What the Deaf Can Do, the Hearing Can, Too: Performance in an ASL Boundary Perception Task Using Naturalistic Stimuli

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Abstract

This study compares the performance of two groups on an American Sign Language (ASL) perception task. Twenty-two L1 signers of ASL and twelve sign-naïve English speakers watched a filmed lecture in ASL and pressed a response pad to identify "natural breaks" in the signing. Responses from each subject group were analyzed into *agreement clusters*—time slices of up to 2 seconds in which a substantial percentage of participants identified a boundary. Comparison of the response patterns of signers and non-signers revealed a one-way implication between signer agreement clusters and non-signer agreement clusters. That is, where signers agreed about the location of a boundary, non-signers did as well, but it was not the case that non-signer agreement about a boundary was a predictor that signers would identify the same boundary.

1 Introduction

A growing body of work on prosody in signed languages has shown that prosodic prominences, formed from variations in timing, intonation, and amplitude, mark prosodic phrasal structure in the world's signed languages. A series of prosodic cues articulated on the hands, face, and body have been identified in American Sign Language (ASL), [6] [11], [12], [9], Israeli Sign Language (ISL) [8], Swiss German Sign Language (DSGS) [1], British Sign Language (BSL) [10], and German Sign Language (DGS) [5], among others.

Prosodic cues in the visual-gestural modality have been shown to aid in the segmentation of signed discourse into Intonational Phrases ([9] and [2] for ASL, [8] for ISL, [1] for DSGS) and into phonological words ([2] for ASL). Recent work on prosody perception has shown that while signers with full access to linguistic information are able to segment the sign stream, so are sign-naïve individuals who may be presumed to have access *only* to prosodic information when performing segmentation tasks. Adult non-signers have been shown to successfully segment naturalistic BSL and Swedish Sign Language (SSL) videos into intonational phrases [3]. Adult and infant non-signers have shown sensitivity to intonational phrase boundaries in ASL when the experimental stimulus is an edited video of child-directed-signing [2].

The current study considers the performance of adult sign-naïve subjects on a segmentation task in ASL, and in this case uses naturalistic, adult-directed signing as the experimental stimulus. The performance of the sign-naïve subjects is compared to the performance of native signer subjects.

2 Methods and Procedures

2.1 Stimulus

A signed lecture was filmed to serve as the experimental stimulus. The lecturer, a male in his late 50s, is a multigenerational Deaf signer for whom ASL is his first language. The lecturer was given a topic for discussion ("describe the Deaf President Now movement at Gallaudet University") and was asked to present without notes, in a register that he would use in the classroom. The lecture was signed at Boston University in front of a Deaf audience. No hearing researchers were in the audience during the recording, allowing the lecturer and audience to interact in a "monolingual language mode" [4], [1]. A hearing camera operator was present during the recording, but this individual did not interact with the lecturer or audience members.

2.2 Participants

Twenty-two multigenerational Deaf individuals were recruited in the Boston and Washington, D.C. areas to serve as the Signer Subject Group for the study. All participants received language input in ASL from birth, and all participants self-identify as members of the American Deaf community and regard ASL as their primary language of communication. The age range for participants in this group was 19-57.

Twelve hearing, non-signing individuals were recruited in the Boston area to serve as the Non-Signer Subject Group for the study. Participants are L1 English speakers with no exposure to ASL. Participants in this group ranged in age from 19-63.

2.3 Testing Procedure

Task instructions and stimuli were presented to subjects using Cedrus Superlab, a software package designed for psychological studies. Subjects were seated in front of an Apple MacBook connected to a Cedrus RB-530 Series Response Pad. Members of the Native Signer Group were shown a video of task instructions, which were signed in ASL by a Deaf graduate student and recorded at Boston University. Members of the Non-Signer Group were were given a parallel set of instructions in written English. All subjects were reminded that ASL is not articulated in an undifferentiated stream, but is instead permeated with "natural breaks." Subjects were instructed to press any key on the Response Pad whenever they saw a natural break occur in the lecturer's signing. These instructions were designed to elicit responses at prosodic phrasal boundaries without making direct reference to the concept of a clause or sentence. Because the stimulus was naturalistic, adult-directed signing in which no prosodic prominences were exaggerated, the researcher anticipated that subjects would respond at intonational phrase boundaries, perceiving these, but few if any lower-level prosodic boundaries, as the 'natural breaks' described in the task instructions.

In the Familiarization Phase, subjects were shown a 3-minute portion of the taped lecture that was not used for the stimulus in the study trials. Subjects were asked to practice the task of responding to 'natural breaks' in the signing by pressing on a response pad, and were given the opportunity to repeat the practice session.

In the Trial Phase, subjects were shown 6 minutes of video clipped from the same taped lecture. The stimulus video was presented in two 3-minute trials separated by a break. The break ended only when subjects pressed a button to initiate the second trial. The order of presentation did not vary, so that the full 6 minutes of the lecture were presented in the same order for all subjects.

3 Analysis of Subject Responses

3.1 Defining Subject Agreement

An initial analytical task was to determine whether subjects within and across groups agreed about the location of boundaries in the video. An algorithm implemented in Python identified clusters of subject agreement within each subject group.

The algorithm first identified clusters of two or more subject responses bounded by a gap of at least 500 ms. If an identified response cluster spanned more than two seconds, a division was introduced at the two-second mark and responses after this point were treated as members of a new cluster. After clusters were identified, all duplicate responses from a single individual within a cluster were removed, with only the individual's first response retained. The algorithm then tallied the number of responses within each cluster. In this way, a set of response clusters were identified which could be categorized based on the number of responses they contained.

Within each subject group, agreement clusters were categorized into two types: *strong agreement*: 50% or more of subjects responded within the cluster, and *weak agreement*: 30-49% of subjects responded within the cluster. Clusters in which fewer than 30% of subject group members responded were excluded from the analysis. For the Signer Group, then, the agreement of 11+ subjects was required for a strong cluster, and the agreement of 7-10 subjects was required for weak agreement. In the Non-Signer Group, the agreement of 6+ subjects was required for a strong cluster and the agreement of 3-5 subjects was required for weak agreement.

3.2 Observed Agreement Patterns

Both strong and weak agreement clusters were found in the Signer Group and Non-Signer Group response data, displayed in Figure 1:

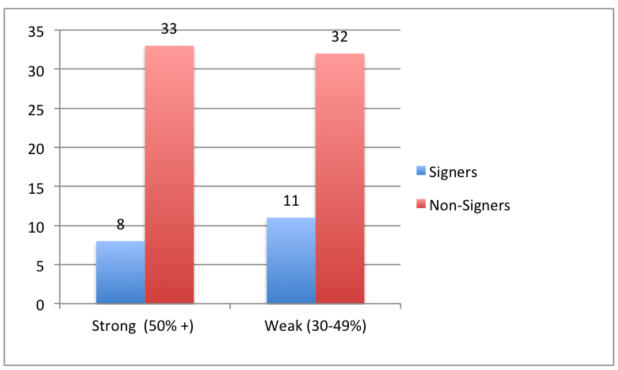

Figure 1: Agreement clusters across subject groups

The conservative response patterns of the signers is apparent from the number of agreement clusters in the Signer Group data: in six minutes of video, signers identified only 8 boundaries with strong agreement, and 11 boundaries are identified with weak agreement.

Subjects in the Non-Signer Group showed agreement about the locations of boundaries substantially more frequently than did signers. In six minutes of video data, non-signers identified 33 boundaries with strong agreement and 32 boundaries with weak agreement.

3.3 Signer Agreement as a Predictor of Non-Signer Agreement

For every agreement cluster in the signer data—strong or weak—there is a corresponding agreement cluster of some kind in the non-signer data within 500 ms. The data allow us to conclude with 95% confidence that there will be a non-signer agreement cluster within 500 ms of each signer cluster over 74% of the time for strong clusters and over 80% of the time for weak clusters.

It is not the case, however, that for every non-signer agreement cluster there is a corresponding signer agreement cluster. To the contrary: 71% of the non-signer clusters (46 of 65 clusters) have no corresponding cluster in the signer data. Thus there is a one-way implication between the agreement clusters from the Signer Group and the agreement clusters from the Non-Signer Group.

3.4 Differences in Response Patterns of Signers and Non-Signers

What can explain the fact that while non-signers agree about every point where signers show agreement about a boundary, they also agree at a large set of locations where signers show no agreement? One possibility is that, in performing the task, non-signers responded to minor prosodic boundary cues that signers did not consider sufficient to mark 'natural breaks'. This interpretation of the results attributes to the signing subjects—and only the signing subjects—a sensitivity to a prosodic hierarchy in ASL. To test this hypothesis would require edited stimuli in which major and minor prosodic boundary marking cues could be isolated, and subject groups' responses to the major and minor cues compared.

Another possibility is that the signing subjects under-responded to high-level prosodic boundaries in the stimulus because the content of the signed lecture distracted them from the assigned task. Having full access to linguistic information, including the engaging content of the narrative, could have been a hindrance to performing the task.

4 Implications

That non-signer subjects should be able to segment a video of ASL discourse into high-level prosodic units is unsurprising: similar results have been found in studies with non-signers responding to naturalistic BSL and SSL stimuli [3] and to edited, child-directed ASL stimuli [2]. One notable finding from this study, predicted but not tested by Brentari et al. in 2011, is that non-signers have no difficulty performing the segmentation task with adult-directed ASL signing in which prosodic cues are less exaggeratively produced. This result is to be expected if the task of prosodic bootstrapping—deducing syntactic boundaries from prosodic ones—can be performed not only on child-directed speech but also on adult-directed speech. We may in fact suppose that much of the success of the signed language learner—either the infant acquiring an L1 or the adult acquiring an L2—is dependent upon the learner's ability to discern prosodic boundary marking in adult-directed signing [7]. The results of this study confirm that this boundary marking is indeed accessible to the sign-naïve adult perceiver. Also notable is the fact that this study asked subjects to respond to naturalistic signing, taped while the signer interacted with a Deaf audience. Naturalistic signing has been shown to be segmentable by sign-naïve perceivers in BSL and SSL, and with this study the finding is replicated with an additional signed language, ASL.

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References

[1] Penny Boyes Braem. Rhythmic temporal patterns in the signing of deaf early and late learners of Swiss German Sign Language. *Language and Speech*, 42(2-3):177–208, 1999.

[2] Diane Brentari, Carolina González, Amanda. Seidl, and Ronnie B. Wilbur. Sensitivity to visual prosodic cues in signers and nonsigners. *Language and Speech*, 54(1):49–72, 2011.

[3] Jordan Fenlon, Tanya Denmark, and Ruth Campbell. Seeing sentence boundaries. *Sign Language & Linguistics*, 10(2):177–200, 2007.

[4] Francois Grosjean and Harlan Lane. Pauses and syntax in American Sign Language. *Cognition*, 5(2):101–117, 1977.

[5] Annika Herrmann. The interaction of eye blinks and other prosodic cues in German Sign Language. *Sign Language & Linguistics*, 13(1):3–39, 2010.

[6] Scott K. Liddell. *American Sign Language Syntax*. Mouton, The Hague; New York, 1980.

[7] James L. Morgan, Richard P. Meier, and Elissa L. Newport. Structural packaging in the input to language learning: Contributions of prosodic and morphological marking of phrases to the acquisition of language. *Cognitive Psychology*, 19(4):498–550, 1987.

[8] Marina Nespor and Wendy Sandler. Prosody in Israeli Sign Language. *Language and Speech*, 42(2-3):143–176, 1999.

[9] Brenda Nicodemus. *Prosodic Markers and Utterance Boundaries in American Sign Language Interpretation*. Gallaudet Univ Press, 2009.

[10] Rachel Sutton-Spence and Bencie Woll. *The Linguistics of British Sign Language: an Introduction*. Cambridge Univ Pr, 1999.

[11] Ronnie B. Wilbur. Eyeblinks & ASL phrase structure. *Sign Language Studies*, 84:221–240, 1994.

[12] Ronnie B. Wilbur. Stress in ASL: Empirical evidence and linguistic issues. *Language and Speech*, 42(2-3):229–250, 1999.