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Brief article

Language exposure facilitates talker learning prior to language comprehension, even in adults

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ABSTRACT

Adults show a native language advantage for talker identification, which has been interpreted as evidence that phonological knowledge mediates talker learning. However, infants also show a native language benefit for talker discrimination, suggesting that sensitivity to linguistic structure due to systematic language exposure promotes talker learning, even in the absence of functional phonological knowledge or language comprehension. We tested this hypothesis by comparing two groups of English-monolingual adults on their ability to learn English and French voices. One group resided in Montréal with regular exposure to spoken French; the other resided in Storrs, Connecticut and did not have French exposure. Montréal residents showed faster learning and better retention for the French voices compared to their Storrs-residing peers. These findings demonstrate that systematic exposure to a foreign language bolsters talker learning in that language, expanding the gradient effect of language experience on talker learning to perceptual learning that precedes sentence comprehension.

1. Introduction

The speech signal conveys both the talker's communicative message and identity, with a growing body of evidence indicating that these two components are fundamentally intertwined (Creel & Bregman, 2011). Listeners receive language comprehension benefits for familiar compared to unfamiliar talkers (e.g., Clarke & Garrett, 2004; Nygaard, Sommers, & Pisoni, 1994; Theodore & Miller, 2010), demonstrating that experience with a talker's voice facilitates recovery of the communicative message. Listeners also show a talker learning advantage for native compared to nonnative talkers (e.g., Goggin, Thompson, Strube, & Simental, 1991; Johnson, Westrek, Nazzi, & Cutler, 2011; Winters, Levi, & Pisoni, 2008), suggesting that access to the communicative message likewise facilitates talker identification. The goal of the current work is to contribute to a theoretical understanding of how language experience influences talker identification.

The literature confirms a strong role for phonological processing in mediating talker identification. Phonological processing refers to knowledge of the abstract sound structure of a specific language. Studies of adult second-language learners suggest that a gradient improvement in phonological knowledge of a language can improve talker identification in that language (Köster & Schiller, 1997; Sullivan & Schlichting, 2000). In addition, Bregman and Creel (2014) found that early learners of a second language were more skilled than late learners with respect to talker learning in their second language. Converging evidence that phonological competence influences talker identification comes from studies of adults with dyslexia, who demonstrate poor talker identification even in their native language, with performance related to their degree of phonological deficit (Perrachione, Del Tufo, & Gabrieli, 2011).

However, developmental research suggests that functional phonological knowledge or language comprehension are not the sole aspects of language experience that influence talker identification. Newborns can recognize their mother's voice over another female's voice (e.g., DeCasper & Fifer, 1980). Moreover, 7-month-old infants who have yet to develop a mature phonological system already show some native language benefit for talker discrimination (Johnson et al., 2011). These findings suggest that infants' sensitivity to the structure of their native language – which precedes phonological competence and word comprehension – may promote talker learning. This leads to the hypothesis that adults with regular exposure to a nonnative language may also promote a native-like benefit for talker learning in that nonnative language. Indeed, one notable exception to the native language

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benefit for talker identification was reported by Johnson et al. (2011). They found that English-monolingual adults living in Toronto performed equally well at identifying voices in English and in Italian and hypothesized that this could be an effect of language exposure given the large Italian community in Toronto.

Here we examined whether phonological competence in a language is necessary for talker learning or, alternatively, whether having regular exposure to talkers of a novel language is sufficient. In contrast to previous studies that have shown a language familiarity effect in individuals after they have gained some expressive and receptive proficiency in the language (e.g., Köster & Schiller, 1997; Sullivan & Schlichting, 2000), here we asked whether having exposure to an unfamiliar language without gaining proficiency (à la monolinguals living in bilingual communities) could promote talker learning in that language. If exposure to nonnative acoustic–phonetic variation promotes talker-learning benefits, then listeners who overhear an unfamiliar language will show increased talker identification compared to listeners who do not overhear that language. If, however, more sophisticated functional language knowledge is needed, then both types of listeners should show similar performance on the talker-learning task.

2. Methods

2.1. Participants

Two groups of English-monolinguals were recruited from cities with different language environments: Montréal, Québec and Storrs, Connecticut. The latest census (2011) reports that 55.8% of individuals living in Montréal have some fluency in both English and French. The two languages co-exist in many cultural and social aspects in Montréal. Thus, Montréal residents have experience hearing French spoken by different talkers. In stark contrast, the latest census (2000) for Storrs, Connecticut reports that 1.3% of the population has any degree of fluency in French. Storrs is an overwhelmingly English-monolingual environment where residents have virtually no opportunity to hear French. Sampling English monolinguals residing in these two communities provides a way to control fluency in English while manipulating exposure to French. Responses to the Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007) and a questionnaire developed in our laboratory confirmed that exposure to French was as predicted by residence.

Participants from Montréal included 20 adults (18–32 years; 7 males). Participants from Storrs included 19 adults (18–27 years; 8 males). One additional participant from Storrs was excluded from analyses due to fluency in French. All acquired English from birth and lived in North American English-monolingual communities prior to residing in Montréal or Storrs. Participants rated their exposure to French on a 5-point scale (1 = never, 5 = daily). All Montréal participants reported some level of exposure to spoken French (mean = 2.65, SD = 1.18). Only 10 out of the 19 Storrs participants reported any French exposure; the French exposure rating among this subset (mean = 1.60, SD = 0.70) was significantly lower than the Montréal group [$t(28) = 2.58$, $p = .015$, $d = 0.97$]. All 20 participants in the Montréal group and 8 out of 19 in the Storrs group had received formal classroom instruction in French. Nonetheless, both groups could neither understand spoken French or converse in French, and none were able to understand the sentences presented in the experiment.

2.2. Stimuli

The auditory stimuli are described in Valji (2004). In brief, four female native speakers of Canadian-English and four female native speakers of Canadian-French were recorded producing 10 sentences in their native language. For each language, five of the sentences were used during training and test, and the remaining five were used only during test. Acoustic analyses were used to calculate mean duration, fundamental frequency (F_0), and F_0 standard deviation for each speaker. We followed methodology outlined in Johnson et al. (2011) to calculate a ratio of the variances in each of these dimensions among the English and French speakers. The within-language variability was not significantly different between the two languages for all three dimensions [($F(3,3) < 9.1$ for $\alpha = .05$ in all cases], indicating that the speakers in each language should be equally difficult to distinguish based on these acoustic parameters

Pilot tests confirmed that the English and French stimuli were equally "easy" to learn for native speakers of each language. We tested 10 native English speakers and 10 native French speakers (some were French–English bilinguals, but all were French dominant and did not learn English before the age of 10) on a talker-learning task in their native language (identical to the training phase described below). There was no difference in performance between the two groups in terms of number of blocks to reach criterion [English: $M = 3.30$, SE = .60; French: $M = 3.80$, SE = .61; $t(18) = .59$, $p > .250$; $d = .28$]. Since baseline performance for our stimuli in native-language conditions was equal across the two languages, any difference in performance across English and French language conditions can be attributed to language exposure/experience rather than stimulus properties.

2.3. Procedure

The design of this experiment was adapted from Bregman and Creel (2014). Participants were tested individually in a single, 2-h session in a sound-attenuated space. Visual stimuli were presented on a computer monitor and auditory stimuli were presented over headphones (Sony MDR-V6) at a constant, comfortable listening level. All responses were collected via button box. Testing procedures and conditions were identical across both laboratories.

Participants learned to identify four English talkers and four French talkers. These voices were associated with one of four cartoon avatars (Fig. 1). For each language, participants completed a training phase followed by a test phase (Fig. 2). Each language was tested separately, with language order counter-balanced within each location group.

The training phase provided listeners with an opportunity to learn the voice-avatar pairings. Each block consisted of 60 randomized trials (4 talkers × 5 sentences × 3 repetitions). On each trial, auditory and visual stimuli were simultaneously presented. The auditory stimulus consisted of one of the sentences. The visual stimulus was an array of the four cartoon faces in a single row, with arrangement held constant throughout the experiment. Participants were asked to indicate the identity of the voice by pressing one of four labeled buttons. Feedback was provided on each trial, with the word "Correct" or "Incorrect" appearing on the screen with the correct avatar. The next trial began after 2000 ms pause. The training block was repeated until the participant met learning criterion, defined as 85% correct talker identification within a single block (52/60 trials) or the completion of eight training blocks. The dependent measure was the number of the training blocks required to meet the learning criterion.

Following the training phase, participants were tested on their ability to retain the voice and face pairings presenting during the training phase. The test included the sentences presented during training along with novel sentences produced by the same talkers in order to assess generalization. The test phase consisted of 120 randomized trials (4 talkers × 10 sentences (5 trained and 5 novel) × 3 repetitions). As schematized in Fig. 2, procedure for the test