Prosodic strengthening at the edges of prosodic boundaries in sighted and blind adult speakers

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Recent studies have shown that when producing isolated vowels, congenitally blind speakers produce smaller displacements of the lips (visible articulators), compared with their sighted peers (Ménard et al., 2009; Ménard, 2015). It is not known, however, if this difference between sighted and blind speakers is still produced in more complex linguistic tasks. To investigate the role of visual experience on articulatory gestures used to produce salient speech contrasts, the production of vowels at the edges of low-level prosodic domains and high-level prosodic domains (in which gestures are reported to be strengthened) was studied in adult speakers of Quebec French. Domain-initial prosodic strengthening means that segments that occur in the initial position of large prosodic units (eg., intonational phrases) are produced more strongly than those in the initial position of small prosodic units (eg., words) (Cho et al., 2011; Georgeton, 2014).

The objective of the current study was to determine how congenitally blind speakers, who are known to produce reduced lip movements in isolated vowels, strengthen articulatory gestures and acoustic features in order to mark prosodic boundaries in French, compared to sighted speakers.

Eight congenitally blind adult speakers (mean age: 38 y.o.) and eight sighted speakers (mean age: 39 y.o.) were recruited. They were all native speakers of Quebec French. All participants had normal auditory thresholds and were native speakers of Canadian French. Blind subjects had a complete visual impairment (class 3, 4, or 5 in the IDCWHO). The experiment consisted of acoustic and articulatory recordings of 10 repetitions of the 4 French vowels /i/, /y/, /u/, /a/ produced in 4 different prosodic contexts. Each vowel was produced in a /bVb/ syllable and was embedded in a carrier sentence. Four prosodic contexts were examined: word-initial position, word-final position, phrase-initial position and phrase-final position. Synchronous acoustic and articulatory recordings were made using an EMA system (Carsten AG 500). Ten coils were placed on the participant's upper and lower lips, mastoids, upper and lower incisons, and tongue (tip, blade, dorsum). Position and orientation were extracted using Linux version of the EMA software and were corrected for head movement using a MATLAB procedure developed by Mark Tiede (Haskins Laboratory). For each vowel, in both positions (initial and final) and in both domains (word and phrase), duration and formant values were extracted at vowel midpoint using Praat. Mean position of the sensors was computed in the horizontal (front-back) and vertical (high-low) dimensions. Linear mixed models were built using articulatory and acoustic values, with group (blind and sighted), position (initial and final) and domain (word and phrase) as the fixed effects and speaker as the random effect.

As can be seen in Figure 1, at the acoustic level, blind and sighted speakers used vowel duration to mark the edges of prosodic units in French. In sighted participants, vowels produced in final positions were longer than those produced in initial positions in phrases only (higher level than words). In blind participants**,** vowels in word-final positions and in phrase-final positions were longer than those in initial positions.

At the articulatory level, Figure 2a suggests that blind speakers used larger tongue displacements than sighted speakers (confirming our previous studies) to produce the 4 vowels /i y u a/ (main effect of group). Sighted speakers used enhanced tongue displacements in initial positions compared to final positions (words and phrases). Blind speakers did so only for words. Upper lip displacements (Figure 2b) were significantly larger in sighted speakers than in blind speakers, and did not differ according to prosodic domain or position.

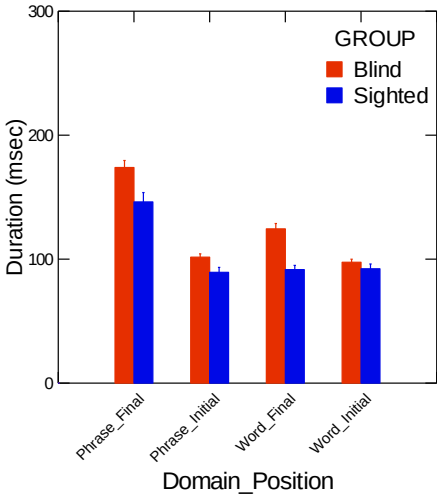

Figure 1 : Average vowel duration, across the vowels /i y u a/.

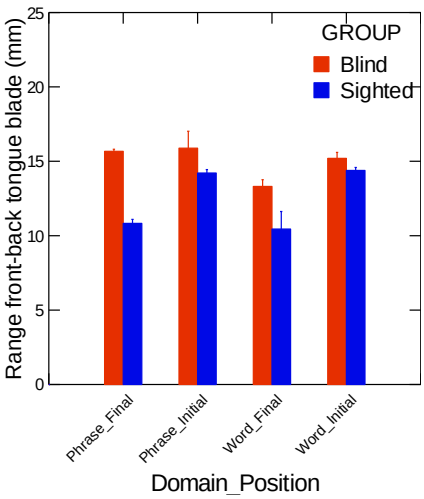

Figure 2a : Average range of front-back position of the tongue blade, across the vowels /i y u a/.

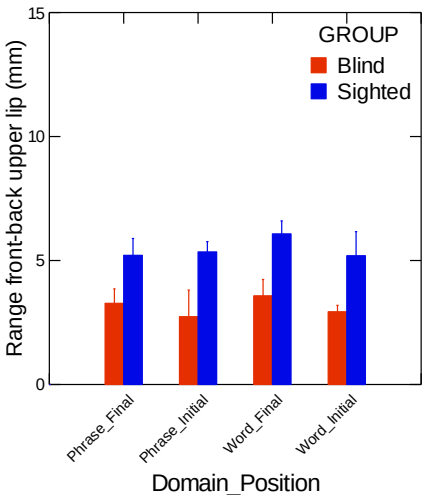

Figure 2b : Average range of front-back position of the upper lip, across the vowels /i y u a/.

The results suggest that sighted speakers likely use multimodal cues (visible and audible) to implement the prosodic structure. Vowel contrasts are implemented through various strategies combining visible and non visible articulators even when more complex linguistic units (word or phrase) are produced.

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