Prosodic Boundary Phenomena

Tianyi Zhao, University of Konstanz, Konstanz, Germany
Cong Zhang[1], Newcastle University, Newcastle upon Tyne, United Kingdom

[1] Corresponding author: cong.zhang@newcastle.ac.uk

1. Overview

Prosodic boundary phenomena, edited by Fabian Schubö, Sabine Zerbian, Sandra Hanne and Isabell Wartenburger, is a compilation of experimental studies presented at a workshop of the *Deutsche Gesellschaft für Sprachwissenschaft* (DGfS) in 2021. It brings together a collection of studies exploring the multifaceted nature of prosodic boundaries, featuring selected topics on prosodic phenomena at boundaries across different populations and languages. Each chapter is dedicated to a different topic, ranging from the initiation and scope of pre-boundary lengthening, domain-initial strengthening, non-native speech chunking, to prosodic boundary detection in infants and age effects on prosodic disambiguation. Chapters 1, 2, and 5 address production and Chapters 3 and 4 focus on perception.

A central focus of the volume is on common prosodic cues used across languages to mark boundaries, including duration (in the form of final or initial lengthening), pauses (occurrence as well as duration), f0 (e.g., f0 range, f0 rise and declination), intensity and so on. Notably, the terminology used to describe the boundaries themselves is not uniform across chapters: terms such as units, domains, prosodic phrases, Intonational Phrases (IPs), clause boundaries, and breaks, are all used to refer to similar concepts. In the following sections, we will briefly introduce the theories and methodologies presented in each chapter.

2. Chapter 1: Schubö & Zerbian

The first chapter by Schubö and Zerbian focuses on the initiation and scope of the

pre-boundary lengthening (hereafter PBL) in German, i.e., the starting point and the span of PBL within the phrase-final word. The authors open the chapter by introducing the well-established final-lengthening phenomenon, which typically occurs in the rhyme of phrase-final syllables (Petrone et al., 2017; Turk & Shattuck-Hufnagel, 2007; White, 2002).

Despite inconsistent findings on the operation domain of PBL, it has generally been reported to range from the vowel in the last main lexical stress syllable (or even further leftward) to the end of the phrase-final word (see, e.g., Cambier-Langeveld, 2000; Cho et al., 2013; Katsika, 2016; Kohler, 1983). Building on this foundation, Schubö and Zerbian investigate the potential influence of the main word stress position and the segmental composition of the phrase-final word (e.g., number of segments) on PBL. To this end, they conducted a production experiment with stimuli that systematically varied in: (1) position of main word stress (e.g., *RaMOna* vs. *KArolin*), (2) presence/absence of an additional consonant (*RaMOna* vs. *RaMOnas*), and (3) presence/absence of prosodic boundary (e.g., left- or right-branching coordination: [[N1 or N2] and N3] vs. [N1 or [N2 and N3]]), which can be elicited by different prosodic phrasing (see, e.g., Kentner & Féry, 2013; Wagner, 2005, among others).

The results revealed reliable lengthening from the stressed syllable to the final segment at the phrase boundary, with a large increase in the final segment, consistent with findings from several previous studies. The initiation point shifted when an additional segment was present (e.g. *RaMOnas*), but it also began further earlier in case of an earlier main lexical stress (e.g., *KArolin*). In addition, the authors observed a

gradual but unstable increase of PBL towards the phrase boundary, which they interpreted as a weak form of progressive lengthening, deviating from some existing research (e.g., Kohler, 1983 for German, Byrd et al., 2006 for American English; Seo et al., 2019 for Japanese). Altogether, the results support their hypothesis that the scope of PBL is determined both by the segmental composition of the phrase-final words and anchored by the position of the main lexical stress.

The present findings on German contributes to our understanding of the variation of PBL from a cross-linguistic perspective and offer valuable insights for the related research on perception.

3. Chapter 2: Napoleão de Souza

In this chapter, Napoleão de Souza investigates the domain-initial strengthening at prosodic boundaries and how it is cued by phonetic correlates via language-specific segmental phonology. Specifically, he compares the Intonational Phrase (IP)-initial unstressed syllable in prenuclear position across three lexical-stress languages: English, Spanish, and Portuguese. The study also explores the relationship between domain-initial strengthening and lexical stress, as well as the scope of the strengthening effects.

The author designed a reading task to examine the aforementioned acoustic cues of domain-initial strengthening by means of VOT, burst releases for stops, f0, vowel dispersion and vowel duration, which has been attested as relevant correlates (Cho et al., 2007; Cole et al., 2007; White et al., 2020). Duration of stressed syllable was also taken into account given its known effects on unstressed syllables (cf. Ortega-Llebaria

& Prieto, 2007; Plag et al., 2011, among others).

Results showed a larger number of burst releases at the stop closure at the IP-initial boundary positions than the IP-medial ones for all three languages. VOT serves as a cue to mark stops only in English, whereas vowel duration in English does not reflect boundary marking. In contrast, vowel duration in Spanish and Portuguese is significantly affected by both the boundary position (IP-initial vs. IP-medial) and the duration of the stressed syllable. Taken together, the findings demonstrate that for Spanish and Portuguese, domain-initial strengthening is encoded not only in the phonetic properties of the boundary-adjacent segment but also in word-initial unstressed CV syllables, contrasting with some previous findings (Cho & Keating, 2009). The observed correlation between boundary marking and lexical prominence provides further evidence that the lexical stress may serve as an anchor for phrasal boundaries marking (Cho et al., 2013; Katsika, 2016; Turk & Shattuck-Hufnagel, 2007). This finding aligns with the results reported for pre-boundary lengthening (PBL) in Chapter 1, where PBL was found to be initiated on the main stress syllable, regardless of the manipulated conditions. More importantly, it was also shown to start at an earlier point in antepenultimate-stressed words compared to penultimate-stressed ones. In other words, the position of lexical stress could be playing a decisive role in both pre- and post-boundary lengthening/strengthening.

The analysis of domain-initial strengthening, with results comparable to final-lengthening, contributes to our understanding of post-boundary segments and their phonetic realisation. The use of unstressed syllables in the experiment design

effectively avoided the confounds related to multiple possible sources of prominence (e.g., from different phrase levels). Compared with previous studies, this study uses a larger set of materials with a similar structure across all three languages, allowing for a well-controlled cross-linguistic comparison. However, the language-specific characteristics of the vowel systems may interfere with the target vowels, introducing some uncertainties into the interpretation of the results.

4. Chapter 3: Ots & Taremaa

Ots and Taremaa examine the influence of prosodic and syntactic clause boundaries on native (Estonian listeners) and non-native (German listeners) speech chunking with a perception study using Estonian stimuli.

Previous research has shown that speech processing can be associated with top-down (e.g., world and linguistic knowledge in terms of lexical, semantic and syntactic domains) and bottom-up (e.g., input from acoustic signals) processing respectively (Dahan & Ferreira, 2019). Native speakers typically have access to and predominantly draw on top-down information, whereas signal-driven bottom-up prosodic cues, such as phrase-final lengthening and f0 movements (Ladd, 1988; Petrone et al., 2017; see also Chapter 1, 4 and 5 in this volume) tend to have lower priority in speech chunking (Cole et al., 2010). The authors argue that native listeners are guided primarily by top-down syntactic-semantic cues, e.g., clause boundaries during speech chunking, whereas non-native listeners are less sensitive to their presence and rely more on the signal-driven prosodic information.

The experiment tested Estonian (native) and German (non-native) listeners who were asked to listen to spontaneous Estonian speech and identify any breaks between words. Phrase-final lengthening (in the form of syllable and pause duration), intensity drop, and rate of f0 declination (f0 proportion) were measured.

Both groups employed pause duration and f0 proportion increase — although, interestingly, higher f0 maxima led to higher likelihood of boundary perception, contrary to the prediction. The similarity in cue uses suggested cross-linguistic convergence in the use of pausing and f0 movement for prosodic chunking. Notably, Estonian listeners' chunking judgment was primarily affected by the presence of clausal boundaries and, to a lesser extent by signal-driven acoustic cues, contrary to the findings of Riesberg et al. (2020). Nonetheless, both top-down and bottom-up processes were involved in Estonian listeners' native speech processing. By contrast, non-native German listeners made broader use of bottom-up information, relying on the full set of available phonetic cues, including phrase-final lengthening and intensity changes.

The current study provides an engaging cross-linguistic comparison of how prosodic cues are perceived by native and non-native listeners. Given the richness of the findings, the chapter would benefit from more detailed description of the pre-processing and categorisation of participants' responses, perhaps illustrated with concrete examples.

5. Chapter 4: Wellmann et al.

The research focus of this chapter is the developmental changes in intonation

phrase boundary (hereafter IPB) cues in six-month-old German infants. Several studies over the past few decades have reported infant's high sensitivity towards prosodic boundary information and how they use these cues to segment continuous speech (Gout et al., 2004; Schmitz, 2008), and such perception may undergo developmental change (Seidl, 2007). The cues examined in the current study are f0 change, final lengthening, and pause (cf. Nespor & Vogel, 1986; Price et al., 1991; Vaissière, 1983).

Existing investigations reveal cross-linguistic differences in the weighting of these three cues. For instance, while six-month-old American English-learning infants could detect boundaries using pitch cues combined with either pause or final lengthening, four-month-old American English-learning infants still needed all three cues (Seidl, 2007; Seidl & Cristià, 2008), suggesting developmental changes in cue processing. Six-month-old Dutch infants relied on pauses for boundary detection (Johnson & Seidl, 2008), whereas pitch change and final lengthening alone sufficed for eight-month-old German infants (Wellmann et al., 2012). For French infants with six- and eight-month-old, however, all three cues were necessary (van Ommen et al., 2020).

Given these mixed findings, the authors explore the weight and development of IPB cues in six-month-old German infants with the Headturn Preference Paradigm (HPP) with a familiarisation phase. They conducted four experiments with carefully manipulated stimuli with or without internal IPB in a discrimination task. The results corroborate earlier findings (Wellmann et al., 2012): German six-month-olds can detect a major prosodic boundary when cued by a combination of pause, final lengthening, and pitch change, with pause possibly remaining necessary before eight months. A

combination of pause and final lengthening is sufficient for boundary detection as well. This may suggest a developmental change towards efficient language processing as infants become increasingly sensitive to subtle differences cued by pitch and lengthening during boundary detection, which are 'functionally relevant cues' (Wellmann et al., 2023, p. 149) in the given language. As the authors point out themselves, it would be interesting to further account for the potential cue trading relations by enforcing the pitch and lengthening cues in the absence of a pause to see if that yields a different outcome.

6. Chap 5: Huttenlauch et al.

Following the authors' previous work (Huttenlauch et al., 2021), this chapter investigates how speakers from two different age groups (younger speakers: mean age 25; older speakers: mean age 68) employ prosodic cues to disambiguate syntactic ambiguities in coordinate structures, and how these cues are adapted across different communicative contexts.

Huttenlauch et al. (2021) found that younger speakers' application of prosodic cues to disambiguate the internal structure of coordinates remained relatively stable, with only slight accommodations of the prosody across different contexts. The present study aims to extend the findings on younger speakers by including the productions of older speakers and directly compare the two groups. The authors seek to investigate prosodic disambiguation, the potential age effects on the realisation of prosodic cues including f0 range, final lengthening, pause insertion, and how they are modified when addressing

different interlocutors.

The experiment employed a referential communication task with coordinated name sequences, i.e., *(Name1 and Name2) and Name3*, in five communicative contexts, employing four female speakers — YOUNG (age 24), CHILD (age 6), ELDERLY (age 82), and NON-NATIVE (age 26) — as interlocutors. The fifth communicative context, NOISE, involved the same YOUNG interlocutor, but added additional background noise. Using the prosodic cues in a similar way across contexts, both age groups disambiguated the ambiguous coordinate structure globally. This corresponds to the predictions of Proximity/Similarity model (Kentner & Féry, 2013), which proposes that prosodic cues mark internal grouping globally rather than locally: for instance, for elements that are syntactically grouped, the left-most element of two sister elements exhibits weaker boundary cues compared to an ungrouped element in the same position, whereas the right-most element of that group tend to show stronger cues. Crucially, prosodic disambiguation, as examined in the current study via f0 range, final lengthening, and pause, was not essentially affected by age-related differences. Nevertheless, there were minor descriptive distinctions (in line with, e.g., Scukanec et al., 1996) and greater variation in older speakers' productions that deviate from the rather extreme productions reported in prior studies (Barnes, 2013; Tauber et al., 2010). All three cues were used consistently by both speaker groups to signal grouping when addressing each interlocutor, suggesting a stable use of these cues to resolve syntactic ambiguities, irrespective of the speaker's age and communicative context (Schafer et al., 2000).

This chapter offers a valuable complement to Chapter 4's focus on infants' use of prosodic cues in boundary marking, by presenting data from both younger and older adults. This chapter hence contributes to a more comprehensive picture of how prosodic boundary cues are used across the lifespan.

7. Final remarks

The five chapters in this book present a rich array of experimental studies on prosodic boundary phenomena. They cover both production and perception across different speaker populations and communicative situations, with a particular focus on the processing of prosodic boundaries. One of the strengths of this book is its inclusion of multiple languages, diverse age groups, and a range of prosodic cues, offering a multifaceted perspective on boundary phenomena and contributing to our broader understanding of the role of prosody in human communication. That said, as a collection of workshop presentations, the book understandably cannot offer an exhaustive treatment of the topic. Outside this book, there is a much wider range of studies available. For readers interested in extending this line of inquiry, several directions are worth exploring.

The inventory of languages in this book, while already diverse, remains primarily limited to Germanic and Romance languages — specifically German, English, Spanish (Mexican), and Portuguese (Brazilian) — with Estonian as the only exception. A fuller typological picture would benefit from the inclusion of languages with markedly different prosodic structures. For instance, Asian tone languages such as Mandarin

varieties (Li & Yang, 2008; Zhang, 2018), Middle Eastern languages such as Lebanese Arabic (Kelly, 2023), and African languages such as Wolof (Rialland & Robert, 2001).

Moreover, the populations examined are restricted to typically developing children and adults in this book. Yet prosodic boundary perception and production in clinical and neurodiverse populations has been shown to differ from, as well as share similarities with, neurotypical controls, e.g., in populations with unilateral brain lesion (de Beer et al., 2022), aphasia (DeDe & Salis, 2019; Zhang et al., 2024), and dyslexia (Geiser et al., 2014). Including such perspectives could offer valuable comparative insights into the robustness and plasticity of prosodic systems.

In addition, the studies included in this book primarily focus on three acoustic parameters for boundary marking: duration, f0, and pausing. While these are undoubtedly key parameters, other cues including the use of various boundary tones (Zhang & Chen, Forthcoming), changes in voice quality (Choi et al., 2005), and use of articulatory strategies such as glottalisation (Di Napoli, 2015) have also been identified as relevant in a growing body of research.

Taken together, this book represents a valuable contribution to the study of prosodic boundaries, offering fresh experimental insights and raising important questions about how prosodic cues are processed and used in communication. Researchers working on prosody will find both inspiration and a point of departure from this book.

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