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PARSING STRATEGIES IN L1 AND L2 SENTENCE PROCESSING

A Study of Relative Clause Attachment in Greek

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To contribute to a better understanding of second language (L2) sentence processing, the present study examines how L2 learners parse temporarily ambiguous sentences containing relative clauses. Results are reported from both off-line and on-line experiments with three groups of advanced learners of Greek whose native languages (L1s) were Spanish, German, or Russian as well as from corresponding experiments with a control group of adult native speakers of Greek. We found that, despite their nativelike mastery of the construction under investigation, the L2 learners showed relative-clause attachment preferences that were different from those of the native speakers. Moreover, the L2 learners did not exhibit L1-based preferences in their L2 Greek, as might be expected if they were directly influenced by L1 attachment preferences. We suggest that L2 learners integrate information relevant for parsing differently from native speakers, with the L2 learners relying more on lexical cues than the native speakers and less on purely structurally based parsing strategies.

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Previous second language (L2) acquisition studies have focused on linguistic knowledge in language learners. By contrast, relatively little is known about the strategies L2 learners employ to process sentences in real time (see Juffs, 2001; Klein, 1999). It is surprising that the question as to how language learners process the target language has received little attention, given that a learner's ability to process an input string appears to be a crucial prerequisite for the acquisition of linguistic knowledge (see Fodor, 1998, for relevant theoretical discussion). Some researchers have recently begun to use reaction-time data and on-line experimental techniques, such as sentence matching, eye tracking, or self-paced reading, to investigate L2 acquisition and parsing (e.g., Clahsen & Hong, 1995; Duffield & White, 1999; Eubank, 1993; Fernández, 1999, 2000; Frenck-Mestre & Pynte, 1997; Juffs, 1998; Juffs & Harrington, 1995, 1996). The results obtained thus far are still rather scarce and not yet conclusive. As Klein (p. 210) pointed out, many of these studies must be replicated before firm conclusions can be drawn.

Against this background, a research team at the University of Essex has recently started to conduct a detailed, experimental psycholinguistic study of sentence processing in child first language (L1) and adult L2 learners, investigating two core aspects of sentence processing: the parsing of temporarily ambiguous sentences and the processing of filler-gap dependencies. The present study examines parsing preferences in temporarily ambiguous sentences of Greek—specifically, preferences in the attachment of relative clauses (RCs). We first present here a brief summary of the psycholinguistic literature on attachment preferences in the L1 and L2. Then, after an overview of some relevant grammatical properties of Greek and the materials and experimental methods used in this study, we present the experimental results from Greek native speakers and three groups of L2 learners.

ATTACHMENT PREFERENCES IN NATIVE SPEAKERS[1]

Consider sentences such as (1) in which the RC can be attached either high, to the first noun phrase (DP-1) *the servant*, or low, to the second noun phrase (DP-2) *the actress*.

(1) *Someone shot* [*the servant*]$_{DP\text{-}1}$ *of* [*the actress*]$_{DP\text{-}2}$ *who was on the balcony.*

Several studies have employed acceptability judgment tasks and reaction-time experiments to examine attachment preferences in such sentences across different languages. Most studies examining native speakers of English have found a DP-2 preference—that is, the RC in (1) is preferably associated with the lower noun phrase (DP) *the actress* (e.g., see Carreiras & Clifton, 1999; Cuetos & Mitchell, 1988; Frazier & Clifton, 1996). This preference has been ascribed to a general parsing strategy[2] termed *right association* (Kimball, 1973), *late closure* (Frazier, 1978), or *recency* (Gibson, Pearlmutter, Canseco-Gonzalez, & Hickock, 1996), according to which new phrases are attached to the

phrase currently being processed (i.e., to the most recent phrase if grammatically possible).

Crosslinguistic Differences in RC Attachment

Results from studies examining languages other than English have shown, however, that the late closure or recency preference does not hold universally. For example, a high (DP-1) attachment preference was found in sentences equivalent to (1) in languages including Spanish (Cuetos & Mitchell, 1988), German (Hemforth, Konieczny, & Scheepers, 2000; Hemforth, Konieczny, Scheepers, & Strube, 1998), Dutch (Brysbaert & Mitchell, 1996), French (Zagar, Pynte, & Rativeau, 1997), and Russian (R. Radach & V. Kempe, personal communication, July 21, 2001). On the other hand, a DP-2 preference was found not only in English but also in Norwegian, Swedish, and Romanian (Ehrlich, Fernández, Fodor, Stenshoel, & Vinereanu, 1999) as well as in Brazilian Portuguese (Miyamoto, 1998) and Arabic (Abdelghany & Fodor, 1999). These findings might mean that at least some parsing strategies are language specific rather than universal.

There have been three main attempts to explain the crosslinguistic attachment differences in these terms. Within Gibson and Pearlmutter's (1998) multiple-constraint model of sentence processing, attachment preferences are determined by the relative strength of a number of interacting parsing strategies in a given language. They argued that, in addition to the universal recency strategy, the parser may employ a second, structurally based parsing strategy termed *predicate proximity*, according to which ambiguous modifiers are preferentially attached to constituents as structurally close as possible to the predicate (i.e., to the S/IP node), hence favoring attachment of the RC to the overall object DP in (1); see also Gibson and Schütze (1999). Gibson and Pearlmutter further argued that the relative strength of the predicate proximity strategy is linked to the degree of (non)configurationality of a given language. That is, in languages such as Spanish, German, or Russian that allow verbs and their complements to be nonadjacent, the verb may be more active during processing and may, therefore, be more likely to attract ambiguous modifiers. By contrast, configurational languages such as English, Norwegian, Swedish, and even Brazilian Portuguese (which, as Miyamoto, 1998, pointed out, does not allow adverbs to intervene between the verb and object) give less weight to predicate proximity. Greek patterns with Spanish, German, and Russian in that it allows verbs and their complements to be nonadjacent; from Gibson and colleagues' account we would therefore expect predicate proximity to be strong enough to outrank recency, yielding a DP-1 preference in the Greek equivalents of (1).

The second proposal is the attachment-binding hypothesis of Hemforth and colleagues (Hemforth et al., 1998; Hemforth et al., 2000; Konieczny, Hemforth, Scheepers, & Strube, 1997). They argued that, in languages in which the RC is introduced by a relative pronoun (e.g., German), attachment preferences

are sensitive to more general constraints on pronouns—in particular, to a discourse constraint on anaphoric binding according to which pronouns have to be attached to salient discourse entities. Arguably, in sentences such as (1), the head of DP-1 is a more salient discourse entity than that of DP-2 given that it is an argument of the verb. Consequently, in the German equivalent of sentences such as (1), the RC is preferably attached high due to constraints on anaphoric binding. In English, however, in which RCs may be headed by a complementizer or appear without any overt introductory element, RC attachment is not sensitive to such constraints, which explains the lack of a high-attachment preference in English. In this regard, Greek patterns with English in allowing RCs to be headed by complementizers. Given the attachment-binding account, we would therefore expect to find a low (DP-2) attachment preference in Greek sentences corresponding to (1).

The third attempt to explain crosslinguistic differences in RC attachment is Mitchell and colleagues' Tuning Hypothesis (e.g., see Mitchell, 1994; Mitchell, Cuetos, Corley, & Brysbaert, 1995), according to which the parser's attachment preferences in temporarily ambiguous sentences directly correspond to the frequency distribution of adjunct attachments. That is, a person who is exposed to a language in which RCs are typically interpreted as high attachments will be more likely to prefer a DP-1 attachment in an ambiguous sentence, whereas a person who is most frequently exposed to low-attachment input will prefer a DP-2 attachment. To support this account, Mitchell et al. presented data showing that RC-attachment preferences obtained from experimental studies were positively correlated with the frequency distribution of attachments obtained from corpus data (see, however, Gibson & Schütze, 1999, for some conflicting evidence). Unfortunately, there are no corpora available that would allow us to examine the frequency distribution of RC attachments in Greek and to test the Tuning Hypothesis for native speakers of Greek. We will, however, examine a prediction derived from the Tuning Hypothesis for the L2 data. Recall that previous research on RC attachment has shown that the L1s of our L2 participants (Spanish, German, and Russian) exhibit a DP-1 attachment preference in sentences such as (1). Likewise, our findings from native speakers of Greek in the present study also show a clear DP-1 preference in these kinds of sentences. Thus, it is reasonable to suppose that our L2 participants have been exposed to a DP-1 preference in both their L1 and L2. From the perspective of the Tuning Hypothesis, we would therefore expect that, when faced with an ambiguity, they would choose the option that had been encountered most often in the past (i.e., high, DP-1 attachment for the RC).

Lexical Biases in RC Attachment

Another set of findings concerns lexical biases in RC attachment. Several studies have found that, when a DP-2 is introduced by a thematic preposition, the RC tends to be attached low (e.g., see Felser, Marinis, & Clahsen, in press;

Frenck-Mestre & Pynte, 2000; Gilboy, Sopena, Clifton, & Frazier, 1995; Traxler, Pickering, & Clifton, 1998). Interestingly, this also holds for languages such as Spanish and French in which the equivalents of (1) show high attachment. Thus, the presence of a thematic preposition such as *with* or *con* seems to affect RC-attachment preferences. Frazier and Clifton's (1996) Construal Theory is an attempt to capture these facts. They argued that so-called nonprimary phrases (i.e., nonobligatory constituents including RC adjuncts) are construed or associated with the closest thematic-processing domain. That is, when the DP-2 receives a theta role from a preposition, as in (2) from *with*, the RC is processed within this thematic domain and is consequently attached low.

(2) *The doctor recognized* [*the pupil*]$_{\text{DP-1}}$ *with* [*the nurse*]$_{\text{DP-2}}$ *who was feeling very tired.*

In this way, the Construal Theory accounts for the fact that in sentences such as (2) low attachment is preferred across languages. However, in sentences such as (1), the closest thematic processing domain is the entire DP (*the servant of the actress*), which includes both DP-1 and DP-2. Consequently, the Construal Theory does not yield an attachment preference in such sentences.

PREVIOUS STUDIES ON ATTACHMENT PREFERENCES IN L2 LEARNERS

A small number of previous studies have examined attachment preferences by L2 learners (Fernández, 1999; Frenck-Mestre, 1997; Frenck-Mestre & Pynte, 1997). Other studies have explored attachment preferences in bilinguals; see Fernández (2000) for a review of these studies. Our focus here is on studies examining adult learners who acquired the L2 after puberty.

In two eye-tracking experiments, prepositional phrase (PP) attachment and main or subordinate clause ambiguities were examined in advanced French learners of English and English learners of French (Frenck-Mestre & Pynte, 1997).[3] In the first experiment, Frenck-Mestre and Pynte addressed the question as to whether L2 learners' parsing strategies differ from the ones native speakers use when the structures under investigation are identical in the L1 and L2. Their materials consisted of temporarily ambiguous sentences involving the attachment of a PP either to a verb phrase (VP) or a DP, such as *Brutus hit the gladiator with the shield with his bare hands*. This sentence is ambiguous up to the PP *with the shield* because this PP could be attached to either the entire VP or the object DP. It is the PP *with his bare hands* that disambiguates the sentence toward DP attachment. It was found that, for both native speakers and L2 learners, attachment preferences were dependent on the argument structure of the verb; for sentences with ditransitive verbs (e.g., *hit*), VP attachment was preferred, and for those with monotransitive verbs (e.g., *reject*), DP attachment was preferred. This was interpreted as supporting a lexically driven parser in both L2 learners and native speakers in which subcategorization information of the verb affects parsing decisions.

The second experiment examined whether L2 learners transfer lexical properties from their L1 when processing temporarily ambiguous L2 input. Sentences such as *Every time the dog obeyed the pretty little girl showed her approval* were used with verbs such as *to obey* (*obéir*) that are optionally transitive in English and obligatorily intransitive in French. Consequently, whereas in English the DP *the pretty little girl* can be parsed as either the direct object of the verb or the subject of the subsequent main clause, in the French translation of this sentence, *Chaque fois que le chien obeissait la jolie petite fille montrait sa joie*, the DP *la jolie petite fille* cannot be constructed as a direct object of the embedded verb. These kinds of sentences were compared with parallel sentences in which *obéir* and the like were replaced by verbs such as *aboyer* "to bark," which are most typically intransitive in both English and French. The experimental results indicated that French learners of English took longer to read sentences with verbs such as *to obey* than corresponding sentences with verbs such as *to bark*. Frenck-Mestre and Pynte (1997) interpreted this finding as an effect of L1 transfer; the L2 learners took extra time "to reflect upon a verb's usage in cases where information from their native language conflicted with that from their second language" (pp. 141–142). Note, however, that a delayed effect is to be expected for verbs such as *to obey* (compared to *to bark*) on independent grounds. Optionally transitive verbs make available a greater number of structural options for on-line processing than intransitive verbs, and this difference may have caused the longer reading times for sentences with *obey*-type verbs. This would also be compatible with the fact that a similar (albeit smaller) difference in reading times was found for native speakers. Moreover, the L2 learners were tested in French and English in the same experiment, which required them to switch back and forth between L1 and L2, and such a design may have produced arbitrary effects. For these reasons, we think that the L1 transfer explanation offered by Frenck-Mestre and Pynte is not particularly convincing.

Fernández (1999) examined RC-attachment preferences in English in two groups of Spanish L2 learners and in adult native speakers using an off-line questionnaire. The experimental materials consisted of ambiguous sentences, such as *Roxanne read the review of the play that was written by Diane's friend*, containing RCs preceded by complex DPs linked by the prepositions *of* or *with*. There were 15 early learners (Spanish speakers who started to learn English before the age of 10) and 15 late learners (who started to learn English after age 10).[4] A clear low-attachment preference was found in the native speakers but not in the L2 learners. Instead, both early and late learners produced more high-attachment answers than the native speakers did. Fernández interpreted this as a result of L1 transfer, reflecting the fact that Spanish prefers high attachment in cases in which English prefers low attachment. Note, however, that whereas native speakers of Spanish exhibited a clear low-attachment preference for DP-*con*-DP (e.g., see Cuetos & Mitchell, 1988; Cuetos, Mitchell, & Corley, 1996), the L2 learners showed no clear preference for either high or low attachment (see Fernández, p. 227, table 1), which indicates

that the L2 learners' responses cannot be accounted for in terms of L1 transfer. It should also be mentioned that a direct comparison between the two conditions (*of* vs. *with*) is not possible because the DPs used in both conditions were different.

Frenck-Mestre (1997) examined RC-attachment preferences in temporarily ambiguous sentences of French by native speakers and so-called beginning adult L2 learners whose L1s were either English or Spanish.[5] RC antecedents consisted of complex DPs with prepositions that do not assign theta roles (DP-*de*-DP). An overall high-attachment preference was found for native speakers and Spanish L1 participants, and no preference was found for English L1 participants. Frenck-Mestre interpreted this finding in support of L1 transfer, reflecting the fact that a high-attachment preference is found in L1 Spanish but not in L1 English. Note, however, that, because Frenck-Mestre did not provide any background information on the L2 participants (except that they were at a beginning level), we cannot rule out the possibility that the Spanish and English participants were at different proficiency levels in their L2 and therefore not directly comparable with each other. Moreover, most studies of native speakers of English have shown a low-attachment preference; L1 transfer in the case of English learners should therefore lead to a low-attachment preference (rather than no preference).

In summary, these studies have not produced conclusive results. They are also hard to interpret because the learners' L2 proficiency and particularly their grammatical knowledge of the constructions under study were not independently assessed. It is therefore possible that differences observed between native speakers and L2 learners in the experiments were, at least in part, due to the L2 learners' incomplete acquisition of the relevant grammatical constructions.

THE PRESENT STUDY

Building on the findings summarized in the previous sections, we investigated RC-attachment preferences in native speakers and L2 learners of Greek. Greek has some morphological and structural properties that are advantageous for studying RC-attachment preferences. For example, Greek has (a) relatively free word order, (b) RCs introduced by complementizers, and (c) morphologically marked genitives. Given (c), genitive antecedents in Greek are therefore clearly distinct from PP antecedents (unlike, for example, in English, French, or Spanish).[6] Moreover, data from Greek allow us to assess different models of RC attachment. For example, given property (b), the attachment-binding model of RC attachment (Hemforth et al., 1998) predicts a low-attachment preference for Greek, whereas, given (a), the multiple-constraint account of Gibson and Pearlmutter (1998) predicts a high-attachment preference for the same sentences. The experimental results reported in the present study show that native speakers of Greek prefer high attachment of the RC in sentences with genitive antecedents, thus providing support for Gibson and Pearlmutter's parsing model.

To examine L2 sentence processing, we investigated RC attachment in three groups of advanced learners of Greek whose L1s were Spanish, German, or Russian, using both off-line and on-line experiments on RC attachment. Additionally, the L2 participants underwent a grammaticality judgment test to ensure that they could handle the kinds of sentences tested in the two main experiments. With respect to RC-attachment preferences, our results from native speakers of Greek show that Greek patterns with Spanish, German, and Russian in that these languages prefer high attachment of the RC in sentences with genitive antecedents. As the L1s and the target language of our L2 participants exhibit the same attachment preferences, one might expect them to perform like native speakers of Greek in these constructions. This would at least be consistent with experience-based parsing models such as the Tuning Hypothesis as well as with the idea that language-particular attachment preferences of the L1 are transferred to the L2. Our results do not confirm this prediction, however. Despite nativelike performance in the grammaticality judgment test and parallel-attachment preferences in both their L1s and Greek, the L2 learners showed RC-attachment patterns different from native speakers of Greek. We argue that these results provide evidence against both the exposure-based models of parsing and the notion of L1 transfer of language-particular attachment preferences in L2 sentence processing.

RESTRICTIVE RCs, GENITIVES, AND PPs IN GREEK

In this section, we provide a brief description of relevant grammatical properties of Greek and the materials used in our experiments. There is extensive linguistic literature on RCs and the structure of nominals in Greek (e.g., see Alexiadou, 1999; Holton, Mackridge, & Philippaki-Warburton, 1997; Theophanopoulou-Kontou, 1989; Varlokosta, 1999), which will not be discussed here. Rather, the following remarks are just meant as background information for those unfamiliar with the Greek language.

To examine attachment preferences in Greek, we constructed experimental sentences with a grammatical structure similar to those in (1) and (2). These sentences have a transitive verb in the main clause with an overt subject and a direct object followed by either a genitive DP or a PP; the main clause is followed by a restrictive RC, which is always introduced by the complementizer *pu* "that," as in (3).

(3) *Enas antras kitakse ton dhaskalo*
a-MASC-SG-NOM *man*-MASC-NOM *looked the*-MASC-SG-ACC *teacher*-MASC-ACC
tis mathitrias pu itan stin avli.
the-FEM-SG-GEN *pupil*-FEM-SG-GEN *that was in-the*-FEM *schoolyard*
"A man looked at the teacher of the pupil who was in the schoolyard."

Mackridge (1985, p. 253) pointed out that the invariant complementizer *pu* "that" is the most common element for introducing RCs and that it is used more frequently than the relative pronouns *o opios* "who, which$_{MASC}$," *i opia* "who,

which$_{FEM}$," and *to opio* "who, which$_{NEUT}$" in both colloquial speech and writing. This is particularly the case for subject RCs such as those used in our experiments. In addition to RCs, *pu* is also used to introduce exclamatives and complements of factive verbs.

Regarding the RC antecedents, the experimental materials contain complex (object) DPs with possessive genitives, as in (3), or PPs with the preposition *me* "with." Similar to previous studies on attachment preferences in languages other than Greek, the two DPs in the genitive condition of our experiments express a functional or professional relationship (e.g., *teacher of the pupil*), a relationship that Tzartzanos (1991) labeled *dependency genitive*. Even though the genitive DP may precede the head DP for purposes of contrast (Holton et al., 1997, p. 264), the typical order for such complex DPs is for the genitive DP to follow the head DP, as illustrated in (3).

Most syntactic accounts of Greek have argued that genitive DPs are base generated postnominally (Alexiadou & Stavrou, 1999; Horrocks & Stavrou, 1987; Theophanopoulou-Kontou, 1989). In contrast to these no-movement analyses, Alexiadou (1999) argued that the possessor DP, such as *dhaskalo* "teacher" in (3), is base generated after the possessum DP *mathitrias* "pupil," from which it is moved to the left of the possessum noun (to check agreement and case features), yielding a derived structure ([[DP$_i$] DP$_{GEN}$ t$_i$]) with a trace for the moved DP. We will not elaborate on the syntactic arguments for and against these conflicting proposals in this study, but it is important to point out that the predictions for parsing sentences such as (3) are dependent on which syntactic analysis is assumed for complex DPs. Consider, for example, the late closure or recency strategies, according to which new material is attached to the most recent phrase. Under the no-movement analysis, the most recent phrase for the attachment of the RC in (3) is the genitive DP. However, under Alexiadou's account, the most recent syntactic element before the RC is the trace of the moved, possessor noun. Thus, late closure or recency paired with Alexiadou's analysis would yield RC attachment to the DP containing the possessor noun, whereas under the no-movement analysis the same parsing strategy would yield RC attachment to the DP with the possessum noun. When discussing the experimental results, we have to consider both possibilities.

The second type of complex DP used in the experimental materials contains PPs with the preposition *me* "with" (e.g., *ton kirio me to koritsi* "the man with the girl") in which the PPs denote spatial or temporal accompaniment. Complex DPs of this kind are straightforwardly right branching and, in contrast to genitive DPs, have not been argued to involve any kind of reordering.

METHOD

Participants

Three groups of advanced learners of Greek, all residents of Greece, were tested. There were 18 adult L2 learners (L2-S) whose L1 was Spanish, whose

Table 1. Characteristics of the L2 groups

	L2-S		L2-G		L2-R	
Characteristics	*M*	*SD*	*M*	*SD*	*M*	*SD*
Years of residence in Greece	11.21	6.90	13.73	12.16	4.30	3.40
Years of formal instruction in Greek	2.06	1.59	1.42	0.58	2.35	2.54
Greek Language Proficiency scores	75.33	3.27	72.63	5.96	71.90	4.89
Age of first exposure to Greek	26.39	4.62	23.74	9.22	22.10	6.47

mean age was 38.8 years, and who were all first exposed to Greek after 12 years of age. There were 19 adults (L2-G) whose L1 was German and whose mean age was 42.9 years. Two of these participants reported having had some occasional contact with Greek during childhood through grandparents and other relatives. The remaining 17 participants were first exposed to Greek in their adulthood. Finally, there were 10 adults (L2-R) whose L1 was Russian, whose mean age was 27.3 years, and who were all first exposed to Greek as adults. Additional background information about these three groups is given in Table 1. All the learners had attended Greek language courses, and when the experiments took place, all of them were living and working in Athens. They all reported using Greek on a daily basis for interaction with native and nonnative speakers—that is, all the participants used Greek in their work environment, and all of them had Greek friends or partners with whom they communicated in Greek.

To obtain a general measure of the L2 learners' proficiency in Greek, we tested them on the Greek Language Proficiency Test used at the University of Athens.[7] The maximum score on this test is 80. As can be seen from the proficiency scores in Table 1, all L2 learners achieved very high scores on this test, which indicated that their knowledge of Greek was at an advanced level.

Additionally, some of the participants knew a third language (L3), which was English, French, or Italian, but none reported being fluent in any of these languages. Within the L2-S group, six participants reported knowing English at an intermediate level and six at an elementary level. However, only one was actively using English when the experiments took place, as she was taking English language courses at the university. The remaining six participants had not studied or learned English at all. A similarly mixed picture regarding their knowledge of English holds for the L2-R group; three reported having advanced knowledge of English, three intermediate, two elementary, and two no English at all. Only the L2-G group was relatively homogeneous in this respect; five learners reported having advanced knowledge of English, and the remaining 14 reported having intermediate knowledge.

All L2 learners participated in a grammaticality judgment task, and all of them, except for one L2-G participant, also took part in the acceptability judgment task. In the self-paced reading (SPR) experiment, there were 16 partici-

pants from the L2-S group, 11 from the L2-G group, and 9 from the L2-R group. Furthermore, the two main experiments were administered to two different control groups of adult native speakers of Greek. For the acceptability judgment task, the control group consisted of 16 native speakers (mean age: 24.2 years; 6 males and 10 females) who were students at the University of Athens. The SPR task was administered to a group of 20 native speakers (mean age: 24.1 years; 7 males and 13 females) who were students at the University of Essex.[8] All of the participants were naïve with respect to the purpose of the experiments.

Experimental Tasks

The purpose of the grammaticality judgment task was to test, independently of the two main experiments, whether the L2 learners could handle the constructions under study, particularly RCs with complex antecedents. The task consisted of 50 sentences, all of which contained various types of RCs. There were 20 grammatical sentences with subject, direct object, indirect object, or genitive RCs (five each), and five RCs with two antecedents. The 25 ungrammatical sentences had doubly filled complementizers, sentences without an overt complementizer, genitive RCs with complementizers but without the required resumptive pronouns, RCs with preposition stranding, and RCs with two antecedents (five each). The format of the grammaticality judgment task was adopted from Hawkins and Chan (1997).

The materials used in the two main experiments were similar.[9] The critical sentences were all grammatical, consisted of 4–6 words, and contained a main clause and a subject-RC with two possible antecedents introduced by the complementizer *pu* "that," as illustrated in (4).

(4) a. Condition Gen-high
Enas kirios fonakse ton fititi
a-MASC-SG-NOM *man*-MASC-SG-NOM *called the*-MASC-SG-ACC *student*-MASC-SG-ACC
tis kathighitrias pu itan apoghoitevmenos apo to neo
the-FEM-SG-GEN *teacher*-FEM-SG-GEN *that was disappointed*-MASC *by the new*
ekpedheftiko sistima.
educational system
"A man called the student$_{MASC}$ of the teacher$_{FEM}$ who was disappointed$_{MASC}$ by the new educational system."

b. Condition Gen-low
Enas kirios fonakse ton fititi
a-MASC-SG-NOM *man*-MASC-SG-NOM *called the*-MASC-SG-ACC *student*-MASC-SG-ACC
tis kathighitrias pu itan apoghoitevmeneni apo to neo
the-FEM-SG-GEN *teacher*-FEM-SG-GEN *that was disappointed*-FEM *by the new*
ekpedheftiko sistima.
educational system
"A man called the student$_{MASC}$ of the teacher$_{FEM}$ who was disappointed$_{FEM}$ by the new educational system."

c. Condition PP-high
Enas kirios fonakse ton fititi me
a-MASC-SG-NOM *man*-MASC-SG-NOM *called the*-MASC-SG-ACC *student*-MASC-SG-ACC *with*

tin kathighitria pu itan apoghoitevmenos apo to neo
the-FEM-SG-ACC *teacher*-FEM-SG-ACC *that was disappointed*-MASC *by the new*
ekpedheftiko sistima.
educational system
"A man called the student$_{MASC}$ with the teacher$_{FEM}$ who was disappointed$_{MASC}$ by the new educational system."

d. Condition PP-low
Enas kirios fonakse ton fititi me
a-MASC-SG-NOM *man*-MASC-SG-NOM *called the*-MASC-SG-ACC *student*-MASC-SG-ACC *with*
tin kathighitria pu itan apoghoitevmeneni apo to neo
the-FEM-SG-ACC *teacher*-FEM-SG-ACC *that was* disappointed-FEM *by the new*
ekpedheftiko sistima.
educational system
"A man called the student$_{MASC}$ with the teacher$_{FEM}$ who was disappointed$_{FEM}$ by the new educational system."

The two DPs preceding the RC were always animate, had different genders (either feminine or masculine), and expressed a functional or professional relationship. To examine the role of lexical biases, the form of the RC antecedent was manipulated (see [4a] and [4b] vs. [4c] and [4d]). The critical sentences were disambiguated by the form of the participle or adjective, through gender agreement, yielding either high or low RC attachment. In this way, the variables antecedent (DP + DP$_{GEN}$ vs. DP + PP) and attachment (high vs. low) lead to four experimental conditions, as shown in (4). Otherwise (i.e., apart from the different antecedent and attachment types), the experimental sentences were identical.

With respect to the acceptability judgment task, we expected the participants' acceptability judgments to be affected by their attachment preferences. Specifically, sentences in which the disambiguating gender information confirms the initial, preferred attachment of the RC should receive higher scores than sentences in which the gender cue is incompatible with the initial attachment. This is because in the latter case the initial interpretation has to be revised, and in a scaled judgment task this is likely to affect the scores assigned to the sentences; see also Birdsong (1992) for support to the argument that scaled judgment tasks are sensitive to degrees of acceptability. There were 20 experimental sentences, 5 for each of the four conditions shown in (4). In addition to the critical sentences, we constructed 40 filler sentences for this judgment task involving a variety of constructions (e.g., reflexive, control, raising, gerund, and *wh*-extraction constructions). Ten filler sentences were grammatically well formed. Twenty filler sentences were made ungrammatical by a gender or number mismatch between the antecedent DP and the past participle; the structure of these sentences was parallel to the experimental sentences. Ten other filler sentences included other kinds of ungrammaticality. Participants were instructed to read the sentences and judge the acceptability of each sentence on a 5-point scale from 1 (*not at all acceptable*) to 5 (*completely acceptable*). They were instructed to read the sentences as carefully and quickly as they could and to rely on their personal judgments, not on prescriptive grammatical rules. Additionally, the participants were instructed to

give the lowest score to any sentence they thought was ungrammatical. The task was completed in less than half an hour.

The rationale for the SPR task is that increased reading times for a particular segment (relative to the same segment in a control condition) indicate a relatively higher processing difficulty at this point during the parse. That is, reading times for the disambiguating segment should be higher for those conditions that force the dispreferred attachment, reflecting the time it takes comprehenders to revise their initial (i.e., preferred) analysis of the sentence. There were 24 critical sentences (6 for each condition) as well as 72 filler sentences with different syntactic constructions, all of which were grammatical. The experimental sentences were parallel to the ones in (4) except that the auxiliary form *itan* was replaced by a finite form of the verb *fenome* "to seem." This was done to avoid a temporal ambiguity that might result from the fact that *itan* is a syncretic form meaning either *was* or *were*. The verb *fenome* has two different forms in the past continuous, one for singular (*fenotan*) and one for plural (*fenodan*), and thus avoids this ambiguity.[10] All experimental and filler sentences were divided into five segments, as illustrated in (5).[11]

(5) First: *Enas* *kirios* *fonakse*
a-MASC-SG-NOM *man*-MASC-SG-NOM *called*
Second: *ton* *fititi* *tis* *kathighitrias*
the-MASC-SG-ACC *student*-MASC-SG-ACC *the*-FEM-SG-GEN *teacher*-FEM-SG-GEN
Third: *pu* *fenotan*
that seemed-SG
Fourth: *apoghoitevmenos*
disappointed-MASC
Fifth: *apo to neo ekpedheftiko sistima.*
by the new educational system
"A man called the student$_{MASC}$ of the teacher$_{FEM}$ who seemed disappointed$_{MASC}$ by the new educational system."

The critical region is the fourth segment (i.e., *apoghoitevmenos* "disappointed$_{MASC}$") because it is here that the disambiguation occurs. A low-attachment preference would be evident from shorter reading times for the fourth segment of conditions Gen-low and PP-low in comparison to Gen-high and PP-high. This is because, in the former two conditions, the form of the gender marking on the adjective is compatible with the initial (low) attachment, whereas in the latter two conditions it is not. If, on the other hand, participants prefer a high (DP-1) attachment, reading times on the fourth segment should be shorter for the Gen-high and the PP-high conditions than for the Gen-low and PP-low conditions.

The stimuli were presented on a computer monitor in white letters (Arial 24-point) on a dark background. The participants were instructed to read the sentences as quickly and carefully as they could. They read the sentences in a segment-by-segment fashion, and the presentation of each new segment was triggered by pressing a pacing button. The times between button presses provide the crucial experimental measure. To make sure that participants paid

Table 2. Mean grammaticality judgment scores and standard deviations for subject RCs with complex antecedents

	L2-S		L2-G		L2-R	
Subject RCs	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hits	4.33	0.84	4	1	3.70	1.16
Correct rejections	5	0	4.84	0.50	4.80	0.42

Note. The maximum score for hits and correct rejections is 5.

attention to the content of the sentences, they were also required to answer a yes/no content question after reading each sentence. Questions eliciting yes/no answers were evenly distributed across the four conditions. The whole experiment lasted 45–60 minutes per person.

RESULTS

Grammaticality Judgments

Table 2 presents the grammaticality judgment scores (mean scores and standard deviations for correct responses) for the constructions that were tested in the two main experiments—namely, subject RCs with complex (DP + DP) antecedents. "Hits" are grammatically well-formed sentences that were accepted, and "correct rejections" are ungrammatical sentences that were rejected. The three groups of L2 learners achieved high scores on this task in terms of hits and correct rejections. Moreover, the scores in Table 2 do not significantly differ among language groups, showing that the three groups of L2 learners performed similarly on this task: $F(2, 44) = 1.415$, $p = .254$ for hits; $F(2, 44) = 1.227$, $p = .303$ for correct rejections. These results indicate that the L2 learners we tested have acquired the grammatical properties necessary for dealing with RCs with complex antecedents such as those used in our main experiments.

Acceptability Judgments

Recall that in this task participants were confronted with grammatical sentences, as in (4), to test their attachment preferences and with ungrammatical sentences involving gender or number agreement mismatches, as in (6), to test whether the L2 learners could handle the kind of long-distance, subject-verb agreement between an antecedent DP and a participle or adjective that is required for correctly interpreting the experimental sentences.

(6) **O ipiretis hamoghelase ston vioghrafo tis*
the servant smiled at-the-MASC-SG-ACC *biographer*-MASC-SG-ACC *the*-FEM-SG-GEN

Table 3. Mean acceptability judgment scores and standard deviations

	Gen-high		Gen-low		PP-high		PP-low	
Participants	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Native speakers	4.24	1.10	3.05	1.53	1.62	1.10	2.97	1.67
L2-S	3.26	1.72	3.17	1.71	2.06	1.44	3.02	1.76
L2-G	3.82	1.24	3.54	1.38	2.50	1.40	3.17	1.36
L2-R	3.50	1.50	2.70	1.53	2.42	1.39	3.04	1.51

Note. The scores ranged on a 5-point scale from 1 (*not at all acceptable*) to 5 (*completely acceptable*).

ithopiu pu itan hamena stis skepsis tus.
actress-FEM-SG-GEN *who was lost*-NEUT-PL *in their thoughts*
"The servant smiled at the biographer of the actress who was lost in their thoughts."

The results from L2 learners' judgments of the ungrammatical sentences were parallel to those of the native speakers; the L2-S group correctly rejected 95%, the L2-G group 95.3%, the L2-R group 96%, and the Greek native speakers 99.3% of the ungrammatical sentences with gender mismatches. These figures indicate that the L2 learners were sensitive to gender or number agreement mismatches.

With respect to the acceptability scores for the four experimental conditions, Table 3 presents mean scores and standard deviations. To determine whether there are reliable differences between the three groups of L2 learners, we first performed a preliminary ANOVA on the acceptability judgment scores with antecedent ($DP + DP_{GEN}$ vs. DP + PP) and attachment (high vs. low) as within-subjects variables and L2 group as the between-subjects variable.[12] This analysis revealed no significant interactions for any of the three L2 groups, which indicated that they exhibit the same L2-attachment preferences regardless of their L1. For further statistical analyses we therefore collapsed them into one L2 group.

To compare the L2 learners to the native speaker control group, a repeated measures ANOVA was performed with antecedent and attachment as within-participants variables and group (native speakers and L2 learners) as a between-participants variable. The labels F_1 and t_1 refer to subject analyses (treating participants as a random effect), and F_2 and t_2 refer to item analyses (treating items as a random effect). A main effect of antecedent was obtained, showing that overall the Gen conditions yielded higher acceptability judgment scores than the PP conditions, $F_1(1, 60) = 77.238$, $p < .001$, and $F_2(1, 78) = 82.052$, $p < .001$.[13] On the other hand, there was no significant main attachment effect, which shows that overall there was no bias toward low or high attachment. We also found a significant interaction between antecedent and attachment, which indicates that genitives were treated differently from PPs with respect to RC attachment, $F_1(1, 60) = 80.203$, $p < .001$, and $F_2(1, 78) = 84.214$, $p < .001$. Moreover, there was a significant interaction between group and antecedent, which

means that native speakers and L2 learners differed in the way they judged the sentences with genitives and PPs: $F_1(1, 60) = 8.398$, $p < .01$, and $F_2(1, 78) = 8.930$, $p < .01$. Finally, there was a significant interaction of antecedent, attachment, and group, $F_1(1, 60) = 13.096$, $p < .01$, and $F_2(1, 78) = 14.234$, $p < .001$, showing that the differences between the two antecedents are not the same for the two attachment types and that the differences between them are not the same for native speakers and L2 learners.

Further examination of these interactions using matched *t*-tests revealed significant differences between the two Gen conditions (Gen-high vs. Gen-low) for the native speakers, $t_{1\text{-}N}(15) = 4.442$, $p < .001$, and $t_{2\text{-}N}(19) = 5.923$, $p < .01$, but not for the L2 learners, $t_{1\text{-}L2}(45) = 1.714$, $p = .093$, and $t_{2\text{-}L2}(59) = 1.877$, $p = .066$. This means that the native speakers judged the high-attachment sentences as more acceptable than the low-attachment ones in the Gen conditions, whereas the L2 learners showed no such preference. In the PP conditions (PP-high vs. PP-low), on the other hand, there was a significant low-attachment preference for both participant groups: $t_{1\text{-}N}(15) = 4.635$, $p < .01$; $t_{2\text{-}N}(19) = 4.586$, $p < .01$; $t_{1\text{-}L2}(45) = 5.451$, $p < .001$; $t_{2\text{-}L2}(59) = 5.474$, $p < .001$.

In summary, we found that the form of the RC antecedent affected both the native speakers' and the L2 learners' attachment preferences but in different ways. The native speakers exhibited a clear high-attachment preference in sentences with genitive antecedents and, conversely, a low-attachment preference for antecedents with PPs. The L2 learners also preferred low attachment in the PP conditions, but in the genitive conditions there was no statistically significant attachment preference. It is also important to point out that the three groups of L2 learners performed in similar ways in this experiment. Before drawing any conclusions from these findings, we report the results of the second main experiment, the SPR task, which provide evidence for attachment preferences in on-line processing.

SPR Task

Recall that in the SPR task each sentence was followed by a comprehension question to make sure that the participants paid attention to the content of the sentences. The percentages of erroneous responses to the filler items were low: native speakers 7.7%, L2-S 11.7%, L2-G 7.1%, and L2-R 7.4%. The percentages of erroneous responses to the experimental items were higher, particularly for the L2 learners (native speakers 8.5%, L2-S 14.6%, L2-G 18.2%, and L2-R 22.7%), probably because overall the experimental sentences were more complex than the filler sentences. Trials that produced erroneous responses to the comprehension questions were excluded from any subsequent analysis. For the native speakers, reading times that were two standard deviations above or below the mean of an experimental condition were removed from the data set before any further statistical analysis, which resulted in the re-

Table 4. Mean reading times (in milliseconds)

		Conditions			
Segments	Participants	Gen-high	Gen-low	PP-high	PP-low
First	Greeks	873.38	900.74	816.12	840.18
	L2-S	1876.03	1987.28	1784.97	1851.88
	L2-G	3000.52	2753.70	3174.88	2919.64
	L2-R	2085.63	2196.24	2137.43	2156.65
Second	Greeks	1419.36	1516.41	1594.86	1618.11
	L2-S	3018.37	3322.55	3230.45	3432.95
	L2-G	5515.01	5209.07	5241.24	4848.40
	L2-R	4459.79	4603.49	4868.03	4861.16
Third	Greeks	970.58	1011.88	1000.27	1086.73
	L2-S	1558.59	1599.23	1718.54	1621.09
	L2-G	1977.86	2288.31	2111.94	2053.23
	L2-R	1956.03	2013.10	1864.65	1745.48
Fourth	Greeks	882.64	1222.12	938.38	864.32
	L2-S	1915.85	1821.26	2035.71	1818.23
	L2-G	2648.49	2894.40	3225.31	2654.04
	L2-R	2285.79	2484.87	2649.23	2223.62
Fifth	Greeks	875.78	961.17	1022.01	872.11
	L2-S	1844.04	1758.26	1766.47	1582.99
	L2-G	2209.39	2476.83	2252.47	2086.57
	L2-R	1653.10	1844.54	1868.19	1513.20
Sixth	Greeks	2645.62	2821.98	3043.62	2708.08
	L2-S	4075.27	4013.82	4012.02	3888.85
	L2-G	5225.79	4624.76	5531.66	4811.26
	L2-R	4601.09	4128.93	4382.88	4898.45

moval of 4.6% of the data set. For the L2 learners, the cut-off point was 2.5 standard deviations, as the data from L2 learners are more susceptible to variation than those from native speakers, resulting in the elimination of 2.1% for the L2-S group, 3.2% for the L2-G group, and 2.3% for the L2-R group. The reading times per segment and condition are shown in Table 4. Recall from (5) that the first segment is identical in all experimental conditions. The second one contains the complex DP, and the third one the beginning of the RC (i.e., the ambiguous region). The fourth segment is the critical one because it contains the disambiguating gender marking. The end of the sentence is presented as the fifth segment, and the sixth segment contains the comprehension question.

We performed the same statistical analyses on the mean reading times as on the acceptability judgment scores reported in the previous section. For the first three segments as well as for the sixth segment, these analyses did not reveal any statistically reliable interactions in either participant group. For the other segments, however, there were significant effects. These will be reported here, focusing on the results from the critical (fourth) segment.

Reading Times for the Fourth Segment

To determine whether there are statistically significant differences among the three groups of L2 learners, a repeated measures ANOVA was performed with antecedent and attachment as within-subjects variables and L2-group as the between-subjects variable. This analysis showed that the variable L2 group did not significantly interact with either antecedent or attachment, indicating that the three learner groups showed the same attachment preferences in the L2. For further statistical analyses, we therefore collapsed them into one L2 group.

To compare the L2 learners to the native speaker control group, an ANOVA was performed with antecedent and attachment as within-subjects variables and group (native speakers and L2 learners) as the between-subjects variable. We found a main effect of group, $F_1(1, 54) = 60.98$, $p < .001$, and $F_2(1, 94) = 111.83$, $p < .001$, which reflected the fact that the native speakers' reading times were overall much shorter than those of the L2 learners. On the other hand, there were no significant main effects of either antecedent or attachment, which indicated that overall there was no bias for a particular attachment or antecedent type. There was, however, a significant interaction between antecedent and attachment, $F_1(1, 54) = 15.061$, $p < .001$, and $F_2(1, 94) = 13.621$, $p < .001$, showing that reading times of high- and low-attachment sentences were different for the two antecedent types. Furthermore, a significant interaction between antecedent and group was obtained, $F_1(1, 54) = 6.214$, $p < .05$, and $F_2(1, 94) = 4.389$, $p < .05$, showing that the L2 learners' reading times were different from those of the native speakers for the two antecedent types. The interaction between attachment and group was also significant, $F_1(1, 54) = 13.156$, $p < .01$, and $F_2(1, 94) = 5.492$, $p < .05$, which indicated that the native speakers' reading times were different from those of the L2 learners with respect to the two attachment types.

Further examination of these interactions using matched *t*-tests revealed significant differences between the two Gen conditions for the native speakers, $t_{1\text{-}N}(19) = 4.57$, $p < .01$, and $t_{2\text{-}N}(23) = 4.56$, $p < .01$, but not for the L2 learners, $t_{1\text{-}L2}(35) = 0.872$, $p = .389$, and $t_{2\text{-}L2}(71) = 0.768$, $p = .445$. This result reflects the fact that in the Gen conditions the native speakers read the (fourth segment of) high-attachment sentences much faster than the one in low-attachment sentences (see Table 4), whereas the L2 learners showed no such preference. In the PP conditions, on the other hand, there was a significant low-attachment preference for both participant groups in the subject analysis. This effect was also significant in the item analysis but only for the L2 group: $t_{1\text{-}N}(19) = 2.49$, $p < .05$; $t_{2\text{-}N}(23) = 1.407$, $p = .173$; $t_{1\text{-}L2}(35) = 3.859$, $p < .001$; $t_{2\text{-}L2}(71) = 3.760$, $p < .001$.

Other Statistical Analyses

The same ANOVA (with antecedent and attachment as within-subjects variables and group as the between-subjects variable) that was performed on the

Table 5. Results from statistical analyses of the reading times of the fifth segment

	Results	
Main effects or interactions	Participant analyses	Item analyses
Antecedent	—	—
Attachment	—	—
Group	**	**
Antecedent × Group	*	—
Attachment × Group	—	—
Antecedent × Attachment	*	**
Antecedent × Attachment × Group	—	—

Note. Nonsignificant results are indicated by a dash.
*$p < .05$. **$p < .01$.

fourth segment was also performed on the reading times for the fifth segment. The results from this analysis are summarized in Table 5. For each comparison, the results from the participant and the item analyses are reported. The significant main effects and interactions shown in Table 5 for the fifth segment are a subset of those obtained for the fourth segment. In particular, there are no effects that were not already present at the fourth segment. Instead, some effects from the fourth segment (Attachment × Group and Antecedent × Group) are either absent or weaker on the fifth segment. These observations suggest that the effects on the fifth segment are due to a spillover from the ones originating at the critical (i.e., the fourth) segment. On the sixth segment, there were no statistically significant main effects or interactions left.

In summary, the overall results of the SPR task are parallel to those of the acceptability judgment task. In both experiments, the L2 learners showed the same attachment preferences as the native speakers in the PP conditions but not in the Gen conditions. That is, when the RC antecedent had a DP + PP structure with the lexical preposition *me* "with," all participant groups preferred low attachment of the RC to the PP. In contrast, when the RC antecedent contained a genitive ($DP + DP_{GEN}$), the native speakers showed a clear preference to attach the RC to the first DP, whereas the L2 learners of Greek did not show any statistically significant preference for either attachment type. Moreover, we found that, in both the SPR and acceptability judgment tasks, the three groups of L2 learners exhibited similar attachment patterns regardless of their L1.

GENERAL DISCUSSION

Attachment Preferences by Greek Native Speakers

Native speakers showed a clear low-attachment preference for the RC in sentences with DP + PP antecedents and a high-attachment preference in sen-

tences with DP + DP_{GEN} antecedents. As previously shown, the explanation for these parsing preferences depends on the syntactic structure posited for complex DPs in Greek. Consider first Alexiadou's (1999) movement account according to which possessive genitives are derived structures ([[DP_i] DP_{GEN} t_i]) that involve possessor movement. Under this syntactic analysis, the RC-attachment preferences could be explained in terms of late closure or recency. This is obviously the case for DP + PP antecedents and, more interestingly, also for DP + DP_{GEN} antecedents, in which case late closure or recency paired with Alexiadou's analysis would yield RC attachment to the trace of the moved DP. This account provides a simple and straightforward analysis of the present set of results, but it presupposes Alexiadou's analysis of the Greek DP, which might turn out to be incorrect on independent syntactic grounds. Furthermore, the idea that high-attachment preferences for genitive antecedents reflect a disguised low-attachment preference (due to possessor movement) probably does not hold crosslinguistically. For example, possessive constructions in Romance languages are syntactically very similar to each other, and yet in terms of RC attachment, Romance languages behave rather differently from one another. The high-attachment preference for genitive antecedents that was found for Spanish and French might perhaps be attributed to possessor movement, but then it remains unclear as to why equivalent constructions in Brazilian Portuguese and Romanian (Ehrlich et al., 1999) yielded a low-attachment preference.

This raises the question as to how the native speakers' attachment preferences can be explained in terms of the no-movement analysis of Greek DPs. Given these syntactic accounts, attachment preferences by Greek native speakers turn out to depend on antecedent types (i.e., high attachment for genitive antecedents and low attachment for PPs). Thus, native speakers' attachment preferences appear to be influenced by both lexical biases of the antecedents and the structural relationship between the RC and its antecedent. Regarding the lexical biases, our results from Greek replicate previous findings from other languages showing that, when the second DP is introduced by a theta-role-assigning lexical preposition, the RC tends to be attached low. On the other hand, for genitive antecedents such as *ton fititi tis kathighitrias* "the student of the teacher," the local thematic processing domain is the entire DP, which means that the RC can be associated with DP-1 or DP-2 within this domain. Our experiments, however, revealed a clear DP-1 attachment preference in these sentences, which indicates that lexical or thematic biases provide only a partial account of Greek RC-attachment preferences.

The second relevant factor is structurally based preferences, such as the late closure or recency strategy and predicate proximity. Recall that (according to the account of Gibson & Pearlmutter, 1998) languages may differ as to how much weight they give to proximity, depending essentially on a language's (non)configurationality. In terms of this property, Greek patterns with Spanish, German, and Russian in that it allows adjuncts and other material to occur

between the head of a predicate phrase and its objects. Consequently, we predicted that predicate proximity would outrank recency in Greek and yield a high-attachment preference in sentences with genitive antecedents. Our results confirm this prediction.

The attachment-binding hypothesis, on the other hand, is not supported by our findings. Recall that according to this model attachment preferences should depend on whether an RC is introduced by a relative pronoun or a complementizer. Only in the former case should there be a preference for high attachment, as has been found, for example, for German. However, in our experimental materials, RCs were always introduced by the complementizer *pu*, and the native speakers of Greek still exhibited a clear high-attachment preference in sentences with genitive antecedents. Thus, the attachment-binding hypothesis cannot explain these data.

Attachment Preferences by L2 Learners of Greek

The L2 learners showed a different overall RC-attachment pattern from native speakers—namely, low attachment in sentences with PP antecedents (like native speakers) and no preference in sentences with genitive antecedents (unlike native speakers). In addition to the present set of findings, a recent study of RC attachment in English (Felser, Roberts, Gross, & Marinis, 2003) yielded parallel results. Felser et al. examined two groups of L2 learners of English—40 advanced learners whose L1 was Greek and 28 advanced learners whose L1 was German—using a questionnaire and an SPR task. They found that both groups of L2 learners preferred low attachment in sentences with lexical PP-antecedents, such as *The dean observed the professor with the researcher who was never happy*. In corresponding sentences with DP-*of*-DP antecedents, however, the L2 learners did not show any attachment preference. This is different from English native speakers, who showed a low-attachment preference for the RC in sentences with DP-*of*-DP antecedents. Thus, despite the fact that Felser et al. examined a different target language and L2 learners with a different L1 background, their experiments revealed the same RC-attachment patterns that we found for L2 Greek. Moreover, both studies examined advanced L2 learners, and yet their attachment patterns were found to be different from those of native speakers of Greek and English. In the following section, we discuss various factors that might be responsible for this difference.

Transfer and Experience-Based Parsing

From the perspective of experience-based parsing models such as the Tuning Hypothesis (Mitchell et al., 1995) and the Competition Model (MacWhinney, 1987, 1997), one would expect that attachment preferences in the learners' L1 directly influence their L2 performance. The specific hypothesis derived from the Tuning Hypothesis was that the L2 participants of our study should easily get attuned to the high-attachment preference of Greek in RCs with genitive

antecedents because this is the option they are exposed to in both their L1 (Spanish, German, or Russian) and their L2 (Greek). Our results do not confirm this prediction. However, proponents of experience-based accounts might argue that L1 parsing preferences only influence L2 parsing during early stages of L2 development and that the advanced L2 learners we have studied could have developed out of that stage. This would mean that (due to L1 influence) Spanish, German, or Russian L2 learners of Greek initially prefer high attachment of an RC to a DP containing a genitive antecedent and that at later stages of L2 acquisition they give up this preference. That is, the L2 learners would initially exhibit the same attachment preferences as native speakers of Greek, and later, when they have acquired more knowledge of Greek, they would perform differently on the same constructions. This kind of developmental progression is not what one would expect from the perspective of experience-based parsing models. According to the Tuning Hypothesis, for example, the advanced L2 learners' persistent exposure to Greek should have strengthened the putative (L1-based) high-attachment preference of the initial stages. Yet none of the three groups of advanced L2 learners we studied showed a high-attachment preference for genitive constructions.

Consider also the possibility that attachment preferences in L2 Greek might be influenced by the learners' knowledge of an L3, specifically their knowledge of English. Even though we cannot completely rule out this possibility, it is not very likely for the following reasons. First, all participants' knowledge of Greek is more advanced than their knowledge of English. Moreover, all participants were living in Greece and using Greek (rather than English) in their everyday life when the experiments took place. From an exposure-based perspective, one would not expect an L3 to have any substantial influence on the learners' attachment preferences in their relatively strong L2. Finally, if knowledge of English had any effect, then those participants who are relatively proficient in English should have exhibited attachment patterns in L2 Greek that were different from those who are less proficient in English. The former might, for example, prefer low attachment in Greek sentences with genitive antecedents corresponding to English. This was not the case, however. The L2-G group was more proficient in English than the L2-S and L2-R groups, and yet the attachment patterns in L2 Greek were similar across these three groups. We therefore conclude that our findings are hard to explain in terms of L1 transfer and experience-based parsing models.

Another possibility that needs to be considered is that language-particular differences precluded the use of L1 transfer. Consider, for example, Spanish versus Greek in the domain of possessive constructions. Although Greek employs a genitive construction such as *i steghi tu spitju* "the roof of the house," the equivalent construction in Spanish, *el techo de la casa*, contains a PP and no genitive. Thus, one might speculate that there is no linguistic basis for Spanish learners of Greek to transfer attachment preferences from their L1 given that the two languages make use of different means of expression in pos-

sessive constructions. As regards German and Russian learners of Greek, however, they have genitive constructions in their respective L1s; the German equivalent would be *das Dach des Hauses* and the Russian one крыша дома (*krisha doma*). Thus, if these linguistic differences played a role for L2 attachment patterns, L1 transfer in the genitive construction should have been more likely for the German and Russian learners than for the Spanish ones—that is, at least the German and Russian learners should have shown a high-attachment preference in the genitive construction. Our results show that this was not the case. Indeed, none of the L2 learner groups showed a reliable high-attachment preference in the genitive construction. We can therefore rule out the possibility that the lack of L1 transfer is due to linguistic differences between the particular languages involved.

Grammatical Knowledge and Parsing Strategies by L2 Learners

Another possibility that needs to be considered is that the differences between L2 learners and native speakers in RC attachment are due to the L2 learners' incomplete acquisition of Greek grammar. For example, gender agreement information was used in the critical experimental sentences for disambiguation, and it is likely that an L2 learner who had not properly acquired agreement in Greek would not be able to use the disambiguating cues in the same way as a native speaker.

To assess this possibility, we can rely on the grammaticality judgment and proficiency tests that were performed by the L2 learners. In the general Greek Language Proficiency Test, the L2 learners were highly proficient in Greek, with scores of 72–75 (out of a maximum of 80), as previously illustrated in Table 1. More importantly, in judgment tasks of the grammatical constructions under study they also achieved high correctness scores. For subject RCs with complex (DP + DP or DP + PP) antecedents such as those used in the main experiments, the L2 learners had mean grammaticality judgment scores of over 90% correct (see Table 2). Similarly, in the task that examined gender agreement, the L2 learners achieved correct judgment scores of 95–96%, similar to those of the native speakers. These results indicate that, with respect to their knowledge of Greek in the relevant grammatical domains, the L2 learners performed at native-speaker levels. The differences between native speakers and L2 learners with respect to RC attachment are therefore unlikely to have resulted from the L2 learners' incomplete acquisition of Greek grammar.

CONCLUSION

We found that advanced L2 learners of Greek with Spanish, German, or Russian as L1s exhibited the same low-attachment preference for RCs in sentences with PP antecedents as native speakers of Greek, whereas they did not

show any attachment preference in sentences with genitive antecedents (unlike the clear high-attachment preferences of the native speakers). Parallel results were obtained by Felser et al. (2003) for Greek and German learners of L2 English. Taken together, these results show that with different target languages, L2 learners with different L1 backgrounds exhibit the same RC-attachment patterns—namely, a clear low-attachment preference in sentences with lexical PP-antecedents and no preference in sentences with genitive or DP-*of*-DP antecedents.

There are various possible reasons as to why the L2 learners' attachment preferences are different from those of native speakers. One factor could be the learners' incomplete acquisition of the target language. L2 learners may have underspecified representations in their lexicons or other gaps in their L2 grammars that may affect their ability to parse particular kinds of sentences. Note, however, that all of our participants scored very highly on both the language proficiency and the grammaticality judgment tests, which does not make this possibility seem very likely. Another potentially relevant factor is that, when L2 learners process a sentence in the L2, grammatical representations and parsing strategies of the learners' L1 might not be completely suppressed, thereby affecting their attachment preferences in the L2. We do not wish to completely exclude the possibility of L1 transfer in L2 sentence processing, but our findings indicate that, at least in the case of RC attachment to genitive antecedents, the advanced learners we studied were not directly influenced by the attachment preferences in their L1s.

A more feasible possibility is that learners may have difficulty integrating different sources of information when processing their L2. We argued that attachment preferences by native speakers of Greek are influenced by both structurally based parsing strategies and lexical or thematic biases, whereas L2 learners' RC-attachment preferences are mainly guided by lexical cues. More generally, this difference might mean that in contrast to the L1 parser, which integrates incoming ambiguous elements immediately into the current parse during on-line processing, the L2 parser delays integration until sufficient lexical (and perhaps other) information has been received for attaching an ambiguous word or phrase. Under this account, our finding that the L2 learners showed the same low-attachment preference in sentences with PP antecedents as the native speakers can be attributed to the presence of a lexical cue (i.e., the lexical PP) that biases them toward low attachment. When there is no such cue (i.e., in sentences with genitive antecedents), the L2 learners do not show any disambiguation preference. However, further experimentation is needed to determine whether our findings on RC attachment are generalizable to other kinds of ambiguous sentences and to answer the broader question as to whether L2 parsing is in any fundamental way different from L1 parsing.

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NOTES

1. The literature referred to in this section is concerned with adults parsing in "monolingual mode" (see Grosjean, 1997). It is assumed in this literature (though not always made explicit) that what is under study is the language the participants have acquired in childhood. This means that even though they may have acquired an L2 (typically in a school setting when they were adults), simultaneous bilinguals (who have learned two languages simultaneously before the age of 5–6 years) are normally not included.

2. We use the term *parsing strategy* to refer to an operation by which a new node is attached or associated to previously processed nodes or domains in the left-to-right parse of a sentence. Parsing strategies make use of different sources of information (e.g., syntactic, semantic, prosodic, and discourse information). For our purposes, the distinction between structure-based parsing strategies (which make use of phrase-structure information) and lexically based strategies (which make use of lexical-semantic information) is particularly important.

3. The only information that is provided about the participants of this study is (a) that the English L2 learners of French were students who had studied French for at least 5 years in a school environment in the United States and lived in France for approximately 9 months and (b) that the French L2 learners of English were students studying to become English teachers who had recently lived in the United States or the United Kingdom for 9–12 months. Unfortunately, the study does not provide any measure of the participants' L2 proficiency.

4. Fernández (1999) did not provide a measure to decide whether her participants had acquired the relevant constructions and had proficient control over them. She mentioned, however, that none of her participants had any trouble understanding the content of the questionnaire, producing, for example, not more than one incorrect answer in the filler items. From this, she concluded that the participants' English proficiency was "intermediate to advanced" (p. 224).

5. Again, as in the previously mentioned studies, the information provided about the participants' linguistic background in the L2 was rather scarce. Frenck-Mestre (1997) mentioned that the participants were "considerably less skilled in their second language" than those studied by Frenck-Mestre and Pynte (1997). No further details about the participants were provided.

6. Consistent with the psycholinguistic literature on this topic, we use the terms *genitive* and *PP* (RC) *antecedents* as shortcuts for the difference between the kinds of sentences under study (e.g., see [1] and [2]). Even though we have adopted this terminology, it should not be forgotten that, from a linguistic perspective, it is not very accurate. Clearly, RCs do not have (genitive or PP) antecedents in the sense that reflexive pronouns do. Instead, they modify heads and combine with DPs.

7. The Greek Language Proficiency Test is available from the Teaching Center of Greek as a Foreign Language at the University of Athens (http://www.nglt.uoa.gr).

8. The participants of the two control experiments acquired Greek during childhood. They also have some knowledge of an L2, typically English acquired in a school setting when they were adults. None of the participants was a simultaneous bilingual having learned two languages simultaneously before the age of 5–6 years. We therefore assume that, in contrast to the three groups of L2 learners, the control participants are processing Greek as a native language or in "monolingual mode" (Grosjean, 1997).

9. A complete list of all experimental stimuli for each task can be found in Papadopoulou (2002) and will be made available on request.

10. The syncretism of the *itan* "was" form is less problematic for the acceptability judgment task, as the participants are required to provide an off-line judgment at the end of the sentence at which the disambiguating gender information has been encountered. The SPR task, however, provides a continuous on-line measure of reading. The number ambiguity resulting from the *itan* form should therefore be avoided.

11. The format of the SPR task with phrase-by-phrase segmentation was similar to the one used by De Vincenzi and Job (1993, 1995). A word-by-word presentation was not chosen because the separation of the two RC antecedents may bias the participants toward low attachment; see De Vincenzi and Job (1995) and Gilboy and Sopena (1996) for discussion.

12. The data from both the acceptability judgment and the SPR tasks pass the customary tests for normality (Kolmogorov-Smirnov test), sphericity (Mauchly test), and homoscedasticity (Levene test) and are therefore suitable for ANOVA analyses.

13. This effect might be caused by PP constructions of the kinds we examined occurring less frequently than corresponding constructions with genitives, but because we do not have any reliable frequency database, this remains speculative. Note also that, if the reduced acceptability of the PP

construction was due to its low frequency, one would expect to find longer reading times in the second segment for PP constructions than for genitives in the SPR task. However, as will become clear in the following section, this was not the case, which suggests that the experimental results are unlikely to reflect a frequency difference between the two types of constructions.

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