Alignment of Prosodic and Syntactic Junctures and Vowel-initial Glottalization in Syntactic Disambiguation: A Preliminary Report

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Significant evidence supporting the role of syntax-prosody boundary mapping in syntactic disambiguation has been accumulated in the existing literature [1, 2, 3]. While prosodic boundaries are commonly treated as phonologically defined and categorical elements involved in syntax-prosody mapping, our proposed approach [4] takes a more nuanced perspective that considers fine phonetic details across suprasegmental and segmental dimensions. In this study, we aim to investigate the phonetic granularity of syntax-prosody mapping, specifically focusing on the voice quality (degree of glottalization) of word-initial vowels aligned with prosodic and syntactic junctures, as well as durational measures encompassing both preboundary and postboundary lengthening. To explore the interaction between syntax, prosody, and focus, we examine syntax-prosody mapping in three focus contexts: Broad, Narrow, and Contrastive. By doing so, we seek to enhance our understanding of how these intricate phonetic aspects contribute to resolving syntactically ambiguous coordinate structures in American English.

An experiment involving acoustic recordings was conducted with a group of fourteen native speakers of American English (7 male, 7 female) aged between 19 and 35. The participants were presented with speech materials (refer to Table 1) in three different focus contexts. They read 'answer' sentences containing ambiguous coordinate structures, such as 'Anna and Annie or Angie,' which can be interpreted in two possible syntactic structures: [N1] and [N2 or N3] (Early Closure) or [N1 and N2] or [N3] (Late Closure). The analysis of prosodic boundaries involved the utilization of the ToBI system to code Intonational Phrase (IP) and Word (Wd) boundaries, as well as the presence of pitch accent. Glottalization was examined using established parameters, including H1*-H2*, CPP, and HNR [5, 6], extracted from three equi-interval segments of vowels (Time points 1~3) using VoiceSauce [7]. Additionally, the duration of the entire syllable preceding and following the prosodic juncture was measured.

Table 1. Speech Materials according to Focus Type. Only the Answer category has been recorded. Early Closure has a syntactic juncture before 'and' whereas Late Closure (LC) has one before 'or'. Note narrow and contrastive focus put emphasis respectively on the whole utterance or syntactic structure than a single lexical item

	Question	Answer	
Broad Focus	What is going on?	Well, (Anna) and (Annie or Angie) are coming.	**EC**
		Well, (Anna and Annie) or (Angie) are coming.	**LC**
Narrow Focus	WHO will come to the party?	Well, (Anna) and (Annie or Angie) will.	**EC**
		Well, (Anna and Annie) or (Angie) will.	**LC**
Contrastive Focus	Did they say (Anna and Annie) or (Angie) will come?	No. They said, (Anna) and (Annie or Angie) will.	**EC**
	Did they say (Anna) and (Annie or Angie) will come?	No. They said, (Anna and Annie) or (Angie) will.	**LC**

The results of the syntax-prosody boundary mappings generally align with the assumptions made in the existing literature [1, 2, 3]. Specifically, major syntactic junctures occurring before conjunctions (e.g., [N1] # and [N2 or N3]; [N1 and N2] # or N3) were consistently aligned with Intonational Phrase (IP) boundaries, referred to as "**critical junctures**", with no exceptions. Furthermore, an "**optional**" occurrence of IP boundary after conjunctions (about 13%) was observed (e.g., [N1] # and (#) [N2 or N3]). Interestingly, the degree of preboundary lengthening was significantly greater before the critical IP boundary (Fig. 2d) compared to the optional one (Fig. 1d). Regarding glottalization, we perceived noticeable glottalization qualitatively for *both* IP-initial and IP-medial occurrences of the word-initial vowels. However, spectral tilt measures indicated prosodic boundary effects at the critical junctures,

with an interaction with pitch-accent. Significant interactions between Boundary and Accent were found for H1H2c, HNR, and CPP. Specifically, conjunction vowels ('and/or') displayed increased glottalization at the critical juncture when pitch-accented (Fig. 2a). Conversely, at the optional IP boundary, no IP boundary effects were observed for vowels of nouns (e.g., [N1] # and (#) [N2 or N3]). This finding was further supported by the HNR and CPP measures for 'and,' where lower HNR and CPP values (indicating more noise) corresponded to increased glottalization at the critical juncture (Fig. 2b-c, upper panels). However, the directionality of HNR and CPP for 'or' exhibited inconsistency at certain points (refer to Fig. 2b-c, lower panels), indicating that noise-related measures did not yield clear results regarding the boundary effect on glottalization. It is also noteworthy that there was no evidence to suggest that pitch accent alone increased the degree of glottalization.

The findings of this study provide strong evidence for distinct phonetic variations in the realization of prosodic structure, which are dependent on different syntactic structures. Specifically, significant differences in glottalization and temporal expansion were observed between the critical IP boundary and the optional one. These results suggest that the phonologically-defined IP category [8] is phonetically modulated through the interaction of prosodic boundaries with syntax and prominence structure [3]. Overall, these findings highlight the intricate relationship between syntax, prosody, and phonetics. The observed fine-grained phonetic differences underscore the dynamic nature of language production, revealing that prosodic cues play a crucial role in disambiguating syntactic structures in a more nuanced manner than previously assumed in traditional syntax-prosody mapping.

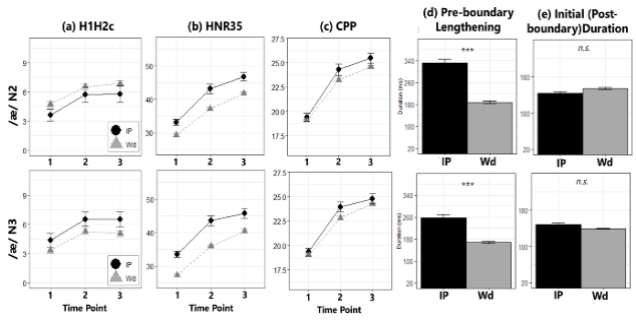

Fig. 1. Boundary effects with an *optional* IP boundary on H1H2c, HNR35, CPP, Pre-boundary lengthening and Initial (post-boundary) duration for the vowel /æ/ of the second and third names (N2, N3). Error bars represent standard errors. The lower the spectral tilt values, the more glottalized (creakier). Note pause duration was not included.

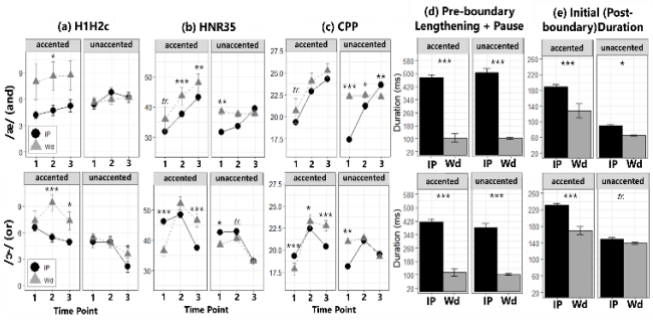

Fig. 2. Boundary effects at the *critical* juncture on H1H2c, HNR35, CPP, Pre-boundary lengthening and Initial (post-boundary) duration for the vowel /æ/ of 'and' and /ɔ-/ of 'or' regarding pitch accent. Error bars represent standard errors. The lower the spectral tilt values, the more glottalized (creakier).

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