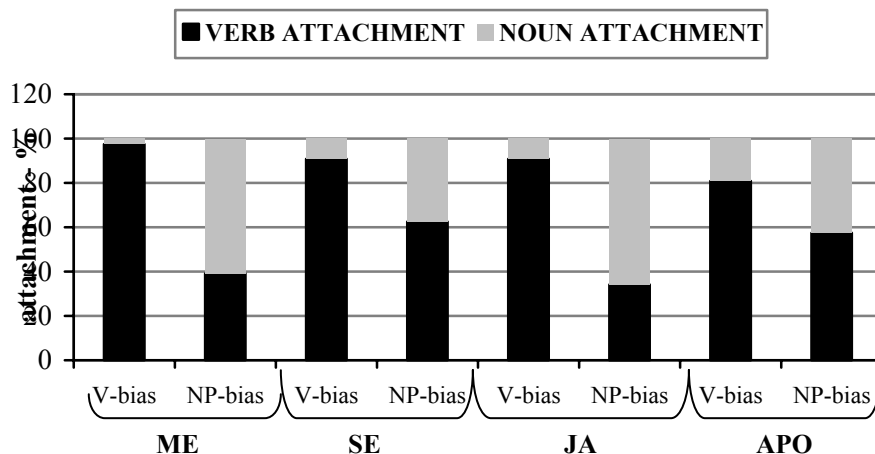
Figure 1. Attachment preferences per each type of condition and per each type of preposition

The total attachment percentages per each type of preposition in the verb and noun conditions appear in the following table:

Table 2. Attachment preference percentages per each preposition

Type of Preposition	Verb-condition		Noun-condition	
	Verb Attachment	Noun Attachment	Verb Attachment	Noun Attachment
ME	97.50%	2.50%	39.16%	60.84%
SE	90.83%	9.17%	62.50%	37.50%
JA	90.84%	9.16%	34.17%	65.83%
APO	80.84%	19.16%	57.50%	42.50%
Totals	*90%*	*10%*	*48.33%*	*51.67%*

4.2.3 Discussion

The results of the present study indicate an overall V (high) attachment preference (90%) in the verb biasing condition. Subjects' attachment preferences were altered but not fully reversed in the noun biasing attachment condition (48.33% overall percentage of V (high) attachment completions *vs* 51.67% of NP (low) attachment completions).

Even though the completions of fragments including the prepositions *me*, *se* and *ja* appear to have low percentages of noun attachment in the verb biasing condition (2.5%, 9.17% and 9.16% respectively), significantly higher levels of NP attachment occur in the case of preposition *apo* (19.16%). This effect could lead us to the conclusion that the preposition *apo* differs from the other three prepositions as far as the final attachment decisions of the parser are concerned. Further study and investigation through on-line measurements is necessary in order to be able to reach clear conclusions regarding the specific properties of all the prepositions investigated in the present study.

In the noun biasing condition, fragments including the prepositions *me* and *ja* produced more noun attachment completions (60.84% and 65.83% respectively). The opposite effect occurred in the case of the preposition *se* (37.5% of noun attachment completions) whereas fragments that included the preposition *apo* did not appear to produce any robust results in favor of either V- or NP-attachment (57.5% and 42.5%

respectively). Consequently, even though the sentence fragments that included the prepositions *me* and *ja* produce similar completion percentages, prepositions *se* and *apo* appear to have a different effect on the subjects' attachment preferences in the noun biasing condition.

It thus appears that attachment preferences have been affected by the lexical and the semantic features that each preposition carries. The offline nature of the present study does not allow us, however, to make any definite claims about the exact processes that underlie attachment preferences as it may well be the case that attachment preferences have also been based on principles of sentence processing that either have to do with processing economy of a structure (e.g. Minimal Attachment, Frazier 1990) or with the effect of the argument structure of particular lexical items in the experimental sentences (Prefer Argument, Abney 1989).

Several studies in the psycholinguistic literature have focused on the effect that the argument structure of particular lexical items – namely verbs and nouns – may have on parsing preferences (e.g. Abney 1989; Clifton et al. 1991; Britt 1994). Abney's (1989) model argues in favor of a "Prefer Argument" principle according to which there should be a preference towards "argument attachments over nonargument (adjunct) attachments". Thus, if a phrase such as a prepositional phrase is an argument of a phrase (e.g. a VP) and a nonargument of another phrase (e.g. an NP), then this prepositional phrase should be attached to the former. In the present study, the Prefer Argument principle could thus partly be the reason why there was a high verb attachment preference in the verb biasing condition in which the prepositional phrase could act as an argument of the preceding verb. In the noun biasing condition, on the other hand, a low noun attachment preference should be expected according to the Prefer Argument principle, as in our study nouns acted as thematic role assigners and could thus take a prepositional phrase as an argument.

Consequently, the overall high V-attachment preference in the verb biasing condition (90%) indicates that overall parsing preferences may have been both affected by the principle of Minimal Attachment (e.g. Frazier 1990) according to which there should be a high verb attachment preference and by the subcategorisation information of the preceding verb which created a strong bias to attach the prepositional phrase as an argument to the verb. Thus, in the verb biasing condition, two different factors (Minimal Attachment and the Prefer Argument strategy) which lead to high verb attachment were in accordance and this may be the reason for the overall high verb attachment. In the noun biasing condition on the other hand, the nouns that were used in the sentence fragments were thematic role assigners and thus a preference to attach low to the NP should be expected according to the Prefer Argument strategy (Abney, 1989). However, no clear overall preference towards high or low attachment in the structure (33% *vs* 67%) was found in the noun biasing condition as the two above mentioned processing strategies appear to have been in conflict, i.e. Minimal Attachment leading to a preference towards V-attachment and the Prefer Argument strategy leading towards NP-attachment.

All in all, the results of the present study indicate that the native speakers' attachment preferences in an off-line sentence completion (production) task may be formed on the basis of syntactic and subcategorisation information of the verbs and nouns in the V-NP-PP structure as well as on the basis of the types of prepositions that occur in each experimental fragment. Consequently, a main factor that the present study investigates and has not generally been taken under consideration in prepositional phrase attachment studies is the effect that different prepositions may have on the processing of ambiguous structures of the V-NP-PP type.

5. Conclusion

The present study allowed us to investigate native speakers' attachment preferences on temporarily ambiguous structures in an off-line sentence completion task and to conclude that these preferences are formed on the basis of syntactic, semantic and lexical information. Future research through on-line sentence comprehension and production tasks is needed in order to be able to make more definite claims with respect to the processes that underlie the resolution of structural ambiguities.

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