Applied Psycholinguistics **24** (2003), 453–489
Printed in the United States of America
DOI: 10.1017.S0142716403000237

The processing of ambiguous sentences by first and second language learners of English

CLAUDIA FELSER, LEAH ROBERTS, and THEODORE MARINIS
University of Essex

REBECCA GROSS
University of Düsseldorf

ADDRESS FOR CORRESPONDENCE
Claudia Felser, Department of Language and Linguistics, University of Essex, Colchester CO4 3SQ, United Kingdom. E-mail: felsec@essex.ac.uk

ABSTRACT
This study investigates the way adult second language (L2) learners of English resolve relative clause attachment ambiguities in sentences such as *The dean liked the secretary of the professor who was reading a letter*. Two groups of advanced L2 learners of English with Greek or German as their first language participated in a set of off-line and on-line tasks. The results indicate that the L2 learners do not process ambiguous sentences of this type in the same way as adult native speakers of English do. Although the learners' disambiguation preferences were influenced by lexical–semantic properties of the preposition linking the two potential antecedent noun phrases (*of* vs. *with*), there was no evidence that they applied any phrase structure–based ambiguity resolution strategies of the kind that have been claimed to influence sentence processing in monolingual adults. The L2 learners' performance also differs markedly from the results obtained from 6- to 7-year-old monolingual English children in a parallel auditory study, in that the children's attachment preferences were not affected by the type of preposition at all. We argue that children, monolingual adults, and adult L2 learners differ in the extent to which they are guided by phrase structure and lexical–semantic information during sentence processing.

Our understanding of how mature readers or listeners process their native language in real time has increased considerably over the last couple of decades. Results from sentence processing studies using a range of different psycholinguistic methods and techniques have shown that the adult parser is capable of accessing and rapidly integrating various types of structural and nonstructural information during comprehension (see Gibson & Pearlmutter, 1998, for review). Comparatively little is known, by contrast, about the way language *learners* process input from the target language. Instead, both first language (L1) and second language (L2) acquisition research to date has focused primarily on the

development of linguistic competence (compare, for instance, the articles in Ritchie & Bhatia, 1996, 1999).

It is conceivable, though, that at least some of the differences in linguistic proficiency that have been observed between children and adults and between L2 learners and native speakers are due to differences in the way language learners and adult native speakers process the target language. As regards L1 acquisition, it is possible that children's linguistic development is constrained by capacity limitations of the developing processing system (Adams & Gathercole, 2000). Mature L2 learners, on the other hand, already have a fully developed language processing system in place. Given that we know very little about how and to what extent this system is employed in L2 processing, though, it could be the case that the lack of nativelike ultimate attainment in the L2 is at least partially attributable to parsing problems rather than to an inability to acquire nativelike grammatical competence per se, as is often assumed (compare also Juffs & Harrington, 1995; Kilborn, 1992; or VanPatten, 1996). Specifically, to the extent that there is crosslinguistic variation in L1 processing (see Cuetos, Mitchell, & Corley, 1996; Frazier & Rayner, 1988; Gibson, Pearlmutter, Canseco–Gonzalez, & Hickok, 1996; MacWhinney, 1997, 2002; and Mazuka & Lust, 1990; among others), L2 learners may transfer nontargetlike processing strategies from their native language to the L2, which could be the crucial barrier to acquiring full nativelike performance in the L2. It is also possible that sentence processing in the L2 differs in more fundamental ways from adult L1 processing, for instance, in that L2 learners may have difficulty with the on-line integration of different information sources (compare, e.g., Kilborn, 1992). In short, answers to the question of whether language learners process the target language in the same way as adult native speakers do are likely to have important implications for theories of both L1 and L2 acquisition.

The present study aims to compare the processing strategies used by advanced L2 learners of English to those employed by adult native speakers and child L1 learners of English. The main empirical questions to be addressed are the following:

- Do adult L2 learners employ the same sentence processing strategies as native speakers of the target language?
- To what extent are language learners capable of using and integrating phrase-structure and lexical–semantic information during processing?
- Is there any evidence that adult L2 learners transfer processing strategies from their L1?

In order to address the above questions, we have examined how advanced L2 learners of English from different language backgrounds resolve relative clause attachment ambiguities in two-site contexts, a phenomenon that has been extensively studied with monolingual speakers in the past and that is known to be subject to crosslinguistic variation. To explore the extent to which L1 and L2 processing are similar (or dissimilar), we contrast the results from the L2 learners with those from parallel studies with adult native speakers and English-speaking children that have recently been conducted by our research group.

The remainder of this paper is organized as follows. The next section provides a brief overview of crosslinguistic differences in the processing of relative clause attachment ambiguities, the phenomenon under investigation, followed by a summary of the results from existing studies of ambiguity resolution in L2 processing in the next section. The following sections present the results from four experiments investigating relative clause attachment preferences in different groups of advanced L2 learners of English using both off-line and on-line tasks, which are then contrasted with the results from a native speaker comparison group. In the following section, we discuss the implications of our findings for theories of L1 and L2 processing, also taking into consideration the results from previous studies of ambiguity resolution strategies employed by children. Our main findings and conclusions are summarized again at the end.

CROSSLINGUISTIC VARIATION IN PARSING

Crosslinguistic differences between the ways in which structural ambiguities are resolved indicate that some parsing strategies are language-specific rather than universal, and thus need to be learned through experience. Consider sentence 1 below, which is ambiguous in that the relative clause *who was on the balcony* can be construed either with the noun phrase (NP) *the servant* (NP1 attachment) or with *the actress* (NP2 attachment).

1. Someone shot the servant of the actress who was on the balcony.

Previous psycholinguistic studies have shown that adult native speakers of *English* tend to associate the relative clause with the second rather than the first NP (i.e., with *the actress*) in both off-line (Cuetos & Mitchell, 1988; Dussias, 2001; Fernández, 1999; Gilboy, Sopena, Clifton, & Frazier, 1995) and on-line reading comprehension tasks (Carreiras & Clifton, 1999; Corley, 1995; Fernández, 2000; Henstra, 1996).[1] A preference for NP1 attachment, in contrast, has been reported for corresponding genitive constructions in numerous other languages, including Spanish (Carreiras & Clifton, 1993; Cuetos & Mitchell, 1988; Gilboy et al., 1995; but cf. Fernández, 2000), Dutch (Brysbaert & Mitchell, 1996), German (Hemforth, Konieczny, & Scheepers, 2000), French (Frenck–Mestre & Pynte, 1997; Zagar, Pynte, & Rativeau, 1997; but cf. Baccino, De Vincenzi, & Job, 2000), and Greek (Papadopoulou & Clahsen, 2002).

Phrase-structure based parsing principles

Within multiple-constraint models of sentence processing, attachment preferences are determined by the relative strength of a number of interacting structural and nonstructural factors in a given language (cf., e.g., Gibson & Pearlmutter, 1998). According to Gibson, Pearlmutter, et al. (1996), the NP2 preference that is typically found in English can be accounted for by assuming that in highly configurational languages like English, ambiguous modifiers are integrated into the current parse in accordance with the locality principle of *recency,* which favors attachment of ambiguous phrases to more recently processed syn-

tactic constituents (and which is similar to the *late closure* strategy proposed earlier by Frazier, 1979; and Frazier & Fodor, 1978).

2. *Recency:* Attach new incoming material to the most recently processed phrase if grammatically possible.

In languages whose speakers prefer NP1 disambiguation, on the other hand, the interacting locality principle of *predicate proximity,* according to which ambiguous modifiers will be preferentially attached to constituents as structurally close as possible to a predicate phrase (hence favoring attachment of the relative clause to the overall object NP in example 1 above), is claimed to be strong enough to outrank the (supposedly universal) recency preference.

3. *Predicate proximity:* Attach as structurally close as possible to the head of a predicate phrase.

The set of languages in which NP1 attachment has been shown to be the preferred option also includes German and Greek, the native languages of the two groups of L2 learners examined in the present study. That is, for both the German and the Greek equivalents of example 1, native speakers preferentially associate the relative clause with the initial NP in the complex, a preference that has been demonstrated in several off-line and on-line tasks similar to those used in the present study. Using the eye-movement monitoring technique, Hemforth et al. (1997), for example, examined German speakers' relative clause attachment preferences in temporarily ambiguous sentences containing subject relatives. Their materials included sentences such as those in example 4 below, which are disambiguated by number marking on the verb within the relative clause, as well as sentences that were disambiguated either by gender marking or through their pragmatic content.

4. a. *Klaus traf die Lehrerin der Töchter, die in Deutschland*
Klaus met the–ACC teacher the–GEN daughters who in Germany
lebten, und freute sich, sie wiederzusehen.
lived–PL and was.glad REFL her to.see.again
"Klaus met the teacher of the daughters who lived in Germany, and was glad to see her again."

b. *Klaus traf die Lehrerin der Töchter, die in Deutschland*
Klaus met the–ACC teacher the–GEN daughters who in Germany
lebte, und freute sich, sie wiederzusehen.
lived–SG and was.glad REFL her to.see.again

The authors found an NP1 attachment preference for all three types of disambiguation in the above on-line task, a finding that matches Hemforth, Konieczny, and Scheepers' (2000) results from a similar questionnaire study. Papadopoulou and Clahsen (in press) obtained parallel results from adult native speakers of Greek and interpreted the NP1 preference in Greek as reflecting the native speakers' use of the predicate proximity (as opposed to the recency) strategy. Gibson, Pearlmutter, et al. (1996) hypothesize that, although both recency and

predicate proximity may be part of a universal sentence processing mechanism, languages may be parameterized in 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 German or Greek that allow verbs and their complements to be nonadjacent, the verb may be more active during processing than it is in a highly configurational language such as English, and hence may be more likely to attract ambiguous modifiers.[2]

Lexical factors influencing parsing

In addition to locality-based parsing principles, modifier ambiguity resolution is also known to be influenced by lexical–semantic information. Evidence for this can be gathered, for example, from the observation that for complex NPs linked by thematic prepositions such as *with,* NP2 disambiguation appears to be universally preferred over NP1 disambiguation in both off-line (cf., e.g., Gilboy et al., 1995) and on-line comprehension tasks (Frenck–Mestre & Pynte, 2000; Traxler, Pickering, & Clifton, 1998; among others). Both German and Greek are among the languages for which an NP2 preference for NPs joined by a thematic preposition has been experimentally confirmed (see Gross, 2002, for German, and Papadopoulou & Clahsen, in press, for Greek). The fact that the presence of a thematic preposition like *with* elicits a robust NP2 attachment preference even in languages for which an NP1 preference has been attested for complex genitive antecedents suggests that this type of lexical bias is strong enough to override any phrase-structure-based locality principle that might otherwise favor NP1 attachment.

One way of accounting for the remarkably robust NP2 preference triggered by *with* and its translation equivalents in other languages has been offered within the framework of construal theory (Frazier & Clifton, 1996), according to which associating modifying phrases with constituents *outside* the current thematic domain is computationally costly, and hence dispreferred. As prepositions like *with,* unlike mere case assigners such as *of* in example 1 above, create a local thematic domain of their own, the construal hypothesis correctly predicts that in sentences such as example 5 below, the ambiguous relative clause should preferentially be associated with the second NP, *the servant*.

5. Everyone liked the actress [with THE SERVANT who was always smiling].

If the second NP is a genitive-marked or prepositional object of the first NP, however, the current thematic processing domain is the overall subject NP, that is, the one headed by the noun *servant* in example 6 below), so that from the point of view of the construal hypothesis, either NP1 or NP2 may serve as the antecedent for an ambiguous relative clause.[3]

6. Someone shot [THE SERVANT of THE ACTRESS who was on the balcony].

According to construal theory, disambiguation preferences in contexts containing complex genitive NPs are determined by the interaction of universal, local-

ity-based parsing strategies, such as those dubbed recency and predicate proximity by Gibson and collaborators (compare Frazier & Clifton, 1996, p. 80), and other factors potentially affecting attachment. Other factors that have been claimed to influence comprehenders' attachment preferences include prosody (Fodor, 1998; Schafer, Carter, Clifton, & Frazier, 1996), the availability of alternative structures such as the Saxon genitive (Frazier & Clifton, 1996), NP modifiability (Thornton, MacDonald, & Gil, 1999), anaphoricity of the relativizing element (Hemforth et al., 2000), and probabilistic factors such as the frequency of past exposure to each attachment pattern (Cuetos et al., 1996; Mitchell & Cuetos, 1991). While a thorough evaluation of existing theories of parsing is beyond the aims and scope of the present paper, virtually all parsing theories agree that both phrase-structure and lexical information influence the way in which adult monolingual speakers resolve structural ambiguities. The well-attested fact that individual languages vary with respect to how ambiguous relative clause modifiers are associated with complex genitive antecedents (but not with complex NPs linked by a thematic preposition) and the evidence suggesting that this crosslinguistic variation is due to language-specific differences in the way certain locality-based parsing principles interact makes this phenomenon a suitable candidate for investigating sentence processing in language learners.

AMBIGUITY RESOLUTION IN L2 PROCESSING

Although results from previous off-line studies suggest that L2 learners are similar to native speakers in that they are able to make use of various types of nonsyntactic cues to L2 sentence interpretation (compare, for instance, Harley, Howard, & Hart, 1995; Ying 1996), properties of a learner's native language have also been claimed to influence sentence interpretation in the L2 (Harrington, 1987; Kilborn, 1989; Kilborn & Ito, 1989; McDonald, 1987; among others; see MacWhinney, 1997, for a review of studies within the *Competition Model*). Comparatively few studies have investigated how L2 learners process sentences from the L2 in real time, though. The following provides a brief overview of existing on-line studies of L2 ambiguity resolution.

Several studies have found evidence for the use of verb-based lexical information during L2 processing. In a word by word reading-time study, Juffs (1998) examined how L2 learners of English from various language backgrounds process sentences containing reduced relative clause ambiguities such as *The bad boys criticized almost every day were playing in the park.* The results show that, although slower than the native speaker controls, advanced L2 learners processed the experimental sentences similarly to the native speakers. This finding indicates that, like native speakers, advanced L2 learners are guided by argument structure information during processing. Similarly, Frenck–Mestre and Pynte (1997) found evidence for the influence of verb subcategorization information on L2 ambiguity resolution. Using the eye-movement monitoring technique, the authors investigated how advanced English-speaking learners of French and French-speaking learners of English resolved prepositional phrase (PP) attachment ambiguities in sentences such as *They accused the ambassador of espionage (of Indonesia) but nothing came of it.* The results from their first

experiment suggest that English-speaking learners of French and monolingual French speakers process temporarily ambiguous sentences of this type in essentially the same way, attaching potential arguments PPs such as *of espionage* to the verb phrase and analyzing PPs like *of Indonesia* as NP modifiers. In a second experiment, Frenck–Mestre and Pynte examined how French-speaking learners of English, and English-speaking learners of French processed sentences such as *Every time the dog obeyed (barked) the pretty little girl showed her approval,* that contained a temporary subject/object ambiguity. The results from the English sentences showed that the French readers experienced more difficulty with verbs of the *obey* type, whose subcategorization frame is different in French, than did the native readers. For the French test items, on the other hand, both participant groups appeared to have some difficulty processing sentences containing verbs that could be used transitively in English only, a finding that, according to the authors may be indicative of L2 influence on L1 processing *(backward transfer)*. Taken together, their results failed to show any qualitative differences between L1 and L2 ambiguity resolution, save for the observation that the L2 learners tended to be more confused by conflicting verb argument structure information than were native readers.

Although several studies exist that have examined the way in which L2 learners process relative clause attachment ambiguities in real time, the results obtained thus far are not fully conclusive. In an eye-tracking study, Frenck–Mestre (1997) investigated how English and Spanish L2 learners of French resolved relative clause attachment ambiguities in sentences such as *Jean connaît les filles de la gardienne qui partent* (John knows the girls of the nanny who are leaving). She found that the Spanish L2 learners patterned with French native speakers in that they showed a preference for NP1 disambiguation, whereas the English group showed no preference. Given that Spanish but not English speakers also usually show an NP1 preference in their L1, Frenck–Mestre interprets these results as evidence for the influence of L1 processing strategies on L2 sentence processing.

Somewhat different results were obtained by Fernández (2000) in a self-paced reading task with "early" Spanish–English bilinguals whose dominant language was either Spanish or English. She found that none of the participant groups exhibited any consistent preferences for either NP1 or NP2 attachment when processing temporarily ambiguous sentences such as *Andrew had dinner yesterday with the nephews of the teacher that was divorced* or their Spanish equivalents. Given that Fernández had found an initial NP2 preference for both English and Spanish monolingual speakers in a parallel experiment (contrary to the NP1 preference normally found in Spanish, though), she argues that the results from the bilinguals cannot be explained in terms of L1 processing transfer or by the assumption that bilinguals use an amalgamated set of processing routines (Fernández, 2000, p. 281). To complicate the emerging overall picture further, results from a similar study reported in Dussias (2001), who, unlike Fernández, did find an NP1 preference for Spanish monolinguals, indicate that Spanish–English bilinguals who learned English in adulthood, but not early bilinguals, are able to acquire an NP2-attachment preference. Further evidence against the transfer of L1 processing strategies was provided by Papadopoulou and Clah-

sen's (in press) study of L2 processing in Greek. Also using a segment by segment self-paced reading task, Papadopoulou and Clahsen compared the relative clause attachment preferences of Spanish, German, and Russian L2 learners of Greek with those of Greek native speakers. Experimental materials included sentences such as those in example 7 below that contained complex NPs followed by a temporarily ambiguous relative clause introduced by the complementizer *pu* (that). The second potential host NP either carried morphological genitive case, for example, *tis kathigitrias* (the teacher) in example 7a or was the complement of the thematic proposition *me* (with; cf. 7b). The disambiguating information forcing either NP1 or NP2 attachment was provided by gender marking on the participle *apogoitevmenos* (disappointed–MASC) versus *apogoitevmeni* (disappointed–FEM) in all four conditions.

7. a. *Enas kirios fonakse ton fititi tis kathigitrias*
a man called the–MASC student–MASC the–FEM teacher–FEM
pu itan apogoitevmenos /apogoitevmeni apo to neo
that was disappointed–MASC disappointed–FEM by the new
ekpedeftiko sistima.
educational system
"A man called the (male) student of the (female) teacher who was disappointed (masc./fem.) by the new educational system."

b. *Enas kirios fonakse ton fititi me tin*
a man called the–MASC student–MASC with the–FEM
kathigitria pu itan apogoitevmenos /apogoitevmeni
teacher–FEM that was disappointed–MASC disappointed–FEM
apo to neo ekpedeftiko sistima.
by the new educational system
"A man called the (male) student with the (female) teacher who was disappointed (masc./fem.) by the new educational system."

Papadopoulou and Clahsen found that the L2 learners performed similarly to the native speakers in that both showed an NP2 preference for complex NPs linked by the preposition *me* 'with', indicating that both the learners and the native speakers were sensitive to the NP2 attachment bias provided by thematic prepositions like *me.* The learners differed from the native speaker controls, however, in that none of the three learner groups exhibited any clear attachment preferences for complex genitive NPs. The native speakers, by contrast, showed a clear preference for NP1 disambiguation. These findings suggest that, despite their high level of competence in the target language (as was demonstrated independently by the results from two off-line judgment tasks), L2 learners of Greek process ambiguous sentences containing complex genitive antecedents differently to native speakers. These results also show that even though an NP1 preference has been attested for complex genitive NPs *both* for the learners' native languages *and* for the target language, neither group of L2 learners appears to have transferred the NP1 attachment preference from their L1.

The present study builds on the above findings and aims to further investigate whether advanced L2 learners are capable of acquiring the processing strategies

of the target language and the extent to which they are influenced by phrase structure and lexical–semantic information during L2 processing. In the following, we present the results from a set of off-line questionnaire and on-line reading-time experiments investigating the manner in which advanced German- and Greek-speaking L2 learners of English resolve relative clause attachment ambiguities in the target language. Results from a parallel study with adult native speakers of English will serve as a basis for comparison.[4] Because German and Greek have been shown to differ from English in that they belong to the group of languages for which an NP1 preference has been attested for complex genitive antecedents, investigating L2 learners from these language backgrounds should help us determine whether L2 learners employ L2 processing strategies that are different from those found in their L1 or whether they transfer the NP1 preference from the native languages to the L2.

EXPERIMENT 1

Method

Participants. 28 advanced German-speaking learners of English (mean age 26.5, range 18–47, 21 female), all of them students at the University of Düsseldorf, participated in this experiment. All participants had normal or corrected to normal vision and were naive with respect to the purpose of the study. All but one of the German-speaking participants had first been exposed to English around the age of 10 (mean age of first exposure = 10, *SD* = 1.54), and had had previous formal instruction in English in Germany, for a period ranging from 6 years to 13 years (mean = 9.5 years, *SD* = 1.6). One of the participants reported that he had first been exposed to English at about the age of 4, but like the others, he did not consider himself bilingual. The participants' general level of proficiency in English was assessed prior to the main experiment using the grammar part of a standardized proficiency test (Oxford Placement Test; Allen, 1992). All participants scored 71% or higher (range = 71–95%) in this test, indicating that all of them were advanced learners of English.

The L2 learners also underwent a grammaticality judgment test, the main purpose of which was to test their off-line knowledge of the construction under investigation, specifically subject–verb agreement (as this was later used for grammatical disambiguation in Experiment 2). Ensuring that the learners could handle subject–verb agreement in sentences containing complex NP antecedents is important in order for us to rule out the possibility that any differences in parsing performance between the learners and native speakers in the main experiments are due to the learners' lack of grammatical competence in this area. The materials for the grammaticality judgment test comprised a total of 64 sentences, including 24 experimental (12 grammatical, 12 ungrammatical) and 40 filler sentences. The critical test sentences all contained a complex object NP followed by a relative clause, as in the following examples. (See Appendix A for a complete list of the critical items that were used in this task.)

Table 1. *Mean proficiency and grammaticality judgment scores of the German L2 learners*

	Mean	*SD*
Oxford Placement Test (grammar only)	85%	7
Grammaticality Judgment Test total score	92%	4
Critical items		
Hits	92.3%	13.6
Correct rejections	92.8%	9.3

8. a. The headmaster smiled at the pupils of the teachers who were standing in the hall.
   b. *The reporter watched the lawyers of the criminals who was speaking to the judge.

The participants were instructed to read the sentences that were presented to them on a questionnaire sheet carefully, to indicate for each sentence whether it contained a grammatical error and to mark the error in all sentences they considered ungrammatical. All participants judged 79% or above (range = 79–100%) of the critical items correctly in this task, suggesting that they had acquired near-native or nativelike knowledge in this area of English grammar. Table 1 summarizes the results from the two pretests.

The fact that the participants were able to identify agreement errors correctly demonstrates that they could handle subject–verb agreement in the target language.

Questionnaire materials. The questionnaire materials included 40 sentences in total (20 experimental, 20 fillers). All experimental sentences were ambiguous and of the form (NP–V–[NP1–P–NP2]–RC, where V is the matrix verb, P is preposition, and RC is relative clause. There were two versions of each sentence, with the two noun phrases in the NP complex being joined either by functional/occupational *of* or by "accompaniment" or attributive *with*, as illustrated by examples 9a and 9b, respectively. Both NPs and the auxiliary in the relative clause appeared in the singular. (The complete set of experimental sentences used in this task is provided in Appendix B.)

9. a. The dean liked the secretary *of* the professor who was reading a letter.
   b. The dean liked the professor *with* the secretary who was reading a letter.

In order to make the experimental sentences sound equally natural in both the *of* and the *with* conditions, we reversed the relative ordering of NP1 and NP2 in the *with* conditions.[5] All NPs used in the experimental sentences had human referents, with each pair of nouns appearing in the NP–P–NP complex being matched for frequency.[6] Two different versions of the questionnaire were created with each set containing one version of each experimental sentence only.

Table 2. *Mean percentages of NP2 responses in Experiment 1*

	Mean	*SD*
NP1-*of*-NP2	52%	28.1
NP1-*with*-NP2	87%	14.4

Each version of the questionnaire contained an equal number of *of* and *with* sentences, and all items were pseudorandomized.

Procedure. Participants were instructed to read the sentences carefully and then to indicate for each sentence which of two possible interpretations they considered the more appropriate one. Compare example 10 below for illustration.

10. The dean liked the secretary of the professor who was reading a letter.
    i. the secretary was reading a letter
    ii. the professor was reading a letter

In half of the choices, the NP1 in the complex appeared first, and in the other half, it appeared second, to avoid the subjects developing a strategy for answering the questions. Although the participants were able to read the sentences more than once, they were instructed to make their choices as spontaneously as possible.

Results

Overall, the participants provided more NP2 than NP1 responses. There was a clear difference between the two experimental conditions, though, in that NPs linked by *with* elicited a much higher number of NP2 responses than did the *of* condition, which produced an about equal number of NP1 and NP2 responses. Table 2 presents the mean percentages of NP2 responses provided for each of the two antecedent types.

One sample *t* tests showed that the number of NP2 responses was significantly above chance level for the *with* condition only, t_1 (27) = 13.503, $p < .001$; t_2 (19) = 17.079, $p < .001$, whereas the group showed no reliable preference for either NP1 or NP2 disambiguation for complex genitive NPs. The relatively high standard deviation for responses to the *of*-condition indicates moreover that there was considerable variation within the group for this condition. A one-way analysis of variance (ANOVA) on the percentages of NP2 attachments with the factor preposition (*of* vs. *with*) revealed a significant main effect of preposition, F_1 (1, 27) = 67.913, $p < .001$; F_2 (1, 19) = 60.172, $p < .001$, confirming that the

participants treated the two conditions differently, in that the number of NP2 responses provided was significantly higher for NPs linked by the preposition *with*.[7]

EXPERIMENT 2

Method

Participants. The same 28 German-speaking learners of English who participated in Experiment 1 also took part in Experiment 2. The two experiments were carried out on separate days, with 1 or more days between experimental sessions.

Materials. The materials used in Experiment 2 were similar to those used in Experiment 1. The stimulus materials for the self-paced reading task comprised 154 sentences in total, including 10 practice, 48 experimental, and 96 filler sentences. The experimental sentences included unambiguous versions of the sentences that were used in Experiment 1, plus another four items of the same type. (The complete set of experimental stimulus sentences can be found in Appendix C.) All experimental sentences were temporarily ambiguous and contained a relative clause modifying either the head of the overall object NP (=NP1 attachment) or the embedded noun phrase (=NP2 attachment). Disambiguation was forced by number marking on the auxiliary (*was* vs. *were*). The two critical NPs were joined by either *of* or *with*, yielding a total of four experimental conditions as illustrated by examples 11a–d below.

11. a. **NP1 Attachment (*of*)**
The dean liked *the secretary* of the professors who *was* reading a letter.
b. **NP2 Attachment (*of*)**
The dean liked the secretary of *the professors* who *were* reading a letter.
c. **NP1 Attachment (*with*)**
The dean liked *the professors* with the secretary who *were* reading a letter.
d. **NP2 Attachment (*with*)**
The dean liked the professors with *the secretary* who *was* reading a letter.

The order of the two critical NPs was reversed in the *with* conditions, and the relative ordering of singular and plural NPs was counterbalanced across all four conditions. Two different experimental sets were created, each of which contained one *of* and one *with* version of each experimental sentence (either example 11a and 11d or 11b and 11c). The test items in each set were pseudorandomized and mixed with the fillers.

Procedure. To obtain an on-line record of the unfolding parse, we used the (noncumulative) moving-window technique described by Just, Carpenter, and

Woolley (1982). In this task, participants read a sentence in a segment by segment fashion by pressing a pacing button in order to receive subsequent words or phrasal segments. The basic rationale underlying the self-paced reading technique is that increased reaction times to a particular segment (compared to the same segment in a control condition) indicate a relatively higher processing difficulty at this point during the parse. That is, reaction times to 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. Participants were seated in front of a 17-in. monitor and instructed to read the sentences as quickly and as carefully as possible. The sentences were presented in a segment by segment fashion, with each sentence being divided into five segments, as indicated in example 12 below. The disambiguating auxiliary always appeared as the fourth segment.

12. The dean liked / the secretary of the professors / who / *was* / reading a letter.

The complex NP was presented as one segment to minimize the possibility of the initial NP fading from short-term memory during the processing of the second one, which might bias participants toward NP2 attachment. The participants were instructed to read the sentences carefully and as quickly as possible by pressing a button on a pushbutton box as soon as they were ready to receive the next segment. The presentation of the stimuli and the recording of reaction times was controlled by the NESU software package (Baumann, Nagengast, & Klaas, 1993). The self-paced reading experiment lasted approximately 30–45 min in total and was divided into two sessions by a short break. The first session was preceded by 10 practice sentences. Each participant read two different sentences from each sentence quadruplet, one in the first session and the other one in the second session. To ensure that the participants made an active effort to comprehend the experimental sentences, all critical sentences and half the fillers were followed by a yes/no comprehension question, which the participants responded to by pushing the corresponding buttons on a dual pushbutton box.

Results

We examined both the participants' answer accuracy and the reaction time results. As the aim of the current experiment was to investigate the participants' *on-line* disambiguation preferences, statistical analyses were performed only on the reaction time data. The overall response accuracy rate was good, with the participants answering 84.42% (SD = 11.35) of the questions to the experimental items correctly, indicating that they were paying attention to the task. Prior to the analysis of the reaction time data, we removed the data from one participant whose overall response accuracy rate was close to chance (57% correct) and more than 2 SD below the group mean. Only reading times from trials that were responded to correctly were included in the statistical analysis. Two items had to be excluded from the analysis because of a computer error. None of the remaining trials exceeded the set timeout of double the mean total reading time per condition. In order to eliminate individual outliers, we further excluded read-

Table 3. *Mean reading times (*SD*) by condition for all segments in Experiment 2*

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Total
Of-NP1	843	1309	522	435	918	4180
	(272)	(388)	(156)	(141)	(264)	(1420)
Of-NP2	838	1393	498	439	938	4204
	(198)	(550)	(127)	(139)	(259)	(1396)
With-NP1	826	1334	511	502	887	4203
	(215)	(440)	(135)	(176)	(258)	(1356)
With-NP2	835	1356	512	428	876	4166
	(238)	(423)	(93)	(119)	(248)	(1353)

ing times above or below 2 *SD* from the group's mean for each condition, leading to the exclusion of 7% of the remaining total data. The remaining data from 27 participants were included in the statistical analysis. Table 3 provides an overview of the participants' mean raw reading times and standard deviations to each segment for the four conditions. Here and in the following, all reaction times are given in milliseconds.

Separate 2 × 2 ANOVAs with repeated measures for the factors preposition (*of* vs. *with*) and attachment (NP1 vs. NP2) were performed on the reaction time results for each of the five segments. No statistical effects or interactions were found for any of the three segments preceding the disambiguating auxiliary. At the disambiguating fourth segment, NP2 attachment elicited substantially shorter reaction times than did NP1 attachment for the *with* conditions only (428 vs. 502 ms). The ANOVA for this segment showed a significant main effect of attachment, F_1 (1, 26) = 11.576, $p < .01$; F_2 (1, 21) = 9.881, $p < .01$, as well as a significant interaction of preposition by attachment, F_1 (1, 26) = 7.674, $p < .05$; F_2 (1, 21) = 5.519, $p < .05$. Subsequent pairwise comparisons showed that the difference between NP1 and NP2 attachment was statistically reliable only for the preposition *with,* t_1 (26) = 3.872, $p < .01$; t_2 (21) = 4.132, $p < .001$. These results indicate that whereas the German-speaking L2 learners showed a preference for NP2 attachment for NPs linked by *with,* they did not show any on-line attachment preferences at all for relative clauses following complex genitive NPs. We further found a main effect of Preposition in the reaction times to Segment 5 that reached significance in the by-participant analysis, F_1 (1, 26) = 6.173, $p < .05$, and which reflects the fact that overall, the final segment was read faster in the *with* conditions than in the *of* conditions.

Discussion

The results from Experiments 1 and 2 indicate that the German-speaking L2 learners of English were sensitive to the NP2 attachment cue provided by the preposition *with* when resolving relative clause attachment ambiguities in the L2. Contrary to the NP2 preference that has been found for monolingual English speakers, though, the L2 learners did not show any attachment preference at all for complex genitive NPs in either the off-line or on-line task. The observation

that in the self-paced reading task, the participants spent more time reading the final segment in the *of* conditions might indicate that it took them somewhat longer to construct a coherent representation for the sentence as a whole in these conditions. The German speaking participants' lack of any preference for the *of* conditions suggest that the L2 learners did not transfer the NP1 preference found by Hemforth et al. (1997, 2000) and others, with materials very similar to ours, from their native language to the L2. This conclusion must be treated with some caution, however, given that in addition to morphological genitives, a more direct equivalent of the English prepositional genitive is also available in (colloquial) German, which is exemplified in example 13 below:

13. *Jemand erschoß die Dienerin von der Schauspielerin, die auf dem Balkon war.*
someone shot the maid of the actress who on the balcony was

Although little is known about German speakers' on-line attachment preferences for sentences such as the latter, preliminary results from an off-line study conducted by Gross (2002) suggest that German comprehenders do not have any clear attachment preferences for NPs linked by *von.* Given this potential confound, then, the results from the first two experiments do not allow us to rule out completely the possibility that the L2 learners' lack of any preference for NPs linked by *of* is due to L1 influence. In the following two experiments, we eliminated this potential confound by investigating L2 learners with Greek rather than German as their L1. In Greek, only morphological genitives can function as the equivalent of the English *of*-NPs in constructions of the type under investigation. As the results from Papadopoulou and Clahsen's (in press) study showed, Greek native speakers preferentially associate ambiguous relative clauses with the initial NP, in accordance with the predicate proximity principle.

EXPERIMENT 3

Method

Participants. A total of 39 Greek-speaking learners of English (mean age = 22.4, range = 19–35, 18 female), all of them students at the University of Essex, participated in Experiment 3. All participants had normal or corrected to normal vision, and were not informed of the ultimate purpose of the study. At the time of testing, all participants had been living in Britain for a period ranging from 5 months to 5 years (mean = 1.7, *SD* = 1.3), and all had received previous formal instruction in English in Greece, for a period ranging from 6 to 14 years (mean = 8.9, *SD* = 2.5). All participants reported that they had first been exposed to English at school, with the average age of first exposure being 13.5 years (*SD* = 3.97; range = 6–28).

Like the German-speaking L2 learners who took part in the previous two experiments, the Greek-speaking participants underwent a general language proficiency test as well as a grammaticality judgment test. The main function of

the latter was to determine that the participants were able to handle relative clause constructions with complex antecedents, and specifically, whether they could detect number agreement violations between either of the antecedents in the noun complex and the auxiliary verb in the following relative clause. The Greek-speaking L2 learners were all classified as advanced learners of English on the basis of their scores in the grammar part of the Oxford Placement Test (range = 70–97% correct).

The design of the grammaticality judgment task was adapted from Hawkins and Chan (1997). Materials included 50 sentences in total (25 grammatical, 25 ungrammatical), all of which were relative clause constructions of various types. (See Appendix D for a complete list of the materials used.) Other types of relative clause construction were included so as to gain a more comprehensive picture of the learners' knowledge of relative clauses in the target language, in addition to testing their knowledge of subject–verb agreement in sentences of the type under investigation. The materials used in this task also included relative clause constructions deemed particularly difficult for Greek-speaking learners of English to judge such as *The children that their mother works as a teacher are very naughty,* which are grammatical in Greek. Ten of the test items were structurally identical to the experimental sentences used in the main experiment, with half of these containing subject–verb agreement violations of the type illustrated by example 8b above. The participants were asked to read the sentences that were presented to them on a questionnaire sheet and to rate the grammaticality of each sentence on a 4-point scale, or else to check the "don't know" option. After excluding all "don't know" responses (less than 1% of the total number of responses), correctness scores were calculated by assigning a score of 3 to the answer *definitely correct,* a score of 2 to the answer *probably correct,* a score of 1 to the answer *probably incorrect,* and a score of 0 to the answer *definitely incorrect* for the grammatically correct items, and vice versa for the incorrect ones. The maximum possible score for the critical grammatical and ungrammatical items (i.e., those containing complex NP antecedents) was 15. The participants also performed very well in this task, scoring an average of 10.6 (range = 5–15) on the critical grammatical items and 13.2 (range = 9–15) on the critical ungrammatical ones (these scores were later converted to percentages). This result demonstrates that the participants were able to handle different types of English relative clause construction, including those of the kind that were used in the main experiment, and that they were sensitive to number agreement violations. Table 4 presents a summary of the participants' scores in the two pretests.

Note that the results from the grammaticality judgment test with the Greek-speaking participants should not be compared directly with those from the grammaticality judgment task carried out with the German-speaking L2 learners described previously, as both the materials and the scoring procedure were different. In conjunction with the fact that the participants could provide scaled rather than absolute judgments and that we did not use a forced choice procedure, this is likely to account for the Greek-speaking participants' slightly lower scores in this task.

Table 4. *Mean proficiency and grammaticality judgment scores of the Greek L2 learners*

	Mean	*SD*
Oxford Placement Test (grammar only)	83.5%	7.6
Grammaticality Judgment Test total score	76.7%	7.3
Critical items		
Hits	70.4%	17.3
Correct rejections	87.7%	11.9

Table 5. *Mean percentages of NP2 responses in Experiment 3*

	Mean	*SD*
NP1-*of*-NP2	51%	25.9
NP1-*with*-NP2	82%	16.2

Questionnaire materials. The questionnaire materials consisted of 20 experimental sentences and 20 fillers. The materials used in this task were structurally identical to those used in Experiment 1 in all relevant respects but different in terms of their content and average overall length. (A list of all experimental sentences is provided in Appendix E.) All experimental sentences and half of the fillers were ambiguous, and there were two versions of each experimental sentence (with NPs linked by either *of* or *with*). As before, the relative order of the two NPs in the complex was reversed in the *with* condition so as to make the sentences sound more natural. All potential host NPs in the test sentences were [+human], and the matrix predicate was always of a type which could pragmatically relate only to the initial NP in the complex, for example, *think about, frown at.*[8] Different versions of the questionnaire were constructed so as to ensure that each participant saw one version of each sentence only, and the test items were pseudorandomized. All questionnaire items were followed by a question and two possible answer options, and the subjects were asked to indicate their preferred interpretation.

Procedure. The experimental procedure was identical to that of Experiment 1.

Results

The pattern of responses provided in this task mirrors that found for the German group in Experiment 1 in that the *with* condition elicited a much higher number of NP2 answers than did the *of* condition. Table 5 presents the mean percentages of NP2 responses elicited by the *of* and the *with* conditions, respectively.

One sample *t* tests showed an above-chance preference for NP2 disambigua-

tion for the *with* condition only, t_1 (38) = 12.198, $p < .001$; t_2 (19) = 11.513, $p < .001$, indicating that the Greek-speaking participants had a clear preference for NP2 disambiguation for complex NPs joined by *with* but no disambiguation preference for complex genitive NPs. This observation that the participants treated the two prepositions differently was shown to be statistically reliable by a one-way ANOVA on the percentages of NP2 attachments, which revealed a significant main effect of preposition type, F_1 (1, 38) = 51.590, $p < .001$; F_2 (1, 19) = 32.122, $p < .001$. As in Experiment 1, responses to the *of* condition showed a higher degree of variation than did responses to the *with* sentences, as witnessed by the difference between standard deviations.

EXPERIMENT 4

Method

The participants were the same as in the previous experiment. The two experiments took place on different days, with at least 1 week in between sessions. Slightly modified, unambiguous versions of the experimental sentences that were used in the questionnaire study were also used in the self-paced reading task, with 4 more test items added (see Appendix F for a complete list of experimental items used in this task). The participants saw 10 practice items, followed by 96 sentences, 24 of which were experimental sentences pseudorandomly set within 72 filler items of various sentence types. As in Experiment 2, all test items were syntactically disambiguated by number on the auxiliary in the relative clause, and the relative ordering of singular and plural antecedents was counterbalanced across the four experimental conditions. Different versions of the experiment were created, so that each subject saw all four conditions but never received the same sentence twice. The self-paced reading experiment took about 30–50 min, depending on how much of a break the participants chose to take during the session. All remaining details of the experimental procedure were identical to those of Experiment 2.

Results

The results were treated in exactly the same way as were those from Experiment 2. Overall, the participants answered 85.6% (*SD* = 13.67) of the comprehension questions following the experimental items correctly. All incorrect trials were eliminated prior to the statistical analysis. In addition, the data from two participants were excluded whose response accuracy rate fell more than 2 *SD* below the group mean. By way of eliminating outlier data, we excluded complete trials whose total reading times exceeded double the group mean for that condition (affecting 1.6% of the remaining total data), as well as individual reaction times beyond 2 *SD* from the group's mean for each condition, which led to the further exclusion of 4.5% of the data. The remaining data from 37 participants were included in the statistical analysis. Table 6 provides an overview of the Greek-speaking learners' mean reading times per segment for each condition.

For each segment, a 2 × 2 ANOVA with repeated measures for the factors

Table 6. *Mean reading times (*SD*) by condition for all segments in Experiment 4*

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Total
Of-NP1	1304	2840	583	508	1113	6347
	(547)	(1368)	(191)	(224)	(423)	(1699)
Of-NP2	1391	2538	631	533	1081	5954
	(618)	(858)	(261)	(256)	(549)	(1949)
With-NP1	1327	2451	668	661	1139	6264
	(565)	(1044)	(235)	(333)	(546)	(1987)
With-NP2	1286	2648	660	532	1202	6343
	(415)	(972)	(312)	(190)	(505)	(1444)

preopsition (*of* vs. *with*) and attachment (NP1 vs. NP2) was done on the reaction time results. There were no significant effects or interactions on the first three segments. The L2 learners' reaction times to the disambiguating auxiliary in Segment 4 were substantially longer in the NP1 condition only for NPs linked by the preposition *with* (532 vs. 661 ms). The ANOVA results for this segment showed a significant main effect of preposition, F_1 (1, 33) = 5.371, $p < .05$; F_2 (1, 23) = 4.984, $p < .05$, as well as an interaction of preposition by attachment that was significant in the analysis by participants and approached significance in the items analysis, F_1 (1, 33) = 7.276, $p < .05$; F_2 (1, 23) = 3.398, $p < .1$. Subsequent paired *t* tests revealed significant differences between NP1 and NP2 attachment for the *with* conditions, t_1 (33) = 2.231, $p < .05$; t_2 (23) = 2.155, $p < .05$, but not for the *of* conditions. No main effects or interactions were found on the final segment.

The results from the on-line experiment mirror those of the questionnaire study. In both the off-line and the on-line task, the Greek-speaking L2 learners showed a marked preference for NP2 attachment for complex NPs linked by *with* but not for complex genitive NPs, indicating that their attachment decisions were influenced by the type of preposition linking the two potential antecedent NPs. Contrary to the NP2 bias typically found for English native speakers, though, the Greek-speaking participants exhibited no attachment preferences for complex genitive NPs in either task.

Results from adult native speakers

The pattern of results from the Greek-speaking participants is remarkably similar to the results obtained from the German group in Experiments 1 and 2 but differs from the pattern of results found in numerous earlier studies investigating English native speakers' relative clause attachment preferences. Specifically, whereas native speakers have been found to favor NP2 attachment for complex NPs linked by the case-marking preposition *of,* neither of our L2 groups showed any attachment preferences at all for ambiguous or temporarily ambiguous sentences containing complex NPs of this type. Previous studies on native speakers, however, have not only used a variety of experimental methods and designs, but have also used somewhat different materials from ours. To find out whether

Table 7. *Mean percentages of NP2 responses for native speakers*

	Mean	*SD*
NP1-*of*-NP2	63%	48.3
NP1-*with*-NP2	91%	29.3

native speakers also perform differently from the learners in exactly the same experimental tasks that were used with the two learner groups, and with the same type of stimuli sentences, we will, in the following, present the results from Marinis, Roberts, and Felser's (2003) study examining relative clause ambiguity resolution in native speakers of English with respect to the role of lexical–semantic properties of prepositions. Marinis et al. (2003) conducted a set of experiments to investigate the influence of different prepositions and of NP order on native speakers' relative clause attachment preferences. Among these were a questionnaire study and a self-paced reading experiment similar to those we carried out with the two learner groups. The questionnaire materials included a subset of the *of* and *with* sentences used in Experiment 1, with two further experimental conditions added in which the two noun phrases were linked by the local preposition *next to* (*the secretary next to the professor* and *the professor next to the secretary*). A total of 45 native speakers of English recruited from the graduate and undergraduate communities at the University of Essex participated in the questionnaire study. The participants produced a considerably higher number of NP2 than NP1 responses in all four conditions. To facilitate comparison with the learner groups, Table 7 presents the mean percentages of NP2 responses provided for *of* and *with* antecedents only.

One sample *t* tests revealed that the preference for NP2 disambiguation was significantly above chance level for both the *of* condition, t_1 (44) = 2.634, p = .012; t_2 (15) = 2.506, p = .024, and the *with* condition, t_1 (44) = 15.913, p < .001; t_2 (15) = 14.500, p < .001. Although contrary to the two learner groups, the native speakers showed a preference for NP2 disambiguation for both antecedent types, the NP2 preference elicited by the *with* condition was stronger than that elicited by the *of* condition. A one-way ANOVA with the factor preposition *(of* vs. *with)* showed a main effect of preposition F_1 (1, 44) = 25.617, p < .001; F_2 (1, 15) = 10.984, p < .01, indicating that the two conditions differed significantly with respect to the relative strength of the NP2 preference.

The same group of native speakers also took part in a self-paced reading experiment. The experimental materials included 24 sentences (the same that were used in Experiment 2) that appeared in eight versions, each of which was disambiguated by number marking on the auxiliary in favor of either NP1 or NP2 attachment (i.e., *of*-NP1, *of*-NP2, *with*-NP1, *with*-NP2, and four *next to* conditions), plus 96 filler sentences.[9] Four different versions of the experiment were created, each containing two versions of each original sentence. These differences in the number of conditions and experimental design apart, all further details of the experimental method and procedure were identical to those

Table 8. *Mean reading times (*SD*) by condition for all segments for native speakers*

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Total
Of-NP1	805	1303	721	581	1056	4428
	(474)	(779)	(623)	(471)	(823)	(2010)
Of-NP2	756	1361	650	495	997	4208
	(451)	(962)	(370)	(229)	(687)	(1707)
With-NP1	752	1373	690	648	1118	4556
	(365)	(832)	(511)	(513)	(792)	(1742)
With-NP2	814	1478	666	512	956	4381
	(387)	(835)	(474)	(272)	(623)	(1624)

that were used with the learners. For the purpose of comparing the native speakers' performance with that of the two learner groups, we will examine the results from the *of* and *with* conditions only. The native speakers' mean raw reading times for each segment are shown in Table 8.[10]

Separate 2 × 2 ANOVAs with the factors preposition (*of* vs. *with*) and attachment (NP1 vs. NP2) were performed for each segment. No statistical effects or interactions were found for the first three segments. At the disambiguating auxiliary (Segment 4), the conditions forcing NP2 attachment elicited shorter reaction times than those forcing NP1 attachment for both *of* (495 vs. 581 ms.) and *with* (512 vs. 648 ms.) antecedents. The ANOVA performed for this segment showed a significant main effect of attachment, F_1 (1, 42) = 11.419, $p < .01$; F_2 (1, 23) = 13.061, $p < .01$, confirming that the overall advantage for NP2 disambiguation was statistically reliable, but no interaction with preposition type. Subsequent paired *t* tests revealed that the difference between NP1 and NP2 attachment was statistically significant for both the *of* conditions, t_1 (42) = 2.268, $p < .05$; t_2 (23) = 2.313, $p < .05$, and the *with* conditions, t_1 (42) = 3.100, $p < .01$; t_2 (23) = 2.789, $p < .05$, indicating that the participants had an on-line preference for NP2 disambiguation for both types of complex NP antecedents. This effect appeared to spill over to Segment 5, where an ANOVA also showed a main effect of attachment that was significant in the by-participant analysis and marginally significant in the by-items analysis, F_1 (1, 42) = 4.671, $p < .05$; F_2 (1, 23) = 4.186, $p < .1$. Subsequent paired *t* tests showed that only the difference between the two *with* conditions, t_1 (42) = 2.693, $p < .05$; t_2 (23) = 2.608, $p < .05$, was statistically reliable at the final segment, though.

These results replicate the findings from numerous earlier studies of English speakers' relative clause disambiguation preferences. Moreover, they show that the native speakers significantly preferred NP2 over NP1 disambiguation for complex NPs linked by either *of* or *with* in the same experimental tasks, and with the same type of materials, as those that were used with the L2 learners.

GENERAL DISCUSSION

Our main results can be summarized as follows:

- In both the questionnaire and the self-paced reading tasks, the two groups of L2 learners pattern with adult native speakers in that they showed a strong preference for NP2 disambiguation for NPs linked by the preposition *with*.
- Contrary to native speakers, however, neither the German-speaking nor the Greek-speaking L2 learners showed any attachment preferences at all for sentences containing complex genitive antecedents in either task.

In what follows, we discuss the implications of our findings for theories of L2 processing, and also compare our results with those obtained from monolingual English-speaking children in a parallel auditory study (Felser, Marinis, & Clahsen, 2003).

Use of phrase-structure versus lexical information during L2 parsing

Recall that mature speakers' relative clause attachment preferences for sentences containing complex genitive antecedents are determined by at least two interacting parsing strategies, a universal recency preference, and a principle such as predicate proximity that favors attachment to the initial NP. Previous results from adult native speakers indicate that recency takes precedence over predicate proximity for ambiguous relative clauses in two-site contexts in English, whereas predicate proximity outranks recency in languages such as German or Greek, that have a less restricted word order than English (compare Gibson, Pearlmutter, et al., 1996). In addition, there is evidence from both off-line and on-line studies suggesting that adult speakers' attachment decisions are also affected by the type of the linking preposition, with NP2 attachment being preferred crosslinguistically for NPs joined by the preposition *with.*

Our results demonstrate that, like native speakers, L2 learners are influenced by the type of linking preposition during the processing of relative clause attachment ambiguities, indicating that adult L2 learners can access and make use of lexical–semantic information during on-line sentence comprehension. This finding is compatible with the results from Juffs' (1998) and Frenck–Mestre and Pynte's (1997) studies that have demonstrated L2 learners' sensitivity to verb argument structure information during processing. There is no evidence from our results, on the other hand, that L2 learners apply either of the two phrase-structure based locality principles (recency or predicate proximity) when processing ambiguous sentences containing complex NPs joined by *of*. As for sentences containing complex *with* antecedents, note that if the learners' NP2 preference reflected their use of a purely phrase-structure dependent recency strategy rather than sensitivity to lexical biases, we would have expected them to show an NP2 preference for complex genitive antecedents as well.

Given that all our participants had scored very highly on both the language proficiency and the grammaticality judgment tests, it is unlikely that their nonnativelike performance in our experiments should have anything to do with insufficient grammatical knowledge of the construction under investigation. If, for example, the learners had misanalyzed the *of*-PPs as independent thematic domains, they should have shown an NP2 preference for complex genitive antecedents, too.

An alternative possibility might be that learners have difficulty integrating different types of information when processing the L2 (Kilborn, 1992), perhaps due to the increased working memory demands posed by reading in a nonnative language (Harrington, 1992). An explanation in terms of a processing problem due to resource limitations would predict that when given more time for interpreting ambiguous sentences (i.e., in off-line tasks), advanced L2 learners should exhibit the same disambiguation preferences as native speakers do where L1 and L2 preferences differ. Recall, however, that the learners performed similarly to native speakers only on sentences containing the thematic preposition *with*, for which no crosslinguistic variation is attested, but not on sentences containing *of*-genitives. In other words, the finding that our participants also failed to show any attachment preferences for complex genitive NPs in the questionnaire task is unexpected under the assumption that L2 learners have problems integrating phrase-structure and lexical–semantic information only in situations where processing or memory resources are short.[11]

The role of transfer in L2 processing

Given that adult L2 learners already possess a fully developed processing system for their L1, it is conceivable that processing strategies from the L1 are transferred to the L2. There is no evidence from our results, however, to suggest that German or Greek-speaking L2 learners have transferred the NP1 preference for complex genitive NPs from their native language, given that the L2 learners exhibited no preferences for the *of* conditions at all.[12] Note that the two groups of L2 learners showed the same pattern of preferences, regardless of whether they were fully immersed in the L2 at the time of testing (like the Greek-speaking participants) or not (like the German group).

Another possibility might be that both the German-speaking and Greek-speaking participants were at a stage "in between" transferring the NP1 preference from their native languages and acquiring the NP2 preference of the target language, a situation that proponents of the Competition Model refer to as *amalgamation* (compare Hernandez, Bates, & Avila, 1994). An explanation along these lines is called into question, however, once we take into account the findings from Papadopoulou and Clahsen's (in press) study on L2 ambiguity resolution by learners of Greek. Their results argue against an intermediate stage in L2 processing as the learners they tested failed to show any attachment preferences for complex genitive antecedents even though both the target language (Greek) and the participants' L1's (Spanish, German, and Russian) favor NP1 attachment. It is interesting that our L2 learners showed exactly the same pattern of attachment preferences as did the Spanish-, German-, and Russian-speaking learners of Greek examined by Papadopoulou and Clahsen, despite the fact that the two target languages, English and Greek, differ with respect to native speakers' disambiguation preferences. Together, the results from these studies demonstrate that while being sensitive to lexical biases provided by the linking preposition, L2 learners show a systematic lack of any clear attachment preferences for relative clauses preceded by complex genitive NPs, irrespective of the preferences found in the target language *or* in the learners' L1.

All models of language acquisition that predict L1 transfer of processing strategies, whether universalist or purely exposure based, have difficulty accounting for these findings. For both our learners and those examined by Papadopoulou and Clahsen (in press), such models would have predicted an NP1 preference for complex genitive antecedents rather than the absence of any preference, especially where the preferences of the learners' L1 and that of the target language converge, as was the case in Papadopoulou and Clahsen's study on Greek.

Given our earlier suggestion that L2 learners do not make use of phrase structure information during L2 processing to the same extent as native speakers do, it is conceivable that in the absence of any lexical biases provided by the linking preposition, L2 learners postpone associating an ambiguous relative clause with either of the two potential host NPs until other cues to interpretation become available, rather than transferring the structure-based predicate proximity (or recency) strategy from their native language to the L2. Other information that might help learners disambiguate relative clause attachment ambiguities includes, for example, pragmatic or contextual information. The fact that in our study, the test sentences were presented in isolation and contained no obvious pragmatic biases in favor of either NP1 or NP2 attachment might then account for the learners' lack of any disambiguation preference in the *of* conditions.[13]

Child L1 versus adult L2 processing

Although the existing body of research into children's processing of ambiguous sentences is too small at present to warrant any firm conclusions, results from several recent studies indicate that children also have difficulty integrating information from different sources during on-line sentence comprehension. Trueswell, Sekerina, Hill, and Logrip (1999), for example, recorded children's eye movements during the comprehension of sentences containing temporary PP-attachment ambiguities such as *Put the frog on the napkin in the box.* The authors found that 5-year-olds preferred to construe the PP *on the napkin* as the destination argument of *put* rather than as a modifier of *the frog,* even if the visual context was manipulated in such a way as to bias them toward the NP modifier interpretation. This finding suggests that during the processing of PP attachment ambiguities, children at the age range tested preferentially attach the ambiguous PP to the verb phrase, in accordance with the predicate proximity principle. A preference for verb phrase attachment has also been reported in comparable studies with adults (Frazier & Rayner, 1982, among others). Contrary to adults, however, the children's attachment preferences remained largely unaffected by the situational context (cf. Altmann & Steedman, 1988, Tanenhaus, Spivey–Knowlton, Eberhard, & Sedivy, 1995).[14]

Further evidence that children's on-line parsing decisions are influenced primarily by phrase structure information is provided by a reading-time study conducted by Traxler (2002), who tested 8- to 12-year-old children's processing of sentences containing temporary subject/object ambiguities, such as examples 14a–c below. Sentences of the type shown in 14a are known to elicit robust garden-path effects in adult native speakers caused by their misanalyzing the postverbal NP as the direct object of an optionally transitive verb, in accordance

with the late closure (or recency) principle. Garden-path effects have been found to be attenuated, however, in sentences such as example 14b, in which the postverbal NP is not a plausible object of the verb, and in sentences like 14c that contain an intransitive verb (cf., e.g., Adams, Clifton, & Mitchell, 1998; Garnsey, Pearlmutter, Myers, & Lotocky, 1997).

14. a. When Sue tripped the girl fell over and the vase was broken.
    b. When Sue tripped the table fell over and the vase was broken.
    c. When Sue fell the policeman stopped and helped her up.

The children tested in Traxler's (2002) study, by contrast, showed a tendency to analyze the postverbal NP in *all* the above conditions as a direct object, irrespective of plausibility or verb subcategorization preferences.

Of particular interest to the present study are the results from Felser et al.'s (2003) study of children's relative clause attachment preferences. In both an auditory questionnaire and a self-paced listening task, Felser et al. investigated relative clause disambiguation preferences in 6- to 7-year-old English-speaking children, using materials similar to those of our L2 study.[15] Felser et al. found that whereas the adult control group's attachment preferences were influenced by the type of preposition joining the two potential antecedent NPs (*of* vs. *with*), children's on-line attachment preferences interacted only with their listening span: whereas children with a relatively high listening span showed a preference for NP1 attachment, irrespective of the type of preposition involved, the low-span children showed an across the board tendency toward NP2 disambiguation. These results suggest that, depending on their working memory capacity, the children preferentially employed *either* the predicate proximity *or* the recency strategy. Crucially, though, and contrary to the adult controls, neither group of children showed any sensitivity at all to lexical biases provided by the preposition during processing, as witnessed by the absence of any interaction between antecedent type and attachment in the results from either of the two span groups in the on-line task. Taken together, the above findings suggest that for children, phrase-structure based locality principles take precedence over lexical or pragmatic biases during parsing.

The results from Felser et al.'s (2003) child study differ in interesting ways from those obtained from the German- and Greek-speaking L2 learners of English reported above. Although advanced L2 learners appear to be sensitive to lexical–semantic cues to disambiguation when processing ambiguous sentences in the L2, there is nothing in our results to suggest that they apply either the recency or the predicate proximity strategy in situations where the linking preposition does not bias them toward any particular attachment. Children, on the other hand, seem to integrate new incoming words or phrases into the current parse in accordance with locality principles such as recency and predicate proximity, while largely disregarding lexical–semantic cues.

Do the observed differences between (adult and child) native speakers and L2 learners mean, then, that L2 processing is qualitatively different from L1 processing? Our results would seem to suggest that this is indeed the case. Note that it is unlikely that the possibility that L2 learners simply require more time

than mature native speakers for revising their initial attachment decision in the conditions forcing the dispreferred attachment, given that we found no significant differences between NP1 and NP2 attachment on the final segment either and that our participants also failed to show any disambiguation preferences in the off-line task. Rather, our results suggest that L2 learners do not rely on phrase structure information to the same extent that both young and mature native speakers do when processing input from the target language, and instead attempt more direct form–function mappings (compare also Gass, 1986; Pienemann, 1998). More specifically, it is conceivable that, contrary to the L1 parser, the L2 sentence comprehension mechanism does not necessarily integrate incoming ambiguous words or phrases immediately into the current syntactic analysis during on-line processing; rather, it delays their integration under certain conditions until sufficient (lexical, pragmatic, or other) information has been received on which to base the attachment decision. In regard to the materials used in the present study, it is possible that the information contained in the preposition *with* (signaling the beginning of a new thematic domain) is enough to bias comprehenders toward associating the following relative clause with the second NP. The preposition *of,* in contrast, fails to trigger any such bias, so that a parser that is not guided by either recency or predicate proximity may simply "wait" until further cues to disambiguation become available, possibly delaying the integration of the relative clause into the current parse until the disambiguating auxiliary has been received (or potentially indefinitely, if the ambiguity is not resolved, as in the questionnaire task). This would explain why the appearance of the auxiliary did not cause any processing disruption in either of the complex genitive conditions in the on-line task and why our participants did not show any disambiguation preferences at all for the ambiguous *NP-of-NP* sentences used in the off-line task.

CONCLUSION

Both the Greek- and German-speaking L2 learners of English who were examined in the present study exhibited the same pattern of relative clause attachment preferences: a strong NP2 bias for the *with* conditions, but no attachment preference for complex genitive antecedents. This is the same pattern that was observed by Papadopoulou and Clahsen (in press) in L2 learners of Greek from different language backgrounds. Our results indicate that, despite their high level of competence in English, neither of our learner groups processed ambiguous relative clauses with complex genitive antecedents in the same way as adult native speakers do. Although our findings suggest that advanced L2 learners are able to make use of lexical–semantic information during processing, there is no evidence from our study that they have either acquired the recency preference for complex genitive antecedents that is found in English or transferred the predicate proximity strategy from their L1. Monolingual English children, by contrast, appear to be guided predominantly by phrase-structure information when resolving relative clause attachment ambiguities in their L1, while showing no evidence of being able to use lexical–semantic cues to disambiguation.

Taken together, these findings suggest that, whereas children are guided by universal, least-effort based parsing principles during sentence comprehension, L2 learners attempt a more direct mapping from surface form to interpretation.

APPENDIX A

CRITICAL SENTENCES USED IN THE GRAMMATICALITY JUDGMENT TASK WITH THE GERMAN GROUP

Grammatical sentences

1. The reporter phoned the boss of the secretary who was reading a book.
2. The cleaning lady noticed the chief of the player who was working very late.
3. The nurse trusted the doctor of the teacher who was preparing to go home.
4. The headmaster smiled at the pupils of the teacher who were standing in the hall.
5. The inspector watched the deputies of the policemen who were watching the report of the crime on TV.
6. The journalist hated the soldiers of the colonels who were sitting down.
7. A reporter interviewed the bodyguard with the prince who was wearing a smart black suit.
8. The man spoke to the secretary with the manager who was about to move to a new office.
9. The little girl envied the princess with the maid who was eating chocolates.
10. The photographer liked the artists with the models who were smiling all the time.
11. The young man noticed the singers with the guitarists who were reading the music.
12. The coach looked at the football players with the fans who were very happy.

Ungrammatical sentences

1. The director noticed the hairdresser of the actress who were wearing a green dress and a yellow hat.
2. The director congratulated the instructor of the schoolboy who were looking very serious.
3. The doctor recognized the nurse of the patient who were feeling very tired.
4. I watched the fans of the singers who was dancing about throughout the concert.
5. The reporter watched the lawyers of the criminals who was speaking to the judge.
6. The woman knew the photographers of the singers who was reading a book.
7. The director spoke to the actor with the cameraman who were preparing the next scene.
8. The young girl favored the player with the driver who were talking to an old woman.
9. The cameraman adored the actor with the director who were wearing round glasses.
10. A strange woman called to the travelers with the guides who was dreaming about to cross the dangerous river.
11. The doctor contacted the lawyers with the nurses who was talking on the phone.
12. The woman blamed the hairdresser with the apprentices who was smiling all the time.

APPENDIX B

EXPERIMENTAL ITEMS USED IN EXPERIMENT 1

Each experimental sentence came in two versions as illustrated by (1a) versus (1b). For items 2–20, only the *of* versions are provided.

1. a. The dean liked *the secretary of the professor* who was reading a letter.
   b. The dean liked *the professor with the secretary* who was reading a letter.
2. The young girl favored the driver of the player who was talking to an old woman.
3. The doctor examined the nurse of the pupil who was feeling very tired.
4. The director congratulated the instructor of the schoolboy who was writing the reports.
5. The secretary saw the driver of the manager who was dreaming of holidays.
6. The publisher hated the executive of the economist who was wearing round glasses.
7. The journalist criticized the pilot of the traveler who was drinking too much.
8. The judge recognized the solicitor of the criminal who was suffering from insomnia.
9. The cameraman adored the director of the actor who was wearing cowboy boots.
10. The doctor observed the attorney of the consultant who was reading the newspaper.
11. The journalist interviewed the assistant of the inspector who was looking very serious.
12. The economist liked the journalist of the editor who was thinking about the stock report.
13. The student photographed the fan of the actress who was looking happy.
14. The woman blamed the apprentice of the hairdresser who was smiling all the time.
15. The woman knew the photographer of the singer who was reading the book.
16. The man questioned the guide of the tourist who was feeling rather exhausted.
17. The nurse trusted the doctor of the teacher who was preparing to go home.
18. The thief hit the technician of the dentist who was calling the police.
19. The journalist hated the soldier of the colonel who was sitting down.
20. The little girl envied the maid of the princess who was eating chocolate.

APPENDIX C

EXPERIMENTAL SENTENCES USED IN EXPERIMENT 2

Four versions of each experimental sentence were created as shown in 1a–d, which corresponded to the four experimental conditions. For the remaining sentences only the (a) versions (i.e., those forcing NP1 disambiguation for complex NPs linked by *of*) are provided.

1. a. The dean liked *the secretary of the professors* who *was* reading a letter.
   b. The dean liked *the secretary of the professors* who *were* reading a letter.
   c. The dean liked *the professors with the secretary* who *were* reading a letter.
   d. The dean liked *the professors with the secretary* who *was* reading a letter
2. The young girl favored the driver of the players who was talking to an old woman.
3. The doctor examined the nurse of the pupils who was feeling very tired.
4. The director congratulated the instructor of the schoolboys who was writing the reports.
5. The doctor contacted the nurses of the lawyer who were talking on the phone.
6. The photographer ignored the ministers of the president who were waving at the crowd.
7. The secretary saw the drivers of the manager who were dreaming of holidays.
8. The publisher hated the executives of the economist who were wearing round glasses.
9. The journalist criticized the pilot of the travelers who was drinking too much.
10. The judge recognized the solicitors of the criminal who were suffering from insomnia.
11. The cameraman adored the director of the actors who was wearing cowboy boots.
12. The doctor observed the attorney of the consultants who was reading the newspaper.
13. The journalist interviewed the assistants of the inspector who were looking very serious.
14. The economist liked the journalists of the editor who were thinking about the stock report.

15. The student photographed the fans of the actress who were looking happy.
16. The woman blamed the apprentices of the hairdresser who were smiling all the time.
17. The policeman arrested the supervisor of the bodyguards who was wearing a black suit.
18. The cleaning lady noticed the chief of the players who was working very late.
19. The woman knew the photographer of the singers who was reading the book.
20. The man questioned the guide of the tourists who was feeling rather exhausted.
21. The nurse trusted the doctor of the teachers who was preparing to go home.
22. The thief hit the technicians of the dentist who were calling the police.
23. The journalist hated the soldiers of the colonel who were sitting down.
24. The little girl envied the maids of the princess who were eating chocolate.

APPENDIX D

MATERIALS USED IN THE GRAMMATICAL JUDGMENT TASK WITH THE GREEK GROUP

Grammatical sentences

A. Critical items

1. The headmaster smiled at the pupils of the teacher who were standing in the hall.
2. A reporter interviewed the bodyguards with the prince who was wearing a smart black suit.
3. The chairman phoned the boss of the clerks who were working on the new project.
4. The inspector watched the deputies of the policeman who were watching the report of the crime on TV.
5. The man spoke to the secretaries with the manager who was about to move to a new office.

B. Other types of relative clause construction

6. The watch he lost was an expensive Rolex.
7. The new educational program the government suggested did not please the media.
8. The girl we just met is a famous model.
9. He couldn't go on the trip he had planned all year because he didn't have enough money.
10. They never gave me back the CDs I lent them.
11. The actor who performs well wins a lot of prizes.
12. The thief that stole the jewelry from the rich woman escaped.
13. The waitress who always serves us is from Scandinavia.
14. The man that lives next door is very strange.
15. Lions who eat only vegetables are extremely uncommon.
16. The dog that we just saw never stops barking.
17. The man who I met at the party last weekend didn't phone me.
18. The tennis player whose leg was broken couldn't play in the tournament.
19. The woman whose husband is in prison now wants a divorce.
20. That bicycle whose wheels are missing is not worth very much.
21. The man that Helen is devoted to is a Casanova and a drunk.
22. I heard that someone was hired for the job that you're interested in.
23. The woman that I've been writing to for a long time hasn't sent me a letter for a month.
24. Sadly, the teacher that Jim was madly in love with got married last week.
25. The old lady that you're always talking about has just gone into hospital.

Ungrammatical sentences

A. Critical items

1. I watched the fans of the singers who was dancing about throughout the concert.
2. The customer spoke to the assistant with the pharmacist who were preparing the medicine.
3. The director noticed the hairdresser of the actress who were wearing a green dress and a yellow hat.
4. The reporter watched the lawyers of the criminals who was speaking to the judge.
5. A strange woman called to the guides with the travelers who was about to cross the dangerous river.

B. Other types of relative clause construction

6. The student that I gave him the book didn't come.
7. The cat that I fed it every day got very fat.
8. The pupils that John taught them for many years successfully passed their exams.
9. The professor to whom I sent him my application form is well-known around the world.
10. The friend for whom I bought her some chocolates sent me a thank-you card.
11. The girl who that lost her way cried.
12. The dog that which hurt a child ran away.
13. The school that which they are studying at is very famous.
14. The woman whom that I was talking to is an actress.
15. The classmate whom that I work harder than always copies my work.
16. The man that his wife we met is a doctor.
17. I saw my neighbor that her name I always forget.
18. The children that their mother works as a teacher are very naughty.
19. The student that her parents were injured in a car accident is really unhappy.
20. The painting that its value is a million pounds was stolen from the National Gallery.
21. This is the secretary who Peter heard the news that the boss will marry.
22. This is the boy who Mary described the way Bill attacked.
23. This is the building which they read in the paper that the government will buy.
24. This is the land which the manager questioned the decision that we should sell.
25. This is the politician that the journalist found out that the prime minister will promote.

APPENDIX E

EXPERIMENTAL ITEMS USED IN EXPERIMENT 3

Each experimental sentence came in two versions as illustrated by 1a versus 1b below. For the remaining sentences, only the *of* versions are provided.

1. a. The dean was thinking about *the researcher of the professor* who never smiled.
   b. The dean was thinking about *the professor with the researcher* who never smiled.
2. The clerk asked for the consultant of the economist who was reading the paper.
3. A client noticed the hairdresser of the actress who had blue eyes.
4. The man smiled at the supervisor of the clerk who was always busy.
5. The publisher smiled at the illustrator of the poet who had an untidy beard.
6. A fan looked at the guitarist of the singer who was reading the music.
7. The headmaster called to the teacher of the pupil who was thinking about the school play.

8. The journalist asked for the secretary of the minister who was always dressed smartly.
9. A client looked at the clerk of the solicitor who was about to leave the room.
10. A man called to the guide of the traveler who was about to cross the river.
11. The inspector glanced at the deputy of the policeman who was smoking a cigarette.
12. A woman caught the attention of the publicist of the writer who was on the telephone.
13. A man observed the barrister of the criminal who was waiting for the decision of the jury.
14. A nurse smiled at the psychiatrist of the patient who had an extremely large nose.
15. A man asked for the apprentice of the builder who was wearing a yellow helmet.
16. The girl was interested in the makeup artist of the actress who was sneezing loudly.
17. The professor frowned at the technician of the physician who always seemed to be unhappy.
18. The coach looked at the physiotherapist of the football player who was scratching his head.
19. A customer frowned at the assistant of the pharmacist who was looking for a pen.
20. The fireman called to the photographer of the journalist who was still shocked because of the fire.

APPENDIX F

EXPERIMENTAL SENTENCES USED IN EXPERIMENT 4

Four versions of each experimental sentence were created as shown in 1a–d below, which corresponded to the four experimental conditions. For the remaining sentences only the (a) versions (i.e., those forcing NP1 disambiguation for complex NPs linked by *of*) are provided.

1. a. The clerk asked for *the consultants of the economist* who *were* reading the reports.
   b. The clerk asked for *the consultants of the economist* who *was* reading the reports.
   c. The clerk asked for *the economist with the consultants* who *was* reading the reports.
   d. The clerk asked for *the economist with the consultants* who *were* reading the reports.
2. The headmaster called to the pupils of the teacher who were thinking about the school play.
3. The inspector glanced at the deputies of the policeman who were always working late.
4. The doctor smiled at the nurses of the patient who were feeling very tired.
5. The man asked for the apprentices of the builder who were wearing blue overalls.
6. The director looked at the makeup artists of the actress who were always smiling.
7. The professor frowned at the technicians of the physicist who were wearing glasses.
8. The customer called to the assistants of the pharmacist who were standing up.
9. The fireman observed the photographers of the journalist who were sitting down.
10. The man noticed the hairdresser of the opera singers who was about to go home.
11. The woman looked at the supervisor of the clerks who was always busy.
12. The publisher smiled at the illustrator of the writers who was dressed colorfully.
13. The fan looked at the guitarist of the singers who was feeling very pleased.
14. The man called to the guide of the travelers who was feeling exhausted.
15. The woman caught the attention of the publicist of the artists who was dressed for dinner.
16. The man observed the barrister of the criminals who was sitting down.

17. The coach looked at the physiotherapist of the football players who was always late to arrive.
18. The client asked for the clerk of the solicitors who was never afraid of hard work.
19. The journalist called to the secretary of the ministers who was sitting in the office.
20. The interviewer looked at the bodyguards of the prince who were very smartly dressed.
21. The cameraman glanced at the director of the actors who was dressed in black.
22. The woman watched the maids of the princess who were feeling hungry.
23. The man observed the sergeant of the soldiers who was preparing to go home.
24. The dean was thinking about the researchers of the professor who were never happy.

ACKNOWLEDGMENTS

Part of the research reported here was supported by the Leverhulme Trust (Grant F/00 213B to Harald Clahsen, Claudia Felser, and Roger Hawkins), which is gratefully acknowledged. We thank Harald Clahsen, Martha Crago, Meike Hadler, Roger Hawkins, Manfred Pienemann and his research group, the members of the Second Language Acquisition Research Group at Essex, the audience at GASLA-6, Ottawa, and two anonymous reviewers for helpful comments and discussion and Phil Scholfield for providing statistical advice.

NOTES

1. Note, however, that some on-line studies have either failed to replicate this finding or produced mixed results (Carreiras & Clifton, 1993; Traxler, et al., 1998).
2. For evidence that modifier attachment preferences are indeed influenced by locality-based parsing principles rather than being solely or primarily determined by probabilistic information such as the relative frequency of NP1 versus NP2 modification in the input, see Gibson, Schütze, and Salomon (1996), and Gibson and Schütze (1999).
3. There may also be a representational difference between postnominal *of* genitives and PPs introduced by *with,* reflecting the fact that the former are arguments of the preceding head noun (and thus might be analyzed as complements), whereas the latter qualify more obviously as adjuncts. Note, however, that whether this difference is assumed to be encoded at the phrase structure level depends, among other things, on the syntactic framework adopted (e.g., whether nonbranching nodes are permitted). Defining the relevant local processing domain in terms of Frazier and Clifton's (1996) notion of thematic domain allows us to remain theory neutral with respect to this issue. Note that, irrespective of any representational differences, it is clearly the *type* of preposition itself (in languages that use prepositional genitives), rather than syntactic category information alone, that signals to the parser whether a new thematic domain is being introduced. It is for this reason that we have chosen here to speak of lexical biases (as opposed to purely phrase structure–based principles).
4. The experiments reported here are each part of larger individual studies (Gross, 2002; Marinis et al., 2003, Roberts, 2003), which accounts for the differences in the materials and/or in the experimental design as described in the following sections. The experiments with the German-speaking learners were carried out by Gross, those with the Greek-speaking learners by Roberts, and the native speaker data were collected by Marinis and colleagues.

5. Preliminary results from a series of off-line and on-line experiments carried out by Marinis et al. (2003) demonstrate that the relative order of the two potential host NPs by itself has no effect on attachment. Any differences in disambiguation preferences found between the *of* and the *with* conditions must therefore be due to lexical properties of the preposition or to the relationship between the two NPs that the preposition signals.
6. The critical nouns were matched on the basis of frequency information provided by the CELEX database. A frequency ratio of at least 0.75 between each pair of nouns was used as a matching criterion.
7. Note that ANOVAs are commonly used for this type of data in the psycholingustic literature (cf., e.g., Gilboy et al., 1995). Results from the Kolmogorov–Smirnov test for normality indicate that the questionnaire data obtained from the German-, Greek-, and English-speaking participants are all normally distributed.
8. The two potential antecedent NPs were not matched for frequency due to the fact that the materials used in the Greek-speaking learners' questionnaire were modeled after those from Papadopoulou and Clahsen's (in press) study on Greek, using English translations of the critical NP complexes wherever possible.
9. As in the questionnaire materials, the *next to* conditions were constructed by varying the relative ordering of the two potential host NPs (the secretary next to the professors vs. the professors next to the secretary), so as to allow us to investigate a possible effect of NP order on native comprehenders' attachment preferences.
10. The data from two participants whose response accuracy rate fell below 2 *SD* from the group mean were excluded. Statistical analysis were performed on correctly answered trials only, after removing outliers.
11. The hypothesis that L2 learners' ability to make use of phrase structure information during L2 processing might be reduced relative to that of native speakers is also supported by the results from recent event-related potentials (ERPs) studies carried out by Hahne (2001) and Hahne and Friederici (2001) on Russian and Japanese learners of German. They found that, whereas there were only quantitative differences between the L2 learners and the native speakers with respect to the N400 ERP component thought to reflect semantic integration difficulty, there were qualitative differences between the groups with respect to the presence of ERP components associated with first-pass parsing (early anterior negativity, Hahne, 2001) or later syntactic processes (P600, Hahne & Friederici, 2001).
12. Given that for complex NPs linked by *with,* NP2 attachment is the universally preferred option, the results from the *with* conditions by themselves cannot tell us anything about the role of L1 transfer in L2 processing. That is, if modification shows a general tendency to occur within the current thematic domain (compare Frazier & Clifton, 1996), then any L2 learner capable of correctly identifying *with* as a thematic preposition would be expected to show an NP2 preference.
13. This hypothesis would also account for the German learners' relatively longer reading times at the wrap-up segment in the *of* conditions (as opposed to the *with* conditions) in Experiment 2. The results from the Greek learners did not show any effect of preposition at this segment, however.
14. Snedeker and Trueswell (2001) report results from a communication task indicating that 5-year-old children also fail to make use of prosodic cues when processing PP-attachment ambiguities. Children's apparent inability to make use of nonsyntactic

information during processing might be due to their relatively limited working memory capacity (cf., e.g., Felser et al., 2003). Results from a sentence production task carried out by Hurewitz, Brown–Schmidt, Thorpe, Gleitman, and Trueswell (2000), for example, indicate that children are quite capable of taking into account information provided by the referential context in a task that puts less demand on the child's processing resources than on-line sentence comprehension does.

15. Presenting the materials auditorily rather than visually was necessary as many children at the age range tested are not yet able to read. As previous studies by Ferreira, Henderson, Anes, Weeks, and McFarlane (1996) and Booth, MacWhinney, and Harasaki (2000) demonstrated, though, the auditory moving-window technique is equivalent to its visual counterpart with respect to the types of effect to which it is sensitive.

REFERENCES

Adams, A., & Gathercole, S. (2000). Limitations in working memory: Implications for language development. *International Journal of Language and Communication Disorders, 35,* 95–116.

Adams, B., Clifton, C., & Mitchell, D. (1998). Lexical guidance in sentence processing? *Psychonomic Bulletin and Review, 5,* 265–270.

Allen, D. (1992). *The Oxford Placement Test.* Oxford: Oxford University Press.

Altmann, G., & Steedman, M. (1988). Interaction with context during human sentence processing. *Cognition, 30,* 191–238.

Baccino, T., De Vincenzi, M., & Job, R. (2000). Cross-linguistic studies of the late closure strategy: French and Italian. In M. De Vincenzi & V. Lombardo (Eds.), *Cross-linguistic perspectives on language processing* (pp. 89–118). Dordrecht: Kluwer.

Baumann, H., Nagengast, J., & Klaas, G. (1993). *New experimental setup* (NESU). Unpublished manuscript, Max–Planck Institute for Psycholinguistics, Nijmegen.

Booth, J., MacWhinney, B., & Harasaki, Y. (2000). Developmental differences in visual and auditory processing of complex sentences. *Child Development, 71,* 981–1003.

Brysbaert, M., & Mitchell, D. (1996). Modifier attachment in sentences parsing: Evidence from Dutch. *Quarterly Journal of Experimental Psychology, 49,* 664–695.

Carreiras, M., & Clifton, C. (1993). Relative clause interpretation preferences in Spanish and English. *Language and Speech, 36,* 353–372.

Carreiras, M., & Clifton, C. (1999). Another word on parsing relative clauses: Eyetracking evidence from Spanish and English. *Memory and Cognition, 27,* 826–833.

Corley, M. (1995). *The role of statistics in human sentence processing.* Unpublished doctoral dissertation, University of Exeter.

Cuetos, F., & Mitchell, D. (1988). Cross-linguistic differences in parsing: Restrictions on the use of the late closure strategy in Spanish. *Cognition, 30,* 73–105.

Cuetos, F., Mitchell, D., & Corley, M. (1996). Parsing in different languages. In M. Carreiras, J. Garcia-Albea, & N. Sebastian-Galles (Eds.), *Language processing in Spanish* (pp. 145–187). Mahwah, NJ: Erlbaum.

Dussias, P. (2001). Sentence parsing in fluent Spanish–English bilinguals. In J. Nicol (Ed.), *One mind, two languages: Bilingual language processing* (pp. 159–176). Malden, MA: Blackwell.

Felser, C., Marinis, T., & Clahsen, H. (2003). *Children's processing of ambiguous sentences: A study of relative clause attachment.* Unpublished manuscript, University of Essex.

Fernández, E. (1999). Processing strategies in second language acquisition: Some preliminary results. In E. Klein & G. Martohardjono (Eds.), *The development of second language grammars: A generative approach* (pp. 217–240). Amsterdam: Benjamins.

Fernández, E. (2000). *Bilingual sentence processing: relative clause attachment in English and Spanish.* Unpublished doctoral dissertation, City University of New York.

Ferreira, F., Henderson, J., Anes, M., Weeks, P., Jr., & McFarlane, D. (1996). Effects of lexical frequency and syntactic complexity in spoken language comprehension: Evidence from the

auditory moving window technique. *Journal of Experimental Psychology: Learning, Memory and Cognition, 22,* 324–335.

Fodor, J. D. (1998). Learning to parse? *Journal of Psycholinguistic Research, 27,* 285–319.

Frazier, L. (1979). *On comprehending sentences: Syntactic parsing strategies.* Unpublished doctoral dissertation, University of Connecticut.

Frazier, L., & Clifton, C. (1996). *Construal.* Cambridge, MA: MIT Press.

Frazier, L., & Fodor, J. D. (1978). The sausage machine: A new two-stage parsing model. *Cognition, 6,* 291–326.

Frazier, L., & Rayner, K. (1982). Making and correcting errors during sentence comprehension: Eye movements and the analysis of structurally ambiguous sentences. *Cognitive Psychology, 14,* 178–210.

Frazier, L., & Rayner, K. (1988). Parameterizing the language processing system: Left- vs. right-branching within and across language. In J. Hawkins (Ed.), *Explaining language universals* (pp. 247–279). Oxford: Blackwell.

Frenck–Mestre, C. (1997). Examining second language reading: An on-line look. In A. Sorace, C. Heycock & R. Shillcok (Eds.), *Proceedings of the GALA 1997 Conference on Language Acquisition* (pp. 474–478). Edinburgh: Human Communications Research Center.

Frenck–Mestre, C., & Pynte, J. (1997). Syntactic ambiguity resolution while reading in second and native languages. *Quarterly Journal of Experimental Psychology, 50A,* 119–148.

Frenck–Mestre, C., & Pynte, J. (2002). Resolving syntactic ambiguities: Cross-linguistic differences? In M. De Vincenzi & V. Lombardo (Eds.), *Cross-linguistic perspectives on language processing* (pp. 119–148). Dordrecht: Kluwer.

Garnsey, S., Pearlmutter, N., Myers, E., & Lotocky, M. (1977). The contribution of verb bias and plausibility to the comprehension of temporarily ambiguous sentences. *Journal of Memory and Language, 37,* 58–93.

Gass, S. (1986). An interactionist approach to L2 sentence interpretation. *Studies in Second Language Acquisition, 8,* 19–37.

Gibson, E., & Pearlmutter, N. (1998). Constraints on sentence comprehension. *Trends in Cognitive Sciences, 2,* 262–268.

Gibson, E., Pearlmutter, N., Canseco–Gonzalez, E., & Hickok, G. (1996). Cross-linguistic attachment preferences: Evidence from English and Spanish. *Cognition, 59,* 23–59.

Gibson, E., & Schütze, C. (1999). Disambiguation preferences in noun phrase conjunction do not mirror corpus frequency. *Journal of Memory and Language, 40,* 263–279.

Gibson, E., Schütze, C., & Salomon, A. (1996). The relationship between the frequency and the processing of linguistic structure. *Journal of Psycholinguistic Research, 25,* 59–92.

Gilboy, E., Sopena, J., Clifton, C., & Frazier, L. (1995). Argument structure and association preferences in Spanish and English compound NPs. *Cognition, 54,* 131–167.

Gross, R. (2002). *"Someone shot the servant of the actress who was on the balcony," Zur verarbeitung von relativsätzen im Deutschen und Englischen.* Unpublished master's dissertation, University of Düsseldorf.

Hahne, A. (2001). What's different in second-language processing? Evidence from event-related brain potentials. *Journal of Psycholinguistic Research, 30,* 251–266.

Hahne, A., & A. Friederici (2001). Processing a second language: Late learners' comprehension mechanisms as revealed by event-related brain potentials. *Bilingualism: Language and Cognition, 4,* 123–141.

Harley, B., Howard, J., & Hart, G. (1995). Second language processing at different ages: Do younger learners pay more attention to prosodic cues to sentence structure? *Language Learning, 45,* 43–71.

Harrington, M. (1987). Processing transfer: Language-specific processing strategies as a source of interlanguage variation. *Applied Psycholinguistics, 8,* 351–378.

Harrington, M. (1992). Working memory capacity as a constraint on L2 development. In R. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 123–134). New York: Elsevier.

Hawkins, R., & Chan, C. (1997). The partial availability of Universal Grammar in second language acquisition: The "failed functional features hypothesis." *Second Language Research, 13,* 187–226.

Hemforth, B., Konieczny, L., & Scheepers, C. (1997). *Modifier attachment in German: Evidence from eyetracking experiments.* Unpublished manuscript, University of Freiburg.

Hemforth, B., Konieczny, L., & Scheepers, C. (2000). Syntactic attachment and anaphor resolution: Two sides of relative clause attachment. In M. Crocker, M. Pickering, & C. Clifton (Eds.), *Architectures and mechanisms for language processing* (pp. 259–282). Cambridge: Cambridge University Press.

Henstra, J.-A. (1996). *On the parsing of syntactically ambiguous sentences: Coordination and relative clause attachment.* Unpublished doctoral dissertation, University of Sussex.

Hernández, A., Bates, E., & Avila, L. (1994). On-line sentence interpretation in Spanish-English bilinguals: What does it mean to be "in between"? *Applied Psycholinguistics, 15,* 417–446.

Hurewitz, F., Brown–Schmidt, S., Thorpe, K., Gleitman, L., & Trueswell, J. (2000). One frog, two frog, red frog, blue frog: Factors affecting children's syntactic choices in production and comprehension. *Journal of Psycholinguistic Research, 29,* 597–626.

Juffs, A. (1998). Main verb vs reduced relative clause ambiguity resolution in second language sentence processing. *Language Learning, 48,* 107–147.

Juffs, A., & Harrington, M. (1995). Parsing effects in second language sentence processing: Subject and object asymmetries in wh-extraction. *Studies in Second Language Acquisition, 17,* 483–516.

Just, M., Carpenter, P., & Woolley, J. (1982). Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General, 111,* 228–238.

Kilborn, K. (1989). Sentence processing in a second language: The timing of transfer. *Language and Speech, 32,* 1–23.

Kilborn, K. (1992). On-line integration of grammatical information in a second language. In R. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 337–351). New York: Elsevier.

Kilborn, K., & Ito, T. (1989). Sentence processing strategies in adults bilinguals. In B. MacWinney & E. Bates (Eds.), *The crosslinguistic study of sentence processing* (pp. 257–291). Cambridge: Cambridge University Press.

MacWhinney, B. (1997). Second language acquisition and the competition model. In A. De Groot & J. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 113–142). Mahwah, NJ: Erlbaum.

MacWhinney, B. (2002). Extending the competition model. In R. Heredia & J. Altarriba (Eds.), *Bilingual sentence processing.* New York: Elsevier.

Marinis, T., Roberts, L., & Felser, C. (2003). *The role of lexical biases in relative clause ambiguity resolution*. Unpublished manuscript, University of Essex.

Mazuka, R., & Lust, B. (1990). On parameter setting and parsing: Predictions for cross-linguistic differences in adult and child processing. In L. Frazier & J. de Villiers (Eds.), *Language processing and language acquisition.* Dordrecht: Kluwer.

McDonald, J. (1987). Sentence interpretation in bilingual speakers of English and Dutch. *Applied Psycholinguistics, 8,* 379–413.

Mitchell, D., & Cuetos, F. (1991). The origins of parsing strategies. In C. Smith (Ed.), *Current Issues in Natural Language Processing* (pp. 1–12). Austin, TX: Center for Cognitive Science, University of Austin.

Papadopoulou, D., & Clahsen, H. (in press). Parsing strategies in L1 and L2 sentence processing: A study of relative clause attachment in Greek. *Studies in Second Language Acquisition*.

Pienemann, M. (1998). Developmental dynamics in L1 and L2 acquisition: Processability theory and generative entrenchment. *Bilingualism: Language and Cognition, 1,* 1–20.

Ritchie, W., & Bhatia, T. (Eds.). (1996). *Handbook of second language acquisition.* San Diego, CA: Academic Press.

Ritchie, W., & Bhatia, T. (Eds.). (1999). *Handbook of child language acquisition*. San Diego, CA. Academic Press.

Roberts, L. (2003). *Syntactic processing in learners of English.* Unpublished doctoral dissertation, University of Essex.

Schafer, A., Carter, J., Clifton, C., & Frazier, L. (1996). Focus in relative clause construal. *Language and Cognitive Processes, 11,* 135–163.

Snedeker, J., & Trueswell, J. (2001, 2–4 November). *Unheeded cues: Prosody and syntactic ambiguity in mother–child communication.* Paper presented at the 26th Annual Boston University Conference on Language Development.

Tanenhaus, M., Spivey–Knowlton, M., Eberhard, K., & Sedivy, J. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science, 268,* 1632–1634.

Thornton, R., MacDonald, M., & Gil, M. (1999). Pragmatic constraints on the interpretation of

complex noun phrases in Spanish and English. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 1347–1365.

Traxler, M. (2002). Plausibility and subcategorization preference in children's processing of temporarily ambiguous sentences: Evidence from self-paced reading. *Quarterly Journal of Experimental Psychology, 55A,* 75–96.

Traxler, M., Pickering, M., & Clifton, C. (1998). Adjunct attachment is not a form of lexical ambiguity resolution. *Journal of Memory and Language, 39,* 558–592.

Trueswell, J., Sekerina, I., Hill, N., & Logrip, M. (1999). The kindergarden-path effect: Studying on-line sentence processing in children. *Cognition, 73,* 89–134.

VanPatten, B. (1996). *Input processing and grammar instruction in second language acquisition.* Norwood, NJ: Ablex.

Ying, H. (1996). Multiple constraints on processing ambiguous sentences: Evidence from adult L2 learners. *Language Learning, 46,* 681–711.

Zagar, D., Pynte, J., & Rativeau, S. (1997). Evidence for early-closure attachment on first-pass reading times in French. *Quarterly Journal of Experimental Psychology, 50A,* 421–438.