Contrastive Focus in Children Acquiring English and ASL: Cues of Prominence

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1. Introduction

In this paper, we present novel data concerning the marking of contrastive focus in two modalities. Using data from an elicitation task conducted with children acquiring English and children acquiring American Sign Language (ASL), we demonstrate that focused constituents in both speech and sign modalities are marked by a bundle of prosodic features. We observe that increased duration and intensity are cross-linguistically relevant cues of contrastive focus despite the differences between the two modalities.

2. Background

Focus can be largely characterized as falling into two categories: information focus and contrastive focus. Information Focus is also known as *presentational focus* or *semantic focus* (Kiss 1998, Zubizarreta 1998, Gundel 1999). It contributes new information and it can be identified as the answer to a question as in (1b):

(1)   a. Who did you invite to the party?
        b. I invited [F **Elizabeth**] to the party.

Contrastive Focus, on the other hand, can be "used in situations when the sender believes that the addressee needs to be given corrected information" (Wilbur 2012:3; also Tomioka 2006, Zimmermann 2008).

(2)   a. Eliza mailed the poster.
        b. No, Eliza mailed the [F **caramels**].   (Katz and Selkirk 2011:772)

Note that focus, as exemplified in (1) and (2), typically involves both prosodic and semantic prominence. In this paper, we are interested in the relationship between the semantic prominence that is expressed through focus, and the prosodic means by which that semantic prominence is expressed.

According to Gussenhoven (2001, 2004), greater pitch excursions, which typically express semantic prominence, require more articulatory effort. Gussenhoven terms this relationship between effort and prominence *The Effort Code*. One implementation of this code within the sign modality is found in Crasborn & van der Kooij's (2013) work, which reports that focused signs have enhanced manual prominence. Furthermore, Schlenker et al. (under review) propose a *Salience Code*, according to which "focused elements are made more easily perceptible in spoken and signed languages." Our study contributes to the ongoing discussion of such effort/salience codes and their prosodic expression in two modalities (sign and speech), by extending the investigation into the domain of child language. More specifically, we investigate the notion of semantic and prosodic prominence of contrastive focus in its corrective function.

3. Motivation

The current study addresses the means of signaling focal prominence, in the case of the corrective function of contrastive focus. In particular, we examine the expression of focal prominence in children acquiring English and children acquiring ASL. We are interested in identifying any commonalities between the two languages and modalities, as well as any aspects of focal expression that are modality-dependent. With this motivation as our starting point, our main research questions can be summarized as follows: (i) What are the cues of contrastive focus used by children in speech and sign? (ii) Are there common cues that can be traced to the idea of a universal Effort Code?

4. Study
4.1. Method

We describe here two experiments, one conducted in English and one conducted in ASL. For both experiments, children were prompted to produce both a 'neutral' version of a sentence, and a version with focus to correct an erroneous version produced by a character presented on a laptop computer. The procedure was as follows. First, the Experimenter introduced the child to an English-speaking puppet called *Lizzy the Lizard*, or to a signing person named *Bob*, through videos on the computer (see Figure 1). Lizzy and Bob were introduced as silly characters who were not very good at paying attention, and who frequently said the wrong things. The Experimenter then presented short stories through a series of cartoon pictures and animations in PowerPoint. Following each story, children were prompted to summarize what had happened in the story. This initial elicitation yielded the data for the "neutral" condition. Subsequently, *Lizzy* or *Bob* appeared on-screen and produced an utterance about something in the story, crucially getting one of the details wrong. Children had to judge Lizzy's or Bob's utterance and provide a corrected version. The elicitation of this correction formed the basis of the contrastive condition.

Figure 1: Lizzy (third party in the speech) and Bob (third party in the sign)

A sample item (with actual responses from a child participant) is provided in Table 1 to illustrate the procedure.

Table 1. Sample test item

Experimenter: This story is about Sue and her friend, Bird. Sue loves to give presents to her friends and she knows Bird loves hats. How will Sue find some hats for Bird? Let's see!	
Experimenter: Sue has enough yarn to make two hats for Bird. And she has enough money to buy two hats for Bird.	
Experimenter: But Bird says: "A present is much more special when someone makes it for you."	
Experimenter: So, Sue makes two hats for Bird. Can you tell me what happened in the story? Child: She **made** two hats for Bird. Experimenter: Yeah, she made hats for Bird.	
Experimenter: Okay! Let's ask Lizzy. Lizzy, what happened in that story? Lizzy: Hmm, Sue bought two hats for Bird. Experimenter: Is that right? Child: Buy? Did he say buy? Experimenter: Yeah he said buy. Child: No! Experimenter: You know what happened. What should Lizzy say? Child: He … He has to say Sue **made** hats for Bird. Experimenter: Exactly.	

In summary, the two sets of data that were compared were the No Contrastive Focus (NCF) condition, elicited in the portion of the experiment when children were initially asked to summarize the story, and the Contrastive Focus (CF) condition, in which children were prompted to correct Lizzy's or Bob's utterance.

4.2. Materials

The experiments contained three pairs of sentences designed to elicit contrastive focus on different syntactic categories: (i) the numerals *two* and *three*, modifying a noun, e.g., *two hats*, *three hats*; (ii) the two nouns *lion* and *apple*; and (iii) the two verbs *throw* and *make*. All participants received one training item, which involved the correction of an adjective, e.g., *green*.

4.3. Participants

Nine hearing monolingual children (5 female) aged 3;09-6;04 (M=5;01) participated in the English experiment. Their details are provided in Table 2. Participants in the ASL group were native signers: each had at least one Deaf, signing parent. The participants themselves were Deaf, Deaf users of a cochlear implant (DDCI), or hearing (Kodas: hearing kids of Deaf adults); see Table 3. Ten participants (7 female) aged 4;07-8;0 (M=7;03) were tested in the ASL group. Many of the ASL subjects are participants in an ongoing long-term project: Development of Bimodal Bilingualism (http://bibibi.uconn.edu).

Table 2: Participants for English

#	Group	Pseudonym	Age	Gender
1	Hearing	ROK	3;09	M
2	Hearing	JAA	3;10	F
3	Hearing	WOW	4;02	M
4	Hearing	ART	4;07	F
5	Hearing	IMU	4;09	M
6	Hearing	MEL	6;01	F
7	Hearing	CAJ	6;01	F
8	Hearing	RAY	6;03	M
9	Hearing	LIA	6;04	F

Table 3: Participants for ASL

#	Group	Pseudonym	Age	Gender
1	Deaf	DOT	4;07	F
2	Deaf	ADA	6;10	F
3	Deaf	BEL	7;00	F
4	Deaf	LEE	7;10	F
5	Deaf	ARI	8;06	F
6	DDCI	FIN	6;09	M
7	DDCI	GIA	7;09	F
8	Koda	KIM	7;04	F
9	Koda	LEX	8;00	M
10	Koda	PET	8;06	M

4.4. Cues measured in Speech

Children's responses in the CF and NCF conditions were analyzed in Praat (Boersma and Weenink 2010). In spoken languages, focus is usually realized by means of phonological prominence, which can be phonetically manifested by various combinations of prominence-marking cues (Gussenhoven 2001, 2004; Heldner & Strangert 2001; Eriksson et al. 2001). Three sets of relevant variables were measured in the children's output: fundamental frequency (F0)-related cues (Hz and st), phonetic cues associated with intensity (dB), and vowel duration (ms).

First, we measured fundamental frequency-related cues that can be associated with focal prominence: mean F0, F0 excursion size, and velocity of pitch change. Higher F0 relates to perceivable higher pitch and in many languages this variable is used to cue different levels of prominence (e.g. Fry 1955, Rietveld & Gussenhoven 1985). F0 excursion size is the difference between the lowest and the highest points of F0 for some unit (st/ms). Velocity is related to the speed of pitch movements. F0 was calculated for time frames of 10 milliseconds; F0 movements were analyzed as intervals between onsets and offsets of F0 falls and rises throughout the target words. Errors (glottal pulse detection errors and octave jumps) were corrected manually.

Intensity relates more or less directly to the perceived loudness of a sound (Fry 1955; Lehiste 1976; Katz & Selkirk 2011). The intensity-related cues measured for this experiment were overall mean intensity and intensity peaks for the target words.

Finally, vowel durations in the CF and NCF conditions were measured in milliseconds.

4.5. Cues measured in Sign

For this phase of the study, we measured manual prosodic cues for ASL. Video-recorded responses were imported and manually annotated using ELAN language archiving software (Max Planck Institute for Psycholinguistics). Prosodic cues that were measured include articulation speed, proximalization of the articulation joint, and repetition of the lexical movement of a sign. These components were informed based on proposals about the phonological/phonetic organization of signs (Liddell and Johnson 1989; Sandler 1989; Brentari 1998), and the limited previous research on focus in sign languages (Crasborn and van der Kooij 2013; Schlenker et al. under review). Further research is needed to define the full set of features involved in the prosodic expression of contrastive focus in sign languages.

5. Results
5.1. Results – English

We observed that children acquiring English make use of three major prosodic cues of focus marking: (i) higher intensity; (ii) modulation of fundamental frequency; (iii) increase in duration.

We conducted t-tests to determine whether the differences between the two groups of measurements (CF and NCF) were significant. First, there was a significant difference in mean intensity between the two conditions ($F_{1,22} = 3.98$, $p = 0.04$). The results for intensity are provided in Figure 2 (CF – Contrastive Focus condition, NCF – No Contrastive Focus condition).

Figure 2: Intensity
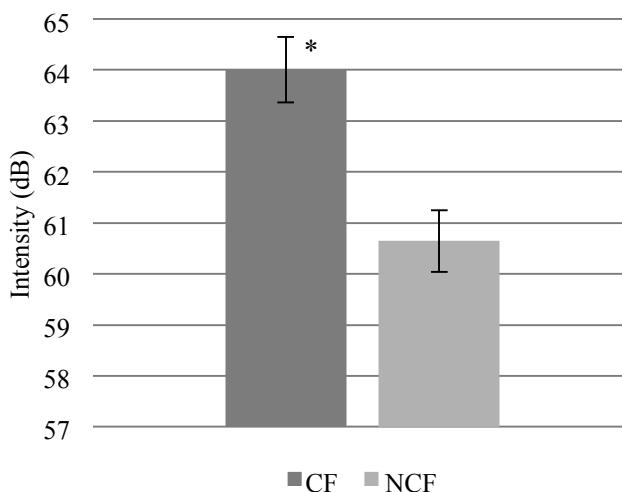
Units under CF are acoustically marked with significantly higher intensity. In perceptual terms, these units are significantly louder than units with no focal accent.

Well-studied cues of focal prominence that have attracted the most attention cross-linguistically are those related to modulation of fundamental frequency. One of the cues in this set turned out to be significant in our data, namely the excursion size. The observed F0 excursion size for contrastively focused words was significantly larger than that of non-contrastively focused words ($F_{1,22} = 4.56$, $p = 0.003$) (Figure 3).

Figure 3: F0 Excursion size
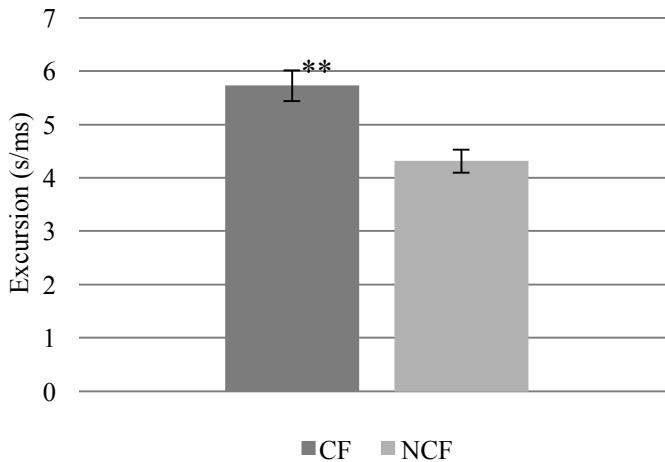
Finally, vowels under contrastive focus were significantly longer than non-contrastively focused vowels ($F_{1,22}$ = 3.98, p = 0.0002). As seen in Figure 4, the difference in duration between the two conditions is quite marked, and the extensive use of this acoustic cue by children to mark focus merits more systematic investigation.

Figure 4: Mean Vowel Duration
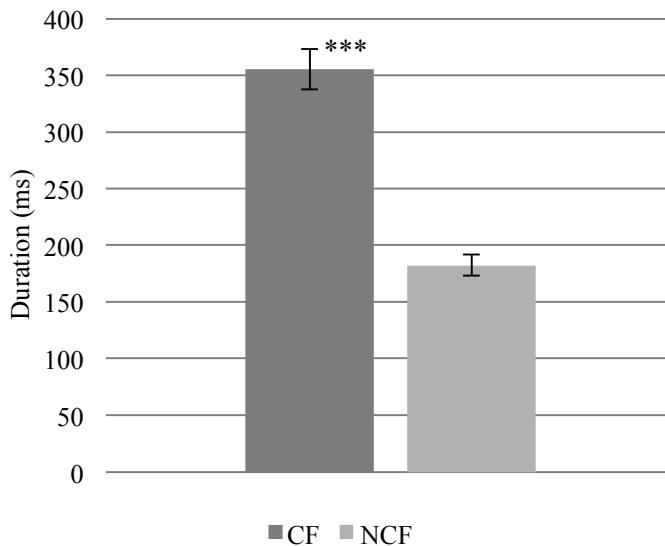
In Figure 5 we present Praat screenshots of two examples. Both are from the same child producing the word made; the first does not involve contrastive focus, while the second contains contrastive focus. In the first excerpt, the duration of the target is about 200ms (Figure 5a), while in the second it is over one second long (Figure 5b).

Figure 5a: Duration of the target *made*, NCF (control)
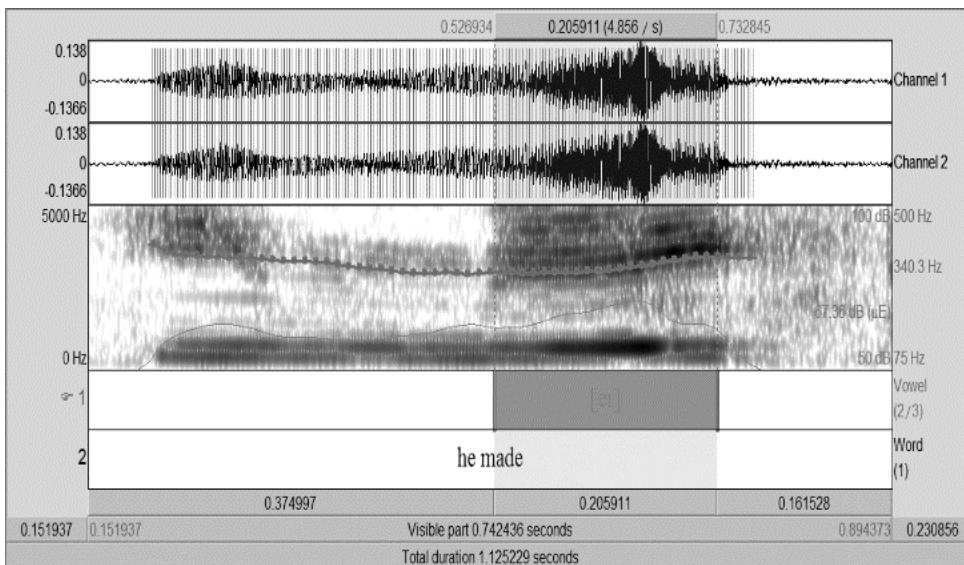
Figure 5b: Duration of the target *made*, CF (contrastive)
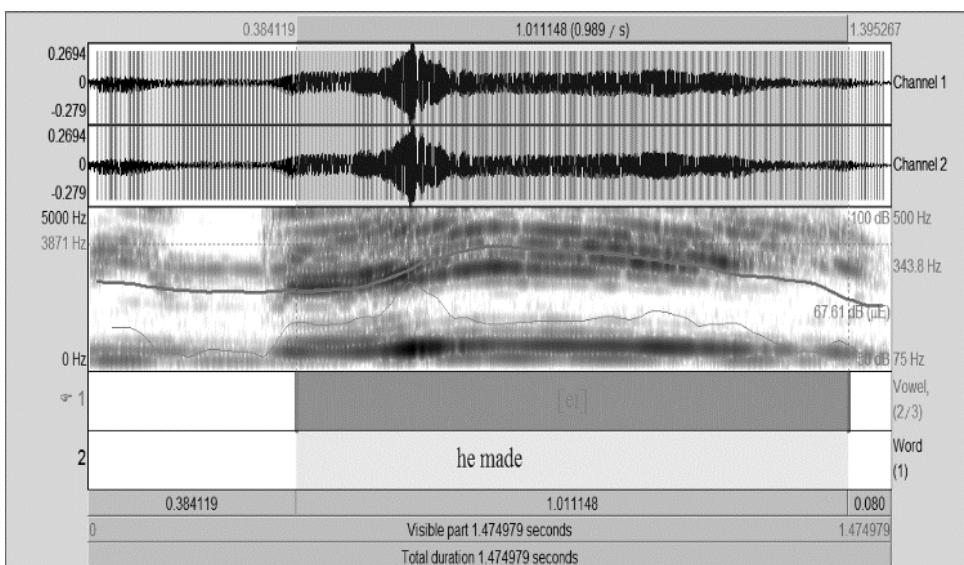
5.2. Results – ASL

The ASL data were coded using ELAN language archiving software (Max Planck Institute for Psycholinguistics). Coding included the duration of target items and prosodic features for all contrastively focused signs. Each focused element was compared to a non-focused element controlling for utterance position (i.e. initial, medial, final, alone).

Signs with contrastive focus were overall significantly longer than the same signs produced without contrastive focus (M=0.99 (CF) vs. M=0.66 (NCF), *p*<.01). This included signs produced alone and in utterance initial or medial positions. However, signs with contrastive focus in final

position were not significantly longer, as non-contrasted signs display a phrase-final lengthening effect (M=1.22 (CF) vs. M=.93 (NCF), *p*>.05).

The following factors were observed to contribute to manual prosody for longer duration: (i) articulation speed, (ii) proximalization, and (iii) repetition, as reported in Table 4.

Table 4: Proportions of manual prosodic factors contributing to the expression of contrastive focus

Type	Proportion (#)
Articulation Speed	.44 (29)
Repetition	.09 (6)
Proximalization	.11 (7)
None	.35 (23)

For articulation speed, an effect of fast articulation was observed for contrastively focused items. Faster articulation includes holds at the beginning and end of a sign to control the high amount of articulation energy exerted to articulate contrastively focused signs with intense/fast movement. The holds at the beginning and end of contrastively focused items result in longer durations.

Signs are produced with the help of one or two of the following joints, in order of proximity to the body: shoulder > elbow > wrist > finger joints. Signs are defined for phonological movement for one or two of these joints. When the movement of a sign spreads from a joint that is distal from the body to a more proximal joint, proximalization is said to occur (Brentari 1998, Meier et al. 1998). Proximalization is another factor that contributes to the longer duration of focused signs. Finally, repetition of the phonological movement specification of a sign is an additional factor contributing to longer duration.

A further analysis investigating all the contrastively focused items without regard to syntactic position but based on the phonological characteristics of lexical items reveals that articulation speed is the major cue for all categories (Figure 6). This cue can be compared with intensity in bringing along a perception of powerful/intense articulation. Proximalization is the secondary cue for the two items LION and THROW, which have complex movements involving more than one joint, as shown in Table 5. The path movement with the finger/wrist joints can be extended to the elbow joint. This is how proximalization is achieved for THROW. The path movement with the elbow joint can be extended to the shoulder joint. This is how proximalization is achieved for LION. This is comparable to F0 excursions in terms of travelling distance (distance understood as spatial distance or in terms of vertical F0 distance). TWO and THREE involve a lexical path movement executed with the elbow joint and for these signs, articulation speed is the only major cue. All of LION, THROW, TWO and THREE are monosyllabic signs. They all have single movements for their lexical specification (Wilbur 2011). On the other hand, MAKE and APPLE are disyllabic. These signs include two lexical movement specifications. Interestingly, repetition is found to be the other major cue in addition to articulation speed for these latter signs.

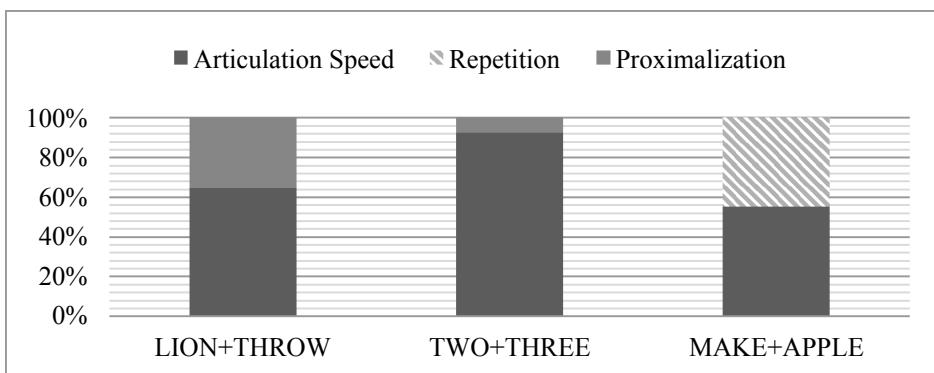Figure 6: Items grouped according to lexical phonological movement

Table 5: Lexical phonological specifications of the target signs
(Based on Prosodic Model, Brentari 1998)

Sign	Joint-1	Joint-2	Syllable Type	Syllable Number
LION	elbow	wrist	complex syllable	monosyllabic
THROW	fingers	wrist	complex syllable	monosyllabic
TWO	elbow	N/A	simple syllable	monosyllabic
THREE	elbow	N/A	simple syllable	monosyllabic
MAKE	wrist	N/A	simple syllable	disyllabic
APPLE	wrist	N/A	simple syllable	disyllabic

Based on these detailed analyses, we conclude alongside Crasborn and van der Kooij (2013) that the lexical phonological movement specification of a sign may be predictive of what cues, besides articulation speed, will be used for prominence. More specifically, if the phonology of a sign includes lexical repetition that sign may be more prone to an increased number of repetitions. If the sign makes use of more than one joint, proximalization may occur. Lastly, if the sign involves neither repetition nor multiple joints, articulation speed may be the only articulatory factor contributing to the prosodic expression of contrastive focus.

6. Discussion and Further Questions

Let us recall the research questions we started with. The first question was what cues of contrastive focus are used by children in speech and sign. In this paper we have demonstrated that for speech, the relevant cues that mark focal accent are: larger pitch excursions, higher intensity, and longer vowel duration. In sign, focus is signaled by articulation speed, repetition, proximalization, and duration. The second question addressed in this research was whether there are prominence cues that are shared between the two modalities, which can be traced to the idea of a universal Effort Code. At this point we propose that duration can be analyzed as the common cue that can be traced back to the Effort Code.

Figure 7: Cross-modal model for the expression of contrastive focus within a universal Effort Code
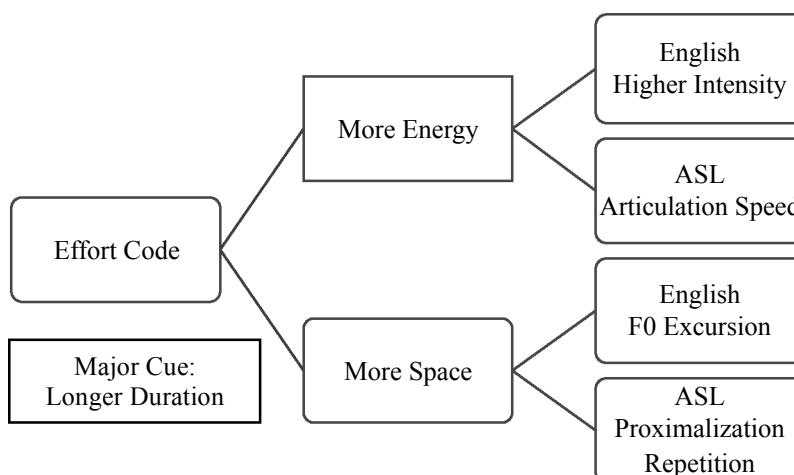
The preliminary model is sketched in Figure 7. According to this model, the Effort Code is commonly responsible for the role that longer durations plays in marking prominence in English and ASL. This code instructs ASL and English to exert more energy and use more space to express semantically prominent information. The first instruction, *exert more energy*, results in higher intensity in English and increased articulation speed in ASL. The second instruction, *use more space*, results in larger F0 excursions for English (enlarged pitch space) and proximalization and repetition for ASL (elongated/enlarged/doubled articulation space).

Our study contributes to at least two issues in the theory of prosody. First, our data call for a closer investigation of the way that enhancement of the diversity of the signal serves as one of the main requirements for a prosodic system. The general stance in the prosody literature is that languages universally use prosodic units of different levels to make the signal more diverse and hence more easily perceivable. Sign languages are understudied in this regard and cross-linguistic studies like the one we are presenting could shed some light on possible parallels in the organization of levels and hierarchy of prominence marking in different systems as we have suggested in Figure 7.

The second theoretical issue that our study highlights pertains to correlations between prominence-marking cues and the type of prosodic system that is used in a given language. In this paper, we claim that some cues (duration, for example) can be cross-linguistically, and, moreover, cross-modally relevant for marking prominence. This hypothesis would be interesting to test, for example, in systems that include vowel duration as a phonemic distinction. It would be informative, for instance, to determine whether such a system could make use of longer vowel duration to mark focus. This question goes back to the Functional Load Hypothesis (Berinstein 1979), which states that in a language where duration has a high functional load for the long/short phonemic distinction, lengthening is not used to cue accent. Comparative studies like the one presented in this paper bring valuable data into the picture.

One issue we have not considered in this paper is the developmental progression of prosodic focus-marking. It may be worthwhile in future studies to compare the child data with adult production data. For instance, we have not addressed whether and how children may differ from adults in their use of the prosodic cues we have discussed. We have also left aside for the moment the question of how caregivers use these same cues in child-directed speech and signing. Further investigation from this perspective may shed light on the developmental path children may take to adult-like usage of prosodic cues of prominence. Finally, continued cross-modal investigations of the kind we have presented here will ultimately help us to understand the nature of the prosodic expression of contrastive focus more generally.

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