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Research Paper

Does the degree of linguistic experience (native versus nonnative) modulate the degree to which listeners can benefit from a delay between the onset of the maskers and the onset of the target speech?

Boaz M. Ben-David [a, b, c, d, *], Meital Avivi-Reich [a, e], Bruce A. Schneider [e]

[a] Communication, Aging and Neuropsychology Laboratory (CANlab), Baruch Ivcher School of Psychology, Interdisciplinary Center (IDC) Herzliya, PO Box 167, Herzliya, 4610101, Israel
[b] Oral Dynamics Lab, Department of Speech-Language Pathology, University of Toronto, 160-500 University Ave., Toronto, Ontario, M5G 1V7, Canada
[c] Toronto Rehabilitation Institute, 550 University Ave., Toronto, Ontario, M5G 2A2, Canada
[d] Rehabilitation Sciences Institute (RSI), University of Toronto, 160-500 University Ave., Toronto, Ontario, M5G 1V7, Canada
[e] Human Communication Laboratory, Department of Psychology, University of Toronto Mississauga, 3359 Mississauga Road N., Mississauga, Ontario, L5L 1C6, Canada

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ABSTRACT

Background noise has a greater adverse effect on word recognition when people are listening in their second language (L2) as opposed to their first language (L1). The present study investigates the extent to which linguistic experience affects the ability of L2 listeners to benefit from a delay between the onset of a masker and the onset of a word. In a previous study (Ben-David, Tse & Schneider, 2012), word recognition thresholds for young L1s were found to improve with the increase in the delay between the onset of a masker (either a stationary noise or a babble of voices) and the onset of a word. The investigators interpreted this result as reflecting the ability of L1 listeners to rapidly segregate the target words from a masker. Given stream segregation depends, in part, on top-down knowledge-driven processes, we might expect stream segregation to be more "sluggish" for L2 listeners than for L1 listeners, especially when the masker consists of a babble of L2 voices. In the present study, we compared the ability of native English speakers to those who had either recent or long-term immersion in English as L2, to benefit from a delay between masker onset and word onset for English words. Results show that thresholds were higher for the two L2s groups than for the L1s. However, the rate at which word recognition improved with word-onset delay was unaffected by linguistic status, both when words were presented in noise, and in babble. Hence, for young listeners, stream segregation appears to be independent of linguistic status, suggesting that bottom-up sensory mechanisms play a large role in stream segregation in this paradigm. The implications of a failure of older L1 listeners (in Ben-David et al.) to benefit from a word-onset delay when the masker is a babble of voices are discussed.

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1. Introduction

Daily communication often occurs in noisy environments (e.g., classrooms, restaurants, stores, offices), where competing sound sources could interfere with one's ability to communicate effectively. The presence of competing sound sources is especially challenging to those operating in their second language (L2, Bradlow and Bent, 2002). As a result, everyday noisy situations present more of a barrier to communication and social interaction for this group than they do for native speakers of a language (L1).

One possible reason for the difficulties L2 listeners experience in the noisy backgrounds characteristic of everyday life, is that it may be more difficult for them than for L1 listeners to segregate the speech stream from the acoustic background. To recognize and comprehend speech in noise, listeners have to be able to parse the auditory scene into its component sound sources (stream segregation, Bregman, 1990), so that they can focus their attention on the target speech. Successful segregation of the acoustic input into separate auditory streams will improve speech perception in the

* Corresponding author. Communication, Aging and Neuropsychology Laboratory (CANlab), Baruch Ivcher School of Psychology, Interdisciplinary Center (IDC) Herzliya, PO Box 167, Herzliya, 4610101, Israel.
E-mail address: boaz.ben.david@idc.ac.il (B.M. Ben-David).

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presence of competing sound sources, leading to a reduction in the interference caused by the maskers, commonly referred to as "release from masking" (e.g., Brungart et al., 2001; Durlach et al., 2003). However, stream segregation is not achieved instantly, and the time it takes for it to develop depends both on the listener and on the stimuli used (see the seminal work by Bregman, e.g., Bregman, 1990; Bregman and Campbell, 1971).

There are a number of acoustic cues that affect the degree of stream segregation that is achieved, such as the temporal proximity of successive sounds, as well as their similarity in F_0 and spectrum. In general, the greater the acoustic dissimilarity between the target and the competing sounds, the easier it is to perceptually segregate the streams. Beyond these acoustic, or bottom-up, factors, there are a number of top-down assisting cues, such as attention, expectations, and prior exposure which could also affect streaming (e.g., Ragert et al., 2014; Shinn-Cunningham and Best, 2008). One possible reason for the difficulties L2 listeners experience in noisy backgrounds is that their ability to parse the auditory scene is either less efficient and/or slower in their L2 than in their L1, because the top-down processes supporting word recognition are not as well developed in their L2 as in their L1.

In a previous study (Ben-David et al., 2012), we investigated the degree to which the ability of L1 listeners to identify a single word masked by a competing sound source improved with increase in the delay between the onset of the masker and the onset of a word. In young L1 listeners, word identification was found to improve as the delay between the onset of the masker and word onset increased (for delays up to approximately 600 ms) for two types of maskers: a stationary broadband noise, and a babble of voices. However, the pattern of results differed for older L1 listeners. Although older L1 listeners were able to benefit from a delay between masker onset and word onset when the masker was stationary speech-spectrum noise, when the competitor was a babble masker, they were not able to benefit from this cue, even when the onset of the speech target followed babble onset by 1.1 s Ben-David et al. (2012) interpreted this pattern of results as indicating that the acoustic and phonetic similarity between the babble of voices and the words to-be-identified interfered with stream segregation more in older than in young adults.

1.1. Linguistic experience and spoken word identification

The present study investigated whether young L2s might also experience greater interference when listening to speech presented in babble than in noise. In these listeners, we would expect their L2 lexicon to be less well established than their L1 lexicon. Hence, access to the meaning of a word might be slowed in L2 compared to L1. In addition, the babble masker could initiate activity in both L1 and L2 lexicons, making it more difficult to segregate the target word from the background babble when listening to L2 words. This simultaneous activation might slow access to the target lexicon, and increase the competition between lexical candidates. We would also expect the babble to be a more effective masker the less fluent the listeners were in their L2. Hence, there are reasons to expect stream segregation to be more difficult when listening for L2 words in the presence of a babble of voices, than it would be when listening for L1 words in the same babble of voices (for a more complete discussion of these issues, see Avivi-Reich et al., 2014).

There are a number of reasons why we might expect word identification to be poorer and slower in L2 listeners than in L1 listeners, and for L2 listeners' performance to be more sensitive to the nature of the competing sounds than their L1 counterparts. Previous studies have shown that when asked to listen to L2 speech in a noisy environment, L2 listeners require substantially more favorable signal-to-noise ratios than L1 listeners. For example, Nakamura and Gordon-Salant (2011) found that young native-Japanese listeners had significantly poorer English speech perception ability than native-English listeners, in both quiet and noise. The psychometric function for the native-Japanese listeners was shifted by 3–4 dB SNR from that of the native-English listeners. The difficulties experienced by L2 listeners may be the result of a reduced ability to make fine phonemic discriminations in L2 and/or to make use of language-specific cues (for a review, see Garcia et al., 2010). The degree of threshold elevation for L2 relative to L1 listeners has been found to be affected by several factors. These include, but are not limited to, the age at which they were exposed to L2, the duration of exposure to L2, the listener's individual vocabulary size and knowledge of the grammatical structure of L2, as well as extent of L2 use. It is important to note that, even in adulthood, L2's acoustic-phonetic characteristics may not be fully acquired (e.g. Florentine, 1985; Mayo et al., 1997). This might result in a reduced ability to discriminate fine phonemic information (Bialystok and Luk, 2012; Garcia Lecumberri et al., 2010), which is crucial for successful speech perception (Bradlow and Pisoni, 1999; Meador et al., 2000).

Failing to identify sounds as different phonemes in L2, could lead to an activation of additional lexical candidates as the word unfolds in time (Weber and Cutler, 2004). The additional lexical candidates could be either: (1) Intra-lingual lexical candidates, due to inefficient phonological processing or a phonemic confusion in L2; or (2) Inter-lingual lexical candidates, due to concurrent activation of words in both L1 and L2 (FitzPatrick and Indefrey, 2009; Spivey and Martin, 1999; Chambers and Cooke, 2009). In other words, those who are competent in more than a single language are likely to experience much greater competition because of simultaneous activation across the languages. For example, Hebrew does not distinguish between short and long vowels as English does. Thus, native-Hebrew listeners might activate words starting with/mee/as well as/mi/while listening to the English word/mint/unfolds. In addition, the initial sounds in the word/mint/may activate lexical candidates in Hebrew as well (e.g.,/mi.ta/, bed in Hebrew). In the case described, the listener will be forced to face a larger competition for the activation of the target word spoken in his/her L2, than a native-English listener will face. Hence, L2 listeners are likely to experience additional cross-language interference due to the activation of lexical processes in more than a single language (e.g., Weber and Cutler, 2004).

In summary, L2 listeners face difficulties with lexical access and competition, have smaller vocabulary size (Portocarrero et al., 2007) and poorer phonemic discrimination in L2 (Bialystok and Luk, 2012). The lesser L2 experience and the greater competition are possible sources for the more preferable signal-to-noise-ratios (SNRs) that L2 listeners require in order to successfully recognize speech in noise (Ezzatian et al., 2010). Indeed, it has been found that L2 listeners achieve lower scores than native listeners on a number of speech recognition measures (Bradlow and Bent, 2002; Bradlow and Pisoni, 1999; Cooke et al., 2008; Mayo et al., 1997; Meador et al., 2000; Rogers and Lopez, 2008; Ezzatian et al., 2010). L2 listeners also tend to be slower than L1 listeners, even at the level of identifying single words in L2 (e.g., Scarborough et al., 1984; FitzPatrick and Indefrey, 2009), as well as less confident (Schulpen et al., 2003). All of these factors are likely to increase the signal-to-noise ratio (SNR) required to recognize and comprehend words. We may conclude that, in the case of L2 listeners, it is reasonable to assume that the difficulties they experience in L2 environments are due to the fact their L2 lexical processes may not be as completely instantiated and differentiated from the lexical processes that are usually invoked when listening in their L1 (Kroll and Steward, 1994).

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