The present study involves the analysis of empirical data in sentences that include Greek prepositional phrases of the V-NP-PP (verb-noun phrase-prepositional phrase) type. The study was conducted in order to investigate whether the frequencies of attachment preferences in V-NP-PP structures meet the predictions of current psycholinguistic models of sentence processing. An additional aim of this study is to investigate whether the use of different prepositions in the experimental sentences affects the frequency pattern of the structure under investigation. PP attachment ambiguities involve structures such as:

1. Ο Γιάννης είδε τον άντρα με το τηλεσκόπιο.

The Janis see\+past\+perf\+3s the\+acc man\+acc with the\+acc\+loc telescope.

« Janis saw the man with the telescope. »

Sentence (1) is ambiguous in that the prepositional phrase με το τηλεσκόπιο [with the telescope] can either be attached to the preceding verb είδε [saw] denoting the instrument of the action described by the verb. Alternatively, the prepositional phrase can be attached to the preceding NP τον άντρα [the man] as a modifier of the noun phrase.

Most of the sentence processing models and theories that have been developed in the psycholinguistic literature basically aim to provide a complete account of a theory of parsing through the investigation of ambiguous structures. These models can be roughly divided into two basic categories: syntax-based models and multiple-constraint satisfaction models. According to the principles of syntax-based models, the parser initially constructs a syntactic representation of a given structure solely on the basis of syntactic information. Other types of information such as lexical, semantic, pragmatic, discourse, etc., come at a later stage and after possible re-analysis of the structure. Syntax based principles such as Minimal

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1 This work has been co-funded by:
- 75% of public cost by the European Union – European Social Fund
- 25% of public cost by the Greek Government – Ministry of Development – General Secretariat for Research and Technology
- and by the private sector

On the grounds of Measure 8.3 of the O.P. Competitiveness – 3rd Community Support Programme.


Attachment pose that attachment ambiguities should be resolved through the use of the fewest nodes in the structure (verb attachment preference). Multiple-constraint satisfaction models mainly claim that during the processing of a given structure the processor has simultaneous access to various types of information (syntactic, lexical, pragmatic, discourse, frequency, etc.) which affect processing depending on the relative strength of each constraint. Ambiguity resolution is accomplished through the satisfaction of multiple probabilistic constraints which compete with each other until the resolution of the ambiguous structure. In addition, frequency-based theories such as the Tuning Theory, claim that the resolution of an ambiguous structure varies according to the individual’s exposure to comparable examples in his or her prior experience with the language. Thus, even though syntax based models claim that attachment preferences are based on abstract syntactic principles and thus parsing decisions should be universal, constraint based and frequency based models claim that parsing decisions are expected to be language specific and to depend on prior exposure to the linguistic input.

Various studies have been conducted in English in order to examine the possible correspondence between attachment decisions and structural frequencies; however, not many such studies can be found in other languages including Greek. In this paper, I will briefly refer to two corpus studies conducted in English and then I will continue with the presentation of the current study. Donald Hindle and Mats Rooth conducted a corpus analysis of V-NP-PP structures on the basis of the 13 million-word sample of the Associated Press news stories from 1989. A sample of 1000 test sentences was randomly selected from the corpus and, after a first analysis, the sentences were restricted to 880 disambiguated items. In 294 of the 880 items, the PP attached to the preceding verb and in 586 sentences the PP attached to the preceding noun phrase indicating a clear preference for noun attachment. Moreover, Hindle and Rooth (1993), analysed the underlying relations (argument / adjunct distinction) of the experimental structures and they found an adjunct preference in the verb condition (378 PPs were adjuncts, whereas 104 PPs were arguments of the preceding verb). In the noun condition, no significant argument / adjunct preference was found (101 noun arguments versus 91 noun adjuncts). The adjunct preference in the verb condition is not compatible with theories and studies in the psycholinguistic literature that claim that verb attachment is preferred over noun attachment and that argument attachment is preferred over adjunct attachment in V-NP-PP structures. It should be noted here that by the term ‘argument’ we mean obligatory phrases such as the direct object of a transitive verb or the locative PP of

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verbs like ‘put’, whereas by the term ‘adjunct’ we mean optional element such as optional objects of optionally transitive verbs.

Michael Spivey-Knowlton and Julie Sedivy\(^7\) conducted an analysis of the Brown corpus\(^8\) from which they extracted 231 V-det-N-PP-“with” constructions. An analysis of both the whole (unrestricted) set of the corpus items and the restricted set of 147 sentences was conducted. The results indicated a predominance of verb attachment (around 60%) versus noun attachment (around 40%) in both the restricted and the unrestricted sets of corpus sentences, compatible with syntax based theories of sentence processing.

The present study focuses on a corpus analysis of sentences that include four basic Greek prepositions in the V-NP-PP structure: *me* (with), *se* (in / on / into), *ja* (for / about) and *apo* (from / by). For example:

**Verb Attachment**

2. Ο μπάρμαν γυάλίζε τον πάγκο με το κλασικό πανάκι.

   "The barman polished the bar with the classic cloth."

**Noun Attachment**

3. Άλλη μια φορά βλέπω τον τύπο με τη μακριά μύτη.

   "Once again I see the guy with the long nose."

In order to determine the frequency of attachment of the Greek prepositional phrases, an analysis of the 45-million-word HNC (Hellenic National Corpus) which has been developed by the ILSP (Institute for Language and Speech Processing) in Greece was conducted. The HNC corpus includes samples of written text from Greek books, newspapers, periodicals and other types of formal and informal written texts in Modern Greek. In order to extract the relevant corpus items, the sequences V-NP-*me* for the preposition *me*, V-NP-*se* for the preposition *se*, V-NP-*ja* for the preposition *ja* and V-NP-*apo* for the preposition *apo* were inserted in the search engine of the HNC. The resulting sentence constructions were analysed in terms of attachment of the prepositional phrase to either the preceding verb or to the preceding noun and in terms of whether the prepositional phrase was an argument or an adjunct of the site to which it attached.

A total number of 37510 corpus sentences was extracted for all the four types of prepositions. Structures that were globally ambiguous, idiomatic phrases or standard expressions as well as structures that did not correspond to the SVOPP (subject-verb-object-Prepositional Phrase) structure were excluded from subsequent analyses. All further analyses

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were thus conducted on a total number of 32140 sentences. Table 1 presents the occurrences and percentages of total verb and noun attachment in the corpus for each preposition.

<table>
<thead>
<tr>
<th>Type of structure</th>
<th>Verb Attachment</th>
<th>Noun Attachment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>V-NP1-me-NP2</td>
<td>3391</td>
<td>64</td>
<td>1886</td>
</tr>
<tr>
<td>V-NP1-se-NP2</td>
<td>13448</td>
<td>78</td>
<td>3806</td>
</tr>
<tr>
<td>V-NP1-ja-NP2</td>
<td>1740</td>
<td>32</td>
<td>3649</td>
</tr>
<tr>
<td>V-NP1-apo-NP2</td>
<td>2970</td>
<td>70</td>
<td>1250</td>
</tr>
<tr>
<td>Total</td>
<td>21549</td>
<td>67</td>
<td>10591</td>
</tr>
</tbody>
</table>

The results indicate an overall verb attachment preference (67%) found also in previous studies in the literature. Items that include prepositions me, se and apo attach most of the time to the preceding verb (64%, 78% and 70%). Sentences that include preposition ja mostly attach to the preceding noun (68%) and not to the preceding verb (32%) as it would be expected on the basis of previous findings and syntax based approaches in the psycholinguistic literature. This differentiation of preposition ja sentences most probably has to do with the specific lexical properties of the preposition ja in the Greek language.

The present study also includes an analysis of prepositional phrases in terms of the argument / adjunct distinction on the basis of the argument preference found in the psycholinguistic literature. In order to investigate the argument / adjunct relations of the prepositional phrase structures, a sample of 1000 sentences for each of the prepositions studied was further analysed. Argument / adjunct frequencies regarding each of the four prepositions studied can be seen on Table 2:

<table>
<thead>
<tr>
<th>Underlying relation</th>
<th>Preposition me</th>
<th>Preposition se</th>
<th>Preposition ja</th>
<th>Preposition apo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb attachment-argument</td>
<td>69</td>
<td>348</td>
<td>134</td>
<td>299</td>
<td>850</td>
</tr>
<tr>
<td>Verb attachment-adjunct</td>
<td>397</td>
<td>419</td>
<td>146</td>
<td>281</td>
<td>1243</td>
</tr>
<tr>
<td>Noun attachment-argument</td>
<td>112</td>
<td>101</td>
<td>369</td>
<td>155</td>
<td>737</td>
</tr>
<tr>
<td>Noun attachment-adjunct</td>
<td>119</td>
<td>31</td>
<td>188</td>
<td>160</td>
<td>498</td>
</tr>
</tbody>
</table>

The results indicate a preference for argument attachment in the noun condition and a preference for adjunct attachment in the verb condition independently of the prepositions studied. This result is not completely compatible with previous findings of sentence processing studies in which a clear argument attachment preference has been found irrespectively of the type of attachment site\(^9\). Moreover, the lexical effect of the preposition is again evident, as noticeable differences can be found in terms of argument / adjunct attachment in the examination of each preposition separately (see Table 2).

To conclude, the analysis of the corpus PP structures indicated a verb attachment preference compatible with psycholinguistic theories of sentence processing. In addition, it was shown that the lexical choice of the preposition affects the frequency pattern of the V-

NP-PP structures that were examined in Greek. A possible extension of the present study would include offline and online sentence processing tasks in order to examine whether the frequency patterns are reflected in the processing of ambiguous structures in Greek.