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Brief article

ANCHORING is amodal: Evidence from a signed language

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ABSTRACT

Across languages, certain linguistic forms are systematically preferred to others (e.g. *bla* > *lba*). But whether these preferences concern abstract constraints on language structure, generally, or whether these restrictions only apply to speech is unknown. To address this question, here we ask whether linguistic constraints previously identified in spoken languages apply to signs. One such constraint, ANCHORING, restricts the structure of reduplicated forms (AB → ABB, not ABA). In two experiments, native ASL signers rated the acceptability of novel reduplicated forms that either violated ANCHORING (ABA) or obeyed it (ABB). In Experiment 1, signers made a forced choice between ABB and ABA forms; in Experiment 2, signers rated signs individually. Results showed that signers prefer signs that obey ANCHORING over ANCHORING violations (ABB > ABA). These findings show for the first time that ANCHORING is operative in ASL signers. These results suggest that some linguistic constraints are amodal, applying to both speech and signs.

1. Introduction

It is well known that across spoken languages, some linguistic structures are preferred to others; for example, syllables like *bla* are preferred to *lba* (e.g., Berent, Steriade, Lennertz, and Vaknin, 2007). But the nature of these constraints is controversial. One possibility is that these restrictions apply to speech, specifically (e.g., *lba* is harder to hear and to say than *bla*; Blevins, 2004; MacNeilage, 2008). On an alternative view, linguistic preferences stem from grammatical principles that are not specific to any particular linguistic modality (e.g., a formal constraint against syllables like *lba*; see Prince and Smolensky, 1993).[1]

To adjudicate between these possibilities, here, we turn to sign language phonology. Like spoken languages, all mature sign languages exhibit phonological patterning (Brentari, 1998; Liddell and Johnson, 1989; Sandler, 1989, 2012), but they are communicated in the manual modality. Our experiments ask whether some phonological constraints that have been previously identified in spoken language might apply across modalities—to both speech and signs.

Our case study concerns the phonological restrictions on *reduplication*. Reduplication copies all or part of a word (called a *base*), resulting in a new word whose meaning is linked to that of the base. For example, in Manam (an Austronesian language), the verb *pana* 'run' is the base of the reduplicated form *panana* 'chase' (Lichtenberk, 1983).

Reduplication is of interest because it is common across languages (Rubino, 2013), yet highly constrained (Lunden, 2004; Marantz, 1982; McCarthy and Prince, 1995). In particular, patterns like AB → ABB (where A and B are distinct phonological elements) and AB → AAB are well attested (e.g. *pana*, 'run' → *panana*, 'chase'; and in Ilocano, *púsa* 'cat' → *puspúsa*, 'cats'; Hayes and Abad, 1989). In contrast, patterns like AB → *ABA (e.g., *pana* → **panapa*) are scarce.[2]

Optimality Theory (Prince and Smolensky, 1993/2004) accounts for this regularity by appealing to abstract grammatical constraints on reduplication. One such constraint, ANCHORING (McCarthy and Prince, 1993), requires that a reduplicative copy be adjacent, or *anchored* to its

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[1] According to Optimality theory, all language users share a universal set of violable grammatical constraints. Particular grammars differ with respect to the relative ranking of these universal constraints, explaining why syllables such as *lba*, though cross-linguistically dispreferred, are nonetheless tolerated in some languages such as Russian. Here, we only ask whether grammatical constraints are amodal; their universality is not directly addressed by our inquiry.

[2] AB → ABA patterns are rare, but not entirely unattested; see Nelson (2005) for one example.

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base (see also McCarthy and Prince, 1995).[3] For example, *panana* (see (1)) obeys ANCHORING because the copy, or *reduplicant* (here, {$\mathbf{n}_{3c}\mathbf{a}_{4c}$}),[4] is adjacent to the portion of the base it is copied from (i.e., $\mathbf{n}_3\mathbf{a}_4$). The same holds for *papana* (2). In contrast, **panapa* (3) violates ANCHORING because the reduplicant is stranded from the portion of the base it copies by intervening material (i.e., $\mathbf{p}_1\mathbf{a}_2$ and{$\mathbf{p}_{1c}\mathbf{a}_{2c}$} are separated by n_3a_4). More generally, given a base AB, ABB and AAB are better formed than ABA.

(1) *pa**na**__na__*: [$p_1a_2\mathbf{n}_3\mathbf{a}_4$]{$\mathbf{n}_{3c}\mathbf{a}_{4c}$}
(2) *__pa__pana*: {$\mathbf{p}_{1c}\mathbf{a}_{2c}$}[$\mathbf{p}_1\mathbf{a}_2n_3a_4$]
(3) **panapa*: [$\mathbf{p}_1\mathbf{a}_2n_3\ a_4$]{$\mathbf{p}_{1c}\mathbf{a}_{2c}$}

Previous experimental work has shown that similar constraints on reduplication are operative in English and Hebrew. Specifically, reduplicative forms like *slaflaf* (where the copy, *laf*, is a contiguous substring of the base, *slaf*) are preferred to noncontiguous forms (e.g., *slafsaf*) by speakers of both Hebrew and English—a language that does not have such forms of reduplication (Berent, Bat-El, and Vaknin-Nusbaum, 2017). These findings suggest that some constraints on reduplication are active in the minds of speakers. Here, we ask whether similar restrictions on reduplication are active in the minds of signers.

Like in spoken languages, reduplication is frequent in sign languages (Sandler and Lillo-Martin, 2006), including ASL (e.g., Wilbur, 2009). For example, reduplication is used to form nouns from verbs (X → XX, e.g. SIT 'sit' → SIT-SIT 'chair'; Klima and Bellugi, 1988). Experimental evidence has shown that ASL signers extend reduplication to novel signs by relying on an abstract rule (Berent, Dupuis, and Brentari, 2014). But whether ASL reduplication conforms to ANCHORING is unclear.

If ANCHORING constrains speech, then *a priori,* there is no reason to expect similar preferences for signs. In contrast, if ANCHORING exists, and is amodal, then it is conceivable that similar preferences (e.g., {ABB, AAB} > ABA) should apply to signs. Furthermore, if ANCHORING is productive, then signers should be able to extend this preference to novel forms. Accordingly, signers should favor novel ABB and AAB signs (that obey anchoring) over ABA forms (which violate it). The following two experiments examine these predictions.

2. Experiment 1

To test whether signers are sensitive to ANCHORING, in Experiment 1 we presented native ASL signers with a matched pair of novel signs: one sign obeyed ANCHORING whereas the other violated it (i.e., ABB and ABA, respectively). Signers were asked to make a forced choice as to which form would make a better ASL sign. If signers are sensitive to ANCHORING, then they should prefer ANCHORING-consistent forms over ANCHORING-inconsistent forms (i.e. ABB > ABA).

2.1. Methods

2.1.1. Participants

12 Deaf native ASL signers took part in this experiment. All signers were from the greater Boston area, and all had been exposed to ASL between the ages of 0 and 8 years, with a majority (8/12) exposed before age 5. All participants were paid $30 for their participation. Each participant was debriefed and provided their informed signed consent according to the local IRB guidelines.

2.1.2. Stimuli

The experimental stimuli consisted of 22 pairs of novel, tri-syllabic signs: ABB and ABA (where "A" and "B" are distinct syllables). Within each pair, signs shared the same "A" and "B" syllables and differed only in their syllable orders. Syllables were chosen for each pair such that "A" always differed from "B" in both handshape and place of articulation. All signs were phonotactically legal in ASL, akin to the structure of ASL compounds (Brentari, 1998; Sandler, 1989, 1999).

2.1.3. Video recording

Three types of signs were recorded during the session: ABB signs (which conform with ANCHORING); ABA signs (which violate ANCHORING); and a third type, AAB, which was used only in Experiment 2. Signs were recorded in matched triplets, with each triplet containing one sign of each of the three types (e.g., ABB, ABA, AAB) and all signs within a triplet containing the same "A" and "B" syllables. Triplet members thus differed from each other only in terms of their syllable order.

Signs were articulated by a hearing, native bilingual/bimodal ASL signer whose mother is Deaf. All signs were recorded in a single session in Photobooth on a Macintosh using a built-in camera. During recording, the signer sat directly across from the camera such that her entire torso, lap, and head were visible. The signer was then familiarized with the complete set of syllables and syllable-combinations used in the experiment, and given ample opportunity to practice.

To ensure uniformity of sign production, the signer articulated all signs along to the rhythm of a metronome, at a rate of one beat per syllable (88 bpm). All sound was removed from videos prior to their inclusion in the experiment. Throughout the session, the signer was monitored by two fluent signers and corrected as needed to ensure consistency in facial expressions and emphasis (e.g. to ensure consistent stress). All signs were further inspected by one of the authors (DB), a sign language phonologist to ensure that they were clear, fluent, and faithful to the intended number of syllables (in line with Brentari & Poizner, 1994; Jantunen, 2013).

The resulting video recordings were clipped in iMovie so that each sign began at the beat immediately before the signer raised her hands, and ended once the signer's hands had returned to rest, after the fifth metronome beat. Final sign durations were 3 s. Fig. 1 illustrates one triplet; for additional phonetic detail, see Fig. S3.

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.cognition.2018.07.016.

2.1.4. Procedure

Instructions to participants were pre-videotaped in ASL (modeled by the same signer who signed the experimental stimuli). Each trial consisted of two matched signs presented side by side (ABB vs. ABA), counterbalanced for order. Signers were instructed to watch each pair of videos and indicate which form made a better sign in ASL using the keypad. The experiment began with three practice trials (using stimuli distinct from experimental signs). No feedback was given during practice or experimental sessions. Signs were presented in a random order using E-Prime 2.0.

2.2. Results

Fig. 2 presents the proportion of ANCHORING-consistent choices made by participants (for the raw data from Experiments 1–2, see SI). An inspection of the means suggests that signers favored ABB over ABA forms. A binomial exact *t*-test demonstrated that this preference was significantly higher than chance ($Z = +4.62$, $p < .001$).[5]

[3] Formally (McCarthy and Prince, 1993:67): "In R + B, the initial element in R is identical to the initial element in B. In B + R, the final element in R is identical to the final element in B." In R + B the reduplicant (R) precedes the base (B), and in B + R it follows it.

[4] In these examples, a 'c' subscript indicates an element that has been copied from the base.

[5] A logistic regression on the data produced similar results ($\beta = 0.7998$, $SE = 0.4005$, $z = 1.997$, $p = .0458$). Only the results of the binomial *t* test are listed here.