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Brief article

Even at 4 months, a labial is a good enough coronal, but not vice versa

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ABSTRACT

Numerous studies have revealed an asymmetry tied to the perception of coronal place of articulation: participants accept a labial mispronunciation of a coronal target, but not vice versa. Whether or not this asymmetry is based on language-general properties or arises from language-specific experience has been a matter of debate. The current study suggests a bias of the first type by documenting an early, cross-linguistic asymmetry related to coronal place of articulation. Japanese and Dutch 4- and 6-month-old infants showed evidence of discrimination if they were habituated to a labial and then tested on a coronal sequence, but not vice versa. This finding has important implications for both phonological theories and infant speech perception research.

1. Introduction

The special status attributed to coronal place of articulation in the phonologies of the world (Paradis & Prunet, 1991) has intrigued phonologists for decades. Indeed, coronals (sounds articulated with the tongue tip or blade) show distinct characteristics, such as a high frequency of occurrence between and within languages (Maddiesson, 1984), and a proneness to undergo phonological processes such as place assimilation (Chomsky & Halle, 1968). This special status would also affect speech processing in the form of a perceptual asymmetry, but whether or not this asymmetry is based on language-general properties (thus, is independent from a listener's language-specific experience) or arises from language-specific experience (thus, changes as a function of experience with a specific language) has been a matter of debate. The current study suggests that language-general properties underlie the special status of coronals based on evidence from young infants.

To highlight the issues being debated, we will introduce two accounts that capture perceptual asymmetries in adults. The Featurally Underspecified Lexicon (FUL; Lahiri & Reetz, 2010) posits perceptual asymmetries independent of experience with a specific language. It assumes sparse and abstract lexical representations in which not all phonological features are specified. Coronal place of articulation is considered the default place, and

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consequently, it is underspecified in the mental lexicon. This predicts perceptual asymmetries such that labial mispronunciations of coronals (e.g., [bɔl] for /dɔl/) do not produce a mismatch ([bɔl] is accepted as an instance of /dɔl/), but coronal mispronunciations of labials do ([dɔl] is not accepted for /bɔl/). The results of numerous perceptual experiments are consistent with this prediction: labial mispronunciations prime coronal target words, but not vice versa, in cross-modal priming (Lahiri & Reetz, 2002). Similarly, event-related potential (ERP) studies have shown smaller ERPs to labial mispronunciations of coronals than vice versa (e.g., Cornell, Lahiri, & Eulitz, 2013).

Other work fails to support the predictions of FUL. Bonte, Mitterer, Zellagui, Poelmans, and Blomert (2005) reported smaller ERPs in response to a coronal-to-labial change compared to the opposite direction, but only when the non-words containing labials had a higher phonotactic probability than those containing coronals. With opposite phonotactic probabilities, this asymmetry reversed. In a series of three eye-tracking experiments, Mitterer (2011) found no evidence for asymmetric perception consistent with FUL, while a fourth experiment found an asymmetry predicted by phonotactic probability, but not FUL (but see Cornell et al., 2013). Based on this, Mitterer (2011) suggested an Optimal Perception account: Asymmetries reflect listeners' familiarity with the phonotactic probability of the input, such that listeners are biased towards accepting a frequent pattern more often than an infrequent one. Given that coronals are very frequent, predictions from this account align with those made by FUL in many cases, but based on the fundamentally different premise of language-specific experience.

To what extent the perceptual asymmetries are independent of language experience can, however, not be conclusively answered based on studies testing adult listeners with rich language experience, even more so because the majority of evidence comes from native speakers of Germanic languages. One way to address this debate is to assess whether the asymmetry is present already in prelexical infants. Based on earlier research, we can assume that infants' perception is not tuned to native consonant categories and phonotactic probabilities until after 6 months of age (cf. Kuhl, 2004, for an overview). Thus, early asymmetries would be independent of the extensive phonotactic experience judged necessary by the Optimal Perception account. A first piece of evidence for such an early asymmetry already exists: 6-month-old Dutch infants were able to detect the change from /pa:n/ to /ta:n/, but not vice versa (Dijkstra & Fikkert, 2011). Nonetheless, as more sensitive methods appear, age of acquisition is constantly being pushed down (e.g., Bergelson & Swingley, 2012). We built an even stronger test of the language-independent nature of such perceptual asymmetries by measuring discrimination at two early ages (4 and 6 months), in two language backgrounds with markedly different phonologies, namely Dutch and Japanese. Japanese is illuminating because, unlike Dutch, coronal is not the most frequent place of articulation for plosives (across both token and type frequency counts in content words; Tsuji, Nishikawa, & Mazuka, 2010). Therefore, coronal as the default place and as the most frequent place are not confounded. If experience-independent perceptual biases can indeed contribute to perceptual asymmetries, a coronal-labial asymmetry should be observed in infants regardless of age and language background.

2. Methods

2.1. Participants

Sixteen 4-month-old Dutch (range 3.7–4.5 months, 8 females) and sixteen 4-month-old Japanese (4.0–5.0 months, 6 females) infants, as well as sixteen 6-month-old Dutch (range 6.4–6.9 months, 10 females) and sixteen 6-month-old Japanese (range 6.1–7.0 months, 9 females) infants were included in the final sample. Dutch infants were recruited and tested in the Netherlands, and Japanese infants in Japan. All infants were healthy full-term infants, raised in monolingual native Dutch or Japanese speaking households. Caregivers gave written consent to participate.

Twenty-nine additional infants were tested but not included in the final sample because of failure to reach the habituation criterion (7 Dutch, 1 Japanese), obscured view on the infant's eyes (1 Dutch), failure to look at the screen after experiment commencement (2 Japanese), fussiness or crying (8 Dutch, 10 Japanese).

2.2. Stimuli

Stimuli involved a labial-coronal contrast in their word-medial consonant cluster (/ɔmpa-ɔnta/). In addition to the small burst and fast transitions found in word-initial plosives, e.g. /pa:n-ta:n/, our stimuli contain rich formant transitions into the nasals' place and some information in the nasal murmur. That 4.5-month-old infants are able to distinguish labial from coronal nasals in /ɔmpa-ɔnpa/ has been demonstrated previously (Jusczyk, Smolensky, & Alloco, 2002). Both sequences are phonotactically legal in both Dutch and Japanese, although the frequency of /ɔnta/ is higher than that of /ɔmpa/ in Dutch (ratio of words containing /ɔnta/ to /ɔmpa/: 7.23; based on CELEX: Baayen, Piepenbrock, & Gulikers, 1995), whereas the opposite is true in Japanese (ratio of words containing /ɔnta/ to /ɔmpa/: 0.55; Amano & Kondo, 2000). Notice that this divergence in frequency should bias Japanese and Dutch infants into opposite directions.

Multiple tokens of /ɔmpa/ and /ɔnta/ were recorded by a female native speaker of Dutch in an infant-directed register. Eight tokens per sequence were selected. These were matched on duration and vowel formant values (cf. Table 1). Five of the eight tokens of each type were used in the labial and coronal habituation lists. Test lists also contained five tokens, of which two had appeared in the habituation lists, and three were novel. This mixture of habituated and novel tokens helps exclude the possibility of dishabituation based on novel tokens alone. Four habituation lists and two test lists were created per sequence by pseudo-randomizing order of tokens. A 1-s pause was inserted between each token, and the mean list length was 14.1 s.

The visual stimulus accompanying auditory stimulus presentation was a dynamic checkerboard presented in