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# Syntactic Ambiguity Resolution in L2 Parsing: Effects of Prosodic Boundaries and Constituent Length

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## 1. Introduction: Crosslinguistic differences in relative clause attachment

Crosslinguistic differences in parsing preferences for ambiguous sentences are well known. A much-studied case involves relative clauses. In sentences like (1a), the relative clause (RC) *who was on the balcony* can be interpreted as referring either to the first NP (NP1, *the servant*) (see bracketing in (1b)) or to the second NP (NP2, *the actress*) (see (1c)). Previous research has reported that, in languages like English, speakers show a low attachment preference when interpreting such sentences, taking the relative clause to modify NP2, *the actress*. In languages like Spanish, on the other hand, high attachment is preferred in equivalent sentences, such that the relative clause modifies NP1, *the servant* (Cuetos & Mitchell 1988).

(1) a. Someone spoke to the servant of the actress who was on the balcony
NP1 NP2 RC
b. Someone spoke to [[the servant [of the actress]] [who was on the balcony]]
c. Someone spoke to [the servant [of the actress [who was on the balcony]]]

As summarized by Fodor (2002), other languages showing a high attachment preference include Afrikaans, Croatian, Dutch, French, German and Russian, while languages showing a low attachment preference include Brazilian Portuguese, Egyptian Arabic, Norwegian, Romanian and Swedish. The strength of the attachment preference varies crosslinguistically. For example, the preference for low attachment in English is relatively weak, at about 60% of the time. This contrasts with Spanish, where speakers exhibit a strong preference for a high attachment interpretation, around 80% (Cuetos & Mitchell 1988). Crucially, regardless of the attachment preference shown by speakers of any particular language, such sentences are potentially ambiguous in that language.

A number of explanations have been offered for the observed variation in attachment preferences. In this paper, we focus on the role of prosody in examining the parsing preferences of Spanish-speaking learners of English. This language combination deserves attention because Spanish speakers must abandon their strong L1 high attachment preference in favour of a weak low attachment preference in the L2. Because prosodic cues to low attachment are less robust than those to high attachment across languages (Fodor 2002; Jun 2003), the acquisition of an English-type language for L1 Spanish speakers is expected to be challenging.

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## 2. Role of prosody in determining attachment preferences

As mentioned, several explanations have been advanced for the observed variation in attachment preferences – both within a language and across languages – and a wide variety of factors have been identified as playing a role in determining which interpretation is preferred for any given sentence. Below, we review those explanations which assign a role to prosody, that is, the location of prosodic boundaries and constituent length.

One kind of account focuses on the position of prosodic boundaries in spoken language.[1] Cross-linguistically, a prosodic boundary before the relative clause generally favours high attachment, as can be seen in (2a), whereas a boundary after NP1 (or the absence of a boundary) favours low attachment, as in (2b) (e.g., Fodor 2002; Jun 2003; Maynell 1999, 2000). Prosodic boundaries are typically signalled by phrase-final lengthening, a pause at the boundary and a boundary tone followed by reset of F0.

(2) a. Someone spoke to the servant of the actress // who was on the balcony.
b. Someone spoke to the servant // of the actress who was on the balcony.

Other accounts address relative clause length (e.g., Colonna, Pynte & Mitchell 2000; Fernández & Bradley 1999; Fodor 1998, 2002; Pynte & Colonna 2000). In particular, long relative clauses are more likely to be interpreted as attaching high. Thus, sentences like (3a) bias towards high attachment in contrast to sentences like (3b).

(3) a. The professor read the review of the poem that was published at the end of the magazine.
b. The professor read the review of the poem that just came out.

Developing a prosodic account that takes constituent length into consideration, Fodor (1998: 302) notes that prosodic phrasing favours balanced structures "in which sister constituents are roughly equal in prosodic weight", where prosodic weight is defined in terms of length, stress, etc. Fodor formalizes this observation as the Same-Size Sister Constraint (SSSC) and suggests that relative clause attachment is subject to this constraint, such that short relative clauses attach low because NP2 is the less heavy/shorter constituent, whereas long relative clauses attach high because the full DP (containing both NP1 and NP2) is heavier/longer.

Fodor also speculates (p. 311) that wherever low attachment is found, the attachee (in this case, the relative clause) will be of about the same length as NP2. Fodor only considers cases where NP2 is short. However, we take this claim to imply that if NP2 is long and the relative clause is long, then the preferred attachment site will be low rather than high.

Finally, Fodor does not discuss potential effects of the length of NP1 (as opposed to the length of the full DP). She does, however, note that prosodic structure is flatter than syntactic structure. This suggests to us that the length of NP1 should also be taken into consideration. In other words, we take the SSSC to imply that a longer relative clause should prefer to be attached to the longer of the two NPs in question, whereas a shorter relative clause should prefer to go with the shorter one, regardless of whether the longer or shorter NP is NP1 or NP2. Thus, the SSSC would predict high attachment in (4a), with a long relative clause and long NP1 (*fashionably dressed bride*), and low attachment in (4b), where the relative clause remains long and it is NP2 (*fashionably dressed prince*) that is long.

(4) a. The detective pursued the fashionably dressed bride of the prince that watched tennis at Wimbledon last year.
b. The detective pursued the bride of the fashionably dressed prince that watched tennis at Wimbledon last year.

Predictions made on the basis of the SSSC differ from predictions based on RC length alone. From the perspective of RC length alone, a long RC will bias towards high attachment, regardless of

[1] Fodor (2002) examines the role of prosody in silent reading.

the relative length of the NPs, while a short RC will tend towards low attachment. In contrast, the SSSC, at least as interpreted by us, predicts that short RCs will be interpreted with whichever of the two NPs is short, and that long RCs will attach to the longer of the two NPs.

To summarize, both the position of the prosodic boundary and the length of the constituents involved have effects on the interpretation of potentially ambiguous sentences involving relative clauses. In this paper, we investigate the extent to which these factors work together in L2 parsing.

## 3. Previous L2/bilingual research

The existence of crosslinguistic differences in parsing preferences has raised questions about the extent to which L1 parsing preferences might shape L2 preferences, both for L2 learners and for bilingual speakers whose L1 and L2 differ in attachment preferences. For example, Fernández (2002) and Dussias (2003) investigated how adult bilingual speakers of English and Spanish parse ambiguous sentences involving relative clauses in each of their languages. Neither study found L1 effects. Rather, Fernández found that language dominance was the determining factor, such that English-dominant speakers preferred low attachment in both languages while Spanish-dominant speakers preferred high attachment in both cases. In contrast, Dussias did not find language dominance to be crucial; instead, her subjects showed a preference for low attachment, both in Spanish and in English, even when Spanish was the L1. In these studies, reading tasks (offline and online) were employed, as was also the case for many studies on native speaker processing of ambiguous sentences. That is, subjects read ambiguous sentences involving relative clauses and had to indicate which NP the relative clause referred to. In other words, possible effects of (silent) sentence prosody imposed by the participants were not taken into consideration. In contrast, effects of overt sentence prosody are the central focus of the current paper.

Unlike other studies on bilingual parsing, Dekydtspotter et al. (2008) probe the relationship between prosody and syntax in the parsing of ambiguous sentences involving relative clauses in L2 French, French being a language that, like Spanish, favours high attachment. English-speaking learners of French were tested on three tasks, the second of which involved listening to ambiguous sentences where the length of the relative clause and the position of the prosodic boundary were manipulated. Results showed no main effects for relative clause length or for position of prosodic boundary. However, more detailed examination showed that about one third of the subjects (30 out of 87) were in fact sensitive to the position of the prosodic boundary.

As far as we are aware, no study has looked at potential effects of the SSSC on L2 parsing of relative clauses. That is, no study has investigated potential interactions between the length of the relative clause and the lengths of the two NPs that it potentially modifies.

## 4. The present study

The failure to include overt prosody in most previous tests of L2 parsing may result in an incomplete picture of influences on L2 parsing decisions. In this paper, we seek to tease apart the relative role of different prosodic effects on L2 parsing, comparing prosodic boundary information and constituent length, particularly as determined by the SSSC, in other words, manipulating length of the relative clause in relation to lengths of NP1 and NP2.

We hypothesize that L2ers will find it harder to use boundary cues to determine relative clause attachment because, in contrast to constituent length, languages vary in how robustly they mark edges. Furthermore, boundary cues are weak for low attachment (Fodor 2002; Jun 2003), the preferred attachment site for English, the L2 in this case.

## 5. Methodology

### *5.1. Participants*

Participants were intermediate (n=22) and advanced (n=37) Spanish-speaking learners of English. Proficiency was determined by the Versant Test of Spoken English (Pearson Education Inc.,

http://www.versanttest.com/).[2] In addition, there were 15 native speakers of North American varieties of English who served as a control group.[3]

The Spanish speakers primarily came from Central and South America, with a few from Spain. Most began learning English between the ages of 6 and 15, the oldest being 32 and the youngest 3.

All participants were living in Montreal, Quebec, at the time of testing. All had had some exposure to French, although those who were advanced speakers of French were excluded. Some had exposure to other languages as well, but none at an advanced level.

### *5.2. Task*

The experiment involved an auditory sentence processing task (based on Hwang et al. 2011). A set of sentences, each of which was potentially ambiguous, was presented to participants through headphones attached to a computer. Participants then saw a question on the screen, asking which NP the relative clause referred to, with a choice between the NP that was NP1, the NP that was NP2 or 'don't know'. Each answer was linked to a key, which they pressed to indicate their response.

The task included 24 test sentences and 42 fillers. There were four different semi-randomized versions of the test. Test items manipulated length of relative clause interacting with the lengths of NP1 and NP2, and the position of the prosodic boundary. Length was determined as follows: the RC was classified as short if it contained four syllables or less, including the complementizer, whereas it was long if it had more than seven syllables; the average length of the long RCs was 10.7 syllables. For the two NPs, the longer one was always 7-8 syllables (4 prosodic words), and the shorter was 2-3 syllables (2 prosodic words). The prosodic boundary, marked by a falling boundary tone and phrase-final lengthening followed by a pause, was placed either after NP1 or between NP2 and the RC. Items were controlled for semantic/pragmatic factors: both NPs were equally appropriate hosts for the RC. Each sentence was recorded in two versions by a native speaker of Canadian English.

We tested 4 sentence types with 6 items per type. Representative examples are shown in (5). In the match conditions, (5a-b), both prosodic boundary and SSSC point toward the same attachment site; in the mismatch conditions, (5c-d), prosodic boundary and SSSC conflict.

(5) **Sentence types**:[4]
(Note: // = prosodic boundary; HA=high attachment; LA=low attachment)

a. Match – high-high
HA prosodic boundary - HA SSSC (Long NP1/Short NP2 + Long RC):
The bartender served the cheerful outgoing cousin of the actor // that always ordered peanuts with his beer.

b. Match – low-low
LA prosodic boundary - LA SSSC (Long NP1/Short NP2 + Short RC):
The bartender served the cheerful outgoing cousin // of the actor that ate peanuts.

c. Mismatch – high-low
HA prosodic boundary - LA SSSC (Short NP1/Long NP2 + Long RC):
The bartender served the cousin of the cheerful outgoing actor // that always ordered peanuts with his beer.

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[2] The Versant Test examines different aspects of L2 proficiency, over the phone or on a computer. Participants are scored on four criteria: (i) sentence mastery; (ii) vocabulary; (iii) fluency; (iv) pronunciation. A single overall score is assigned. Participants scoring 69 to 80 were labelled advanced, and 47 to 68 were intermediate.

[3] Another 14 participants (12 learners, 2 controls) were removed from analysis for obtaining less than 80% correct on fillers, for 15% or higher 'don't know' responses or because of high proficiency in another language.

[4] The sentence types in (5) include only 4 of the 8 logical possibilities. For example, for the condition in (5a), a predicted preference for HA arises by combining a long NP1 with a long RC (Long NP1/Short NP2 + Long RC). Such a preference could also arise through combining a short NP1 with a short RC (Short NP1/Long NP2 + Short RC) but this possibility was not tested here. All 8 conditions were included in Hwang et al. (2011), which tested monolingual speakers of English, but we felt that the longer task would prove too taxing for L2ers.

d. Mismatch – low-high
LA prosodic boundary - HA SSSC (Short NP1/Long NP2 + Short RC):
The bartender served the cousin // of the cheerful outgoing actor that ate peanuts.

Pitch contours for the two sentence types with short RCs are provided in Figure 1. Figure 1a shows the sentence in (5b), which has a long NP1, while Figure 1b shows the sentence in (5d), with a short NP1. In both cases, the prosodic boundary is located after NP1, favouring low attachment; the prosodic boundary is marked by a falling boundary tone on NP1 and phrase-final lengthening, which is followed by a long pause.

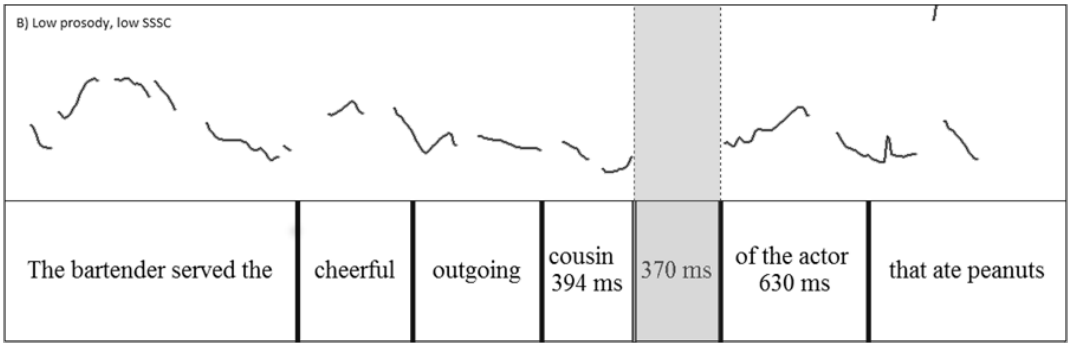


**Figure 1a. Sample pitch contour for sentence (5b)**

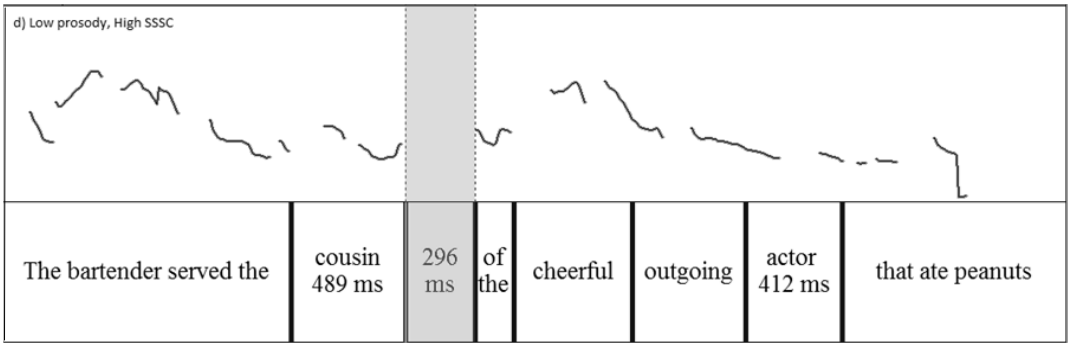


**Figure 1b. Sample pitch contour for sentence (5d)**

## 6. Predictions

We first discuss the predictions of constituent length and position of the prosodic boundary independently. We then put these two factors together.

Considering only constituent length, and assuming the SSSC as we do, attachment preferences should be affected by the relationship between length of the relative clause and length of one of the NPs: if the relative clause is long and NP1 is long, then high attachment will be preferred (as in (5a)); if the relative clause is long and NP2 is long, then low attachment will be preferred (see (5c)); if the relative clause is short and NP2 is short, then low attachment will be preferred (5b); and if the relative clause is short and NP1 is short, then high attachment will be preferred (5d).

Turning now to the position of the prosodic boundary regardless of constituent length, the prosodic boundary in (5a) and (5c) occurs before the relative clause, favouring high attachment, whereas the boundary in (5b) and (5d) occurs after NP1, favouring low attachment.

Finally, putting together position of the prosodic boundary and constituent length as determined by the SSSC, some of our sentence types have both cues (boundary and length) favouring a particular attachment site (in other words the cues match), whereas others have the two cues conflicting (mismatch). In (5a) and (5b), the prosodic boundary and constituent length conspire towards the same

attachment site, high in (5a), low in (5b). In (5c) and (5d), on the other hand, the position of the prosodic boundary favours one attachment site whereas the SSSC favours the other.

Specific predictions are as follows. Stronger attachment preferences are expected when the prosodic boundary and SSSC match in favouring the same attachment site (high-high and low-low conditions). This should be true of both native speakers and L2 learners, and would demonstrate that the latter are sensitive to prosodic cues in the L2. We further predict that L2 learners of English whose L1 favours high attachment, as is the case here, may have difficulties detecting the prosodic cues indicating low attachment, since LA is weakly marked in all languages (Fodor 2002; Jun 2003). These learners are expected to rely more on the SSSC to establish the attachment site of the relative clause in the mismatched conditions. Specifically, they are predicted to prefer high attachment in sentences like (5d).

## 7. Results

Overall results are provided in Figure 2, which shows proportion of high attachment responses in the various conditions. There was a significant main effect for prosodic boundary ($F1(1,58) = 168.751$, $p < .001$; $F2(1,23) = 128.735$, $p < .001$)), no significant main effect of relative clause length or SSSC ($p > .1$) and a significant interaction between prosodic boundary and SSSC ($F1(1,58) = 4.134$, $p < .05$; $F2(1,23) = 6.231$, $p < .02$).

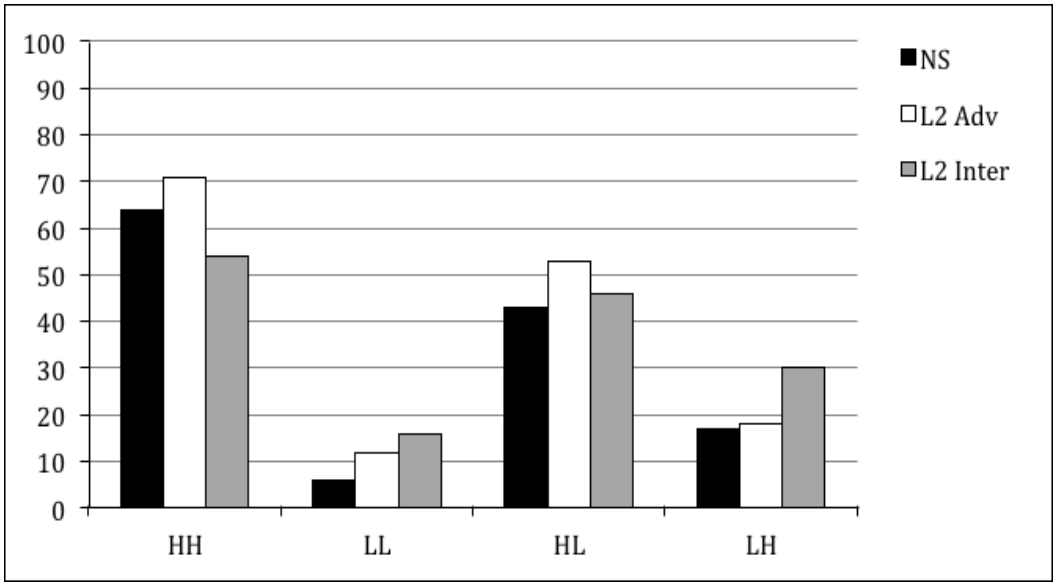


**Figure 2. Proportion of high attachment responses by condition**

We now consider the different sentence types in more detail. In Figures 3 and 4, we present the results from sentence types where the SSSC favours the same attachment site (high attachment in Figure 3 and low attachment in Figure 4) while the position of the prosodic boundary varies. Figure 3 compares matched sentences like (5a) with mismatched cases like (5d); Figure 4 compares matched sentences like (5b) with mismatched cases like (5c). All groups show a significant difference between the matched and mismatched sentences ($p < .006$ in all cases), attributable to the varying position of the prosodic boundary, suggesting that all groups are in fact sensitive to the prosodic cues marking the boundary.

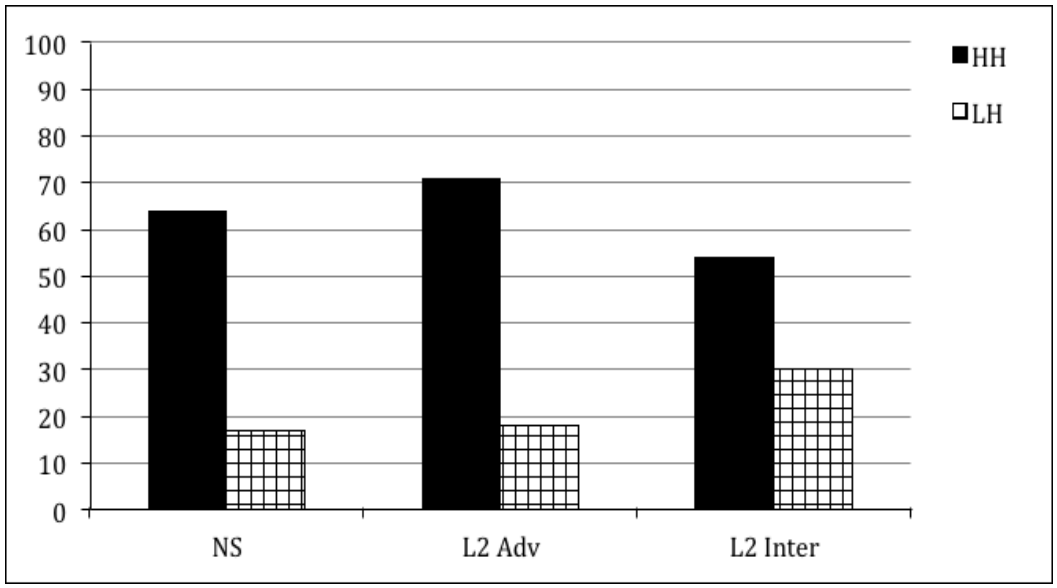


**Figure 3. Variation in prosodic boundary: high-high vs. low-high conditions (% high attachment)**

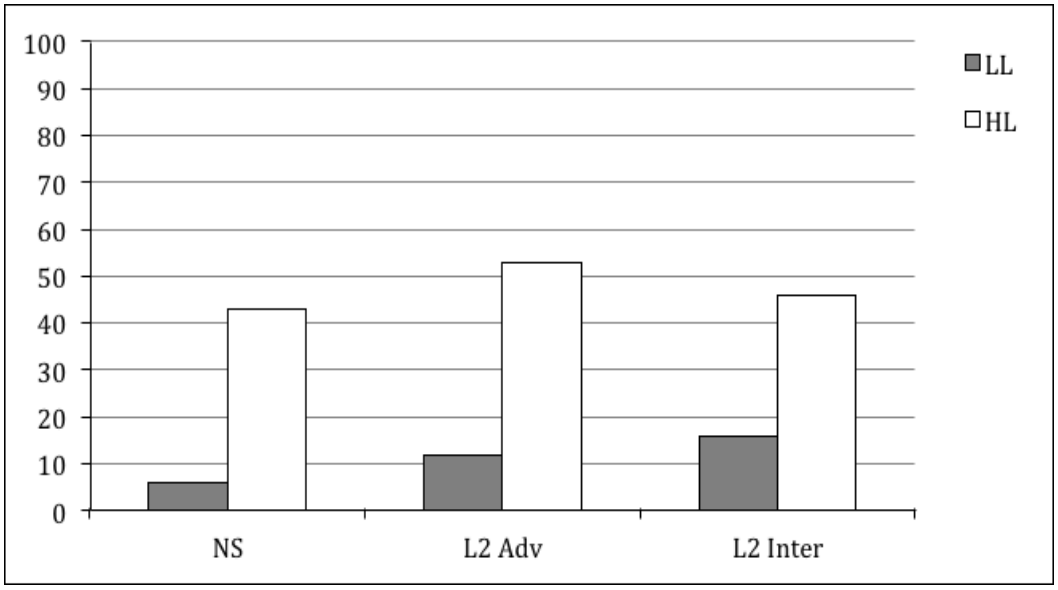


**Figure 4. Variation in prosodic boundary: low-low vs. high-low conditions (% high attachment)**

In Figures 5 and 6, the position of the prosodic boundary is held constant and constituent lengths vary. Figure 5 compares matched sentences like (5a) with mismatched sentences like (5c), while Figure 6 compares matched (5b) with mismatched (5d). As can be seen in Figure 5, the native speakers and advanced group show a significant difference between the condition where the cues match to favour high attachment and the condition where there is a mismatch (NS: $p < .015$; L2Adv: $p < .0001$). Crucially, in the mismatch condition, NP2 and the relative clause are long, confirming a role for the SSSC. Recall that earlier literature had found that long relative clauses typically favour high attachment when NP length is not controlled. For the intermediates, on the other hand, there is no

significant difference between the matched and mismatched conditions, suggesting insensitivity to the SSSC.

In contrast, as Figure 6 shows, when the prosodic boundary favours low attachment, it is only the intermediate group that shows a significant difference between matched and mismatched conditions, with a significantly higher acceptance of high attachment responses in the mismatched condition when the SSSC favours high attachment ($p < .01$). Note that in this case, NP1 and the relative clause are short, so if it were only the length of the relative clause that was responsible, low attachment would be expected, regardless of matching. The fact that the intermediates do show a difference, then, supports a role for the SSSC. The fact that the other groups do not show a significant difference between matched and mismatched conditions is, we suggest, due to the fact that they are able to place more weight on the prosodic cues. We speculate on reasons for the apparent discrepancy in the intermediate group's treatment of length cues in the next section.

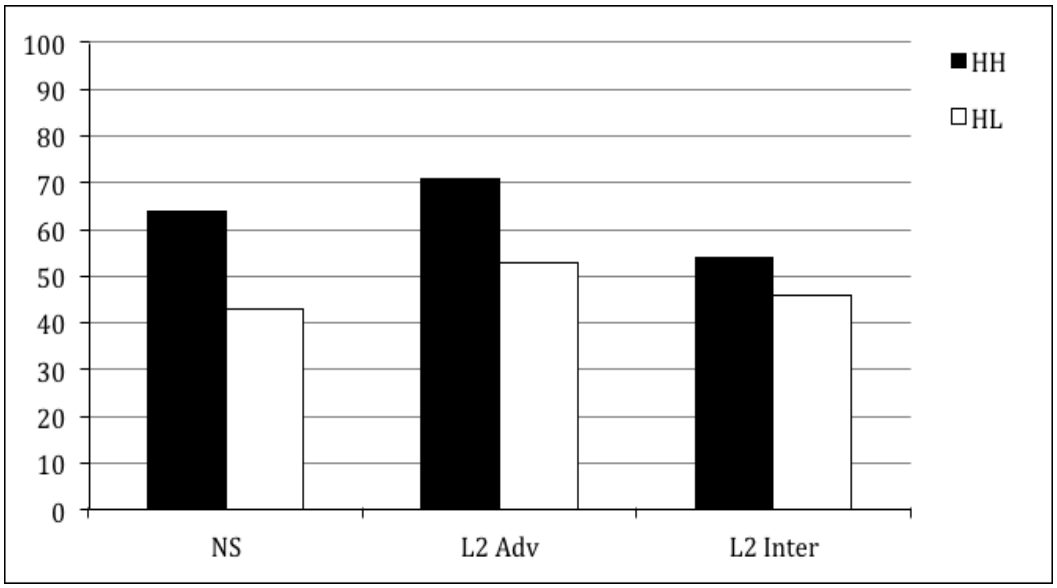


**Figure 5. Variation in SSSC: high-high vs. high-low conditions (% high attachment)**

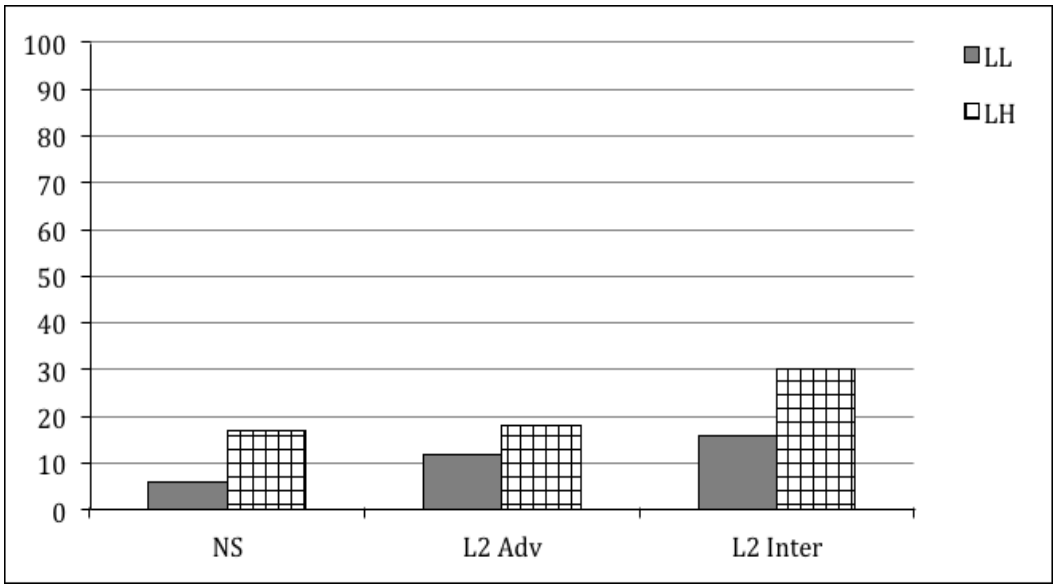


**Figure 6. Variation in SSSC: low-low vs. low-high conditions (% high attachment)**

## 8. Conclusion

To summarize the results, the native speakers show sensitivity to position of the prosodic boundary as well as to the SSSC, and show stronger preferences in conditions where boundary and length favour the same attachment site, as predicted. The advanced L2ers behaved like native speakers in all conditions, though the difference between these two groups in the LL conditions borders on significance (HH: p=.189; LL: p=.054; HL: p=.141; LH: p=.774). These results suggest sensitivity to both types of cues that we have examined here, including in cases of low attachment where the boundary cues are less robust. Contrary to expectation, intermediate proficiency L2ers showed sensitivity to prosodic boundaries but not consistently to the SSSC. Furthermore, they did not show a stronger preference when the conditions matched to favour high attachment. However, the SSSC did have an effect on the intermediate group's performance in low attachment contexts where the prosodic boundary cues are weaker. We suggest that when the SSSC together with L1 preferences favour high attachment, the prosodic cue is sometimes ignored, so that there is a 'pull' towards high attachment. In conclusion, the results suggest that sensitivity to different cues relevant to determining ambiguity resolution in the L2 is acquirable but that intermediate L2ers are less able than advanced to take full account of prosodic boundary information in determining ambiguity resolution.

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