Relative prosodic boundary strength and syntactic ambiguity resolution

Efrat Pauker, Michael Wagner, Meghan Clayards, Hyekyung Hwang, Shari Baum, and Karsten Steinhauer

Several theories account for the role of prosodic boundaries in resolving attachment ambiguities: (i) The Prosodic Visibility Hypothesis **(PVH)** (Schafer, 1997) and (ii) the Informative Boundary Hypothesis **(IBH)** (Clifton et al., 2002) assume that the *global prosodic structure* of the sentence – manifested by the distribution and relative magnitude among all boundaries within a given utterance – is pivotal to the prosody-syntax mapping. In contrast, (iii) the Anti Attachment Hypothesis **(AAH)** (Watson & Gibson, 2004, 2005) assumes that the prosody-syntax mapping is performed *locally*, immediately upon encountering a strong prosodic boundary.

(1) The PVH assumes that both (weak) ip and (strong) IPh boundaries immediately group the preceding constituents; 'visible' attachment sites within the same prosodic phrase should be preferred. (2) According to the IBH, syntactic preference relies on the relative strength of the final boundary compared to that of the preceding boundaries. (3) The AAH assumes only IPh boundaries trigger syntactic closure (although two IPh boundaries will cancel each other's closure effect out (Watson, personal communication), re-establishing the default syntactic preference.

Previous research has examined these theories using global attachment ambiguities (e.g., *you can feel #1 the cat #2 with the feather*), which can be parsed in either one of two grammatical ways (e.g., high and low attachment), regardless of prosodic bias. Moreover, when using globally ambiguous structures, even strong prosodic cues only modulated (but did not override) the initial syntactic bias towards one structure (Carlson et al., 2001; Lee & Watson, in press). Little evidence comes from temporarily ambiguous structures, such as Early and Late Closure (EC/LC), where particular prosodic patterns can override initial preferences and lead to an ungrammatical parse.

Methodologically, the common approach to distinguish among boundary sizes has been strictly categorical (Carlson et al., 2009). However, recent work suggests that *gradient quantitative boundary size* may be sufficient to explain parsing decisions (Wagner & Crivellaro, 2010).

The main goals of our study were: **(1)** to contrast the predictions of the three theories using EC/LC ambiguities, and **(2)** to test whether boundaries have a strictly categorical effect, or whether they can yield a gradient effect.

We recorded 42 EC/LC pairs with 2 ip boundaries (H-L) each (see example (1)). We then manipulated each boundary by adding 320 ms or 80 ms, to create IPh-compatible (H-L-L) and intermediate size boundaries. Full permutation of boundary strengths resulted in 9 prosodic conditions for both EC and LC sentences.

Twelve native English listeners rated the sentence acceptability on a scale from 1-7 (1=worst; 7=best). Data showed significant main effects of syntax and prosody as well as a significant syntax x prosody interaction ($p < .0001$). As illustrated in Figure 1, we found evidence for a general advantage for EC over LC and a gradient pattern of acceptability that mirrors the parametric manipulation of both boundary 1 and boundary 2. Data are in partial agreement and disagreement with all three theories (Table 1), but support a boundary gradient rather than strict categories.

Sample sentence (1):

Whenever the bear was approaching **#1** *the people* **#2** ...

a. (LC) ... *the dogs would run away*

b. (EC) ... *would run away*

Table 1: Likely predictions for the three theories

	AAH	PVH	IBH
1 > 2	EC-pref; IPh-dependent	EC preference (strong)	EC preference
1 < 2	LC-pref (default)	LC pref if #2 is an IPh	LC preference
1 =2	LC-pref (default)	Modulated by boundary size	LC pref or no pref

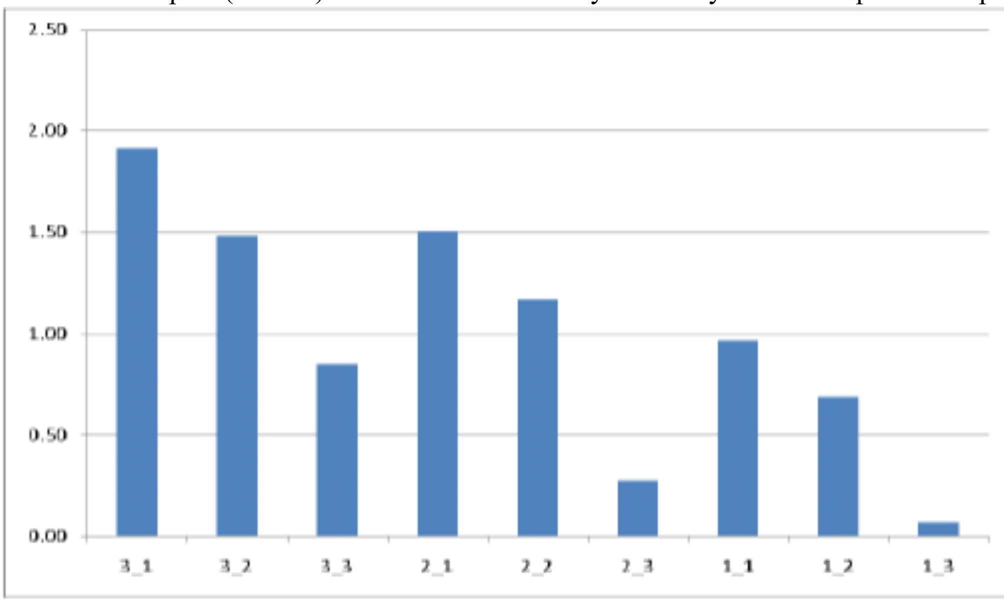

Figure 1: Difference in acceptability between EC and LC structures as a function of prosodic boundary strengths. X-axis: prosodic pattern (3_1= initial strong IPh boundary followed by a weak ip boundary; 2_2 = intermediate boundary followed by intermediate boundary; 1_3 = weak ip followed by strong IPh boundary). Y-axis: EC-acceptability minus LC-acceptability for each prosodic structure. Data illustrate a general, but graded EC advantage in all conditions: the longer the first boundary and the smaller the second boundary, the stronger the EC preference.

References

1. Carlson, K., Clifton, C., & Frazier, L. (2001). Prosodic boundaries in adjunct attachment. *Journal of Memory and Language, 45*, 58-81.
2. Carlson, K., Clifton, C., & Frazier, L. (2009). Nonolocal effects of prosodic boundaries. *Memory & Cognition, 37(7),* 1014-1025.
3. Clifton, C., Carlson, K., & Frazier, L. (2002). Informative prosodic boundaries *Language and Speech, 45*(2), 87-114.
4. Hwang, H., & Schafer, A.J. (2006). Prosodic effects in parsing early vs. late closure sentences by second language learners and native speakers. In R. Hoffmann & H. Mixdorff (Eds.), *Proceedings of the 3rd International Conference on Speech Prosody* (pp. 585–588). Dresden: TUD Press.
5. Lee, E. K., & Watson, D. (In press). Incremental interpretation of intonational boundaries.
6. Schafer, A. J. (1997). *Prosodic parsing: The role of prosody in sentence comprehension.* Unpublished PhD dissertation, University of Massachusetts, Amherst, MA.
7. Snedeker, J., & Johnson, E. (In press). Is it all relative? Effects of prosodic boundaries on the comprehension and production of attachment ambiguities.
8. Snedeker, J., & Trueswell, J. (2003). Using prosody to avoid ambiguity: Effects of speaker awareness and referential context *Journal of Memory and Language, 48*(1), 103-130.
10 Wagner, M., & Crivellaro, S. (2010). Relative prosodic boundary strength and prior bias in disambiguation. *Proceedings of the 5th Speech Prosody*, Chicago, Illinois.
11. Watson, D., & Gibson, E. (2005). Intonational phrasing and constituency in language production and comprehension. *Studia Linguistica, 53*(2/3), 279-300.
12. Watson, D., & Gibson, E. (2004). The relationship between intonational phrasing and syntactic structure in language production. *Language and Cognitive Processes, 19*, 713-755.