Come again? A multi-site reexamination of the 'native advantage' in adverse listening conditions

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Study to be replicated and justification

Adverse listening conditions, such as a noisy room, can make understanding speech difficult. This occurs because less intense regions of the speech signal can be masked and rendered unintelligible by extraneous noise in the acoustic environment (Helfer & Wilber, 1990). As a result, speech perception in noise is more difficult due to decreased acoustic and linguistic cues available to the listener and becomes increasingly more difficult as the signal to noise ratio (SNR) decreases. This is particularly true when listening in one's non-native language (referred to in the literature as the 'native advantage'). Three decades of research on speech perception in adverse conditions consistently shows that listening in background noise poses more difficulties for bilinguals in their L2 than for monolinguals (See Scharenborg & Os, 2019 for an overview). Furthermore, some studies show that the 'native advantage' persists even when one is highly proficient in the L2 and learns it at an early age (See Mayo, Florentine, & Buus, 1997; Meador, Flege, & Mackay, 2000; Rogers, Lister, Febo, Besing, & Abrams, 2006, among others), including simultaneous bilinguals with two L1's (Mayo et al., 1997; Shi, 2010).

According to Scharenborg & Os (2019), the 'native advantage' results from 'imperfect knowledge' of the L2. This explanation seems plausible for late learners, but cannot explain the apparent difficulties of early sequential and simultaneous bilinguals that are proficient in both languages. A recent study by Reetzke, Lam, Xie, Sheng, & Chandrasekaran (2016) finds that simultaneous bilingual children exhibit comparable difficulties perceiving speech in noise as age-matched monolingual peers. Thus, contrary to initial findings, the 'native advantage' cited in the literature may also include individuals with multiple native languages.

What, then, can explain the simultaneous and early bilinguals' difficulties cited in the early studies? One possibility is type-I error. In other words, the early studies on bilingual speech perception in noise may present false-positive results. Type-I errors are common in studies with low power; studies with small sample sizes are virtually always underpowered. The investigations in question include samples ranging from 3 to 18 participants per group. We believe that the current assessment of the 'native advantage' is incomplete with regard to simultaneous and early bilingual adults. Thus, the question we intend to address with our replication is the following: Do simultaneous and early sequential bilingual adults have more difficulty perceiving speech in noise than monolinguals? We propose a multi-site replication of Reetzke et al. (2016).

Type of replication

We will complete a close replication of the Reetzke et al. (2016) study, with several minor differences. The theoretical/conceptual framework is the same. Our research questions/hypotheses also parallel those of Reetzke et al. (2016), with slight differences due to the population of interest. The research design is the same, as are the procedures we will use for presenting stimuli and coding the listening task. We will use the same stimuli, if possible, or recreate them using similar equipment. The participants' profile is slightly different with regard to the Reetzke et al. (2016) study. Specifically, we are interested in adult bilinguals, both simultaneous and early sequential. We will also employ most of the same analytic strategies, though we will use a Bayesian framework. The primary differences between our study and that of Reetzke et al. (2016) deal with the population of interest and the modality of the stimuli, which we describe in the following section.

Variable modification

With regard to variable modification, our study will differ from that of Reetzke et al. (2016) in two ways. First, we will recruit a participant sample of adult Spanish-English bilinguals, as opposed to Spanish-English simultaneous bilingual children. The rationale for expanding the participant pool to adults is straightforward. We want to test the 'native advantage' attested in the literature with a comparable population (adults) and an adequate sample size. Thus far, the only studies showing a monolingual advantage with regard to simultaneous/early bilinguals have included small samples of adults. Thus, we believe this decision more closely aligns our study with the previous investigations, which have focused on bilinguals at or near the end state of their language development (e.g., Mayo et al., 1997; Meador et al., 2000; Rogers et al., 2006, among others). In the same vein, we will extend the findings from Reetzke et al. (2016) to include early sequential bilinguals. In line with the previous research, we operationalize early bilinguals as individuals that have been exposed to their L2 at or before the age of 6. Importantly, we will still include simultaneous bilinguals as part of our sample. Second, we will omit one of the conditions used in Reetzke et al. (2016), the audio-visual condition. Previous research on speech perception in noise finds that listening when audio and visual information are both available results in higher accuracy than when only auditory information is presented. Our study is concerned with speech perception in noise in the most difficult listening conditions, thus we believe this condition would be redundant in our study.

In sum, our replication of Reetzke et al. (2016) includes two subtle modifications. Our *group* factor focuses on adults and includes three levels rather than two (monolingual control, simultaneous bilingual, early sequential bilingual) and we do not include a *modality* factor (only auditory stimuli).

Design and availability of materials

The original materials from Reetzke et al. (2016) are not publicly available. We are in contact with the corresponding author in order to obtain the original materials. At the time of writing this proposal, the corresponding author is looking for the sound files. In the case that we are not able to obtain the original materials, we will recreate them using professional recording equipment. The process of recreating the stimuli is well-documented in the manuscript and appears to be straightforward.

Analysis

Statistical analyses

Our primary analysis will mirror that of the original study. Specifically, the outcome variable of Reetzke et al. (2016) was the number of correct responses from a speech perception in noise task. Participants heard Basic English Lexicon (BEL) sentences (e.g., “The hot sun warmed the ground”) with two masker types (2-speaker babble and pink noise) at SNRs of -16, -12, -8, -4, -2, and 0. The data were analyzed using mixed effects logistic regression models (correct responses coded as ‘1’) with masker-type and signal to noise ratio as fixed effects (signal to noise was a continuous variable). We will use the same analytic strategy as Reetzke et al. (2016) under a Bayesian framework.

Sample size

The Reetzke et al. (2016) study included two groups of participants, monolinguals (n = 12) and simultaneous bilinguals (n = 12). This sample size parallels those of the most closely related investigations (Mayo et al., 1997; Meador et al., 2000; Rogers et al., 2006). In order to approximate the minimum sample size for our study, we estimated the effect size from the Rogers et al. (2006) study in the most difficult listening condition (SNR = -6). This study was selected because the analytic strategy more closely resembles that of Reetzke et al. (2016). We calculated Cohen's D to be 1.38 (CI: 0.54, 2.22). Given the wide CI, we used the lower-bound of this estimate to approximate a conservative sample size of approximately 55 participants per group at 80% power.

Other differences

Our intention is that this replication be a large(r) scale, multi-site replication, including research teams from across the United States. Each team would collect data independently, following the same procedures detailed in a forthcoming pre-registration. The aforementioned statistical analysis would include the pooled sample from all labs. Additionally, we will investigate the 'native advantage' effect using Bayesian meta-analytic techniques. The corresponding author of the present proposal has previous experience managing multi-site collaborations (See https://many-speech-analyses.github.io for an example). At this time, three additional research teams have expressed interest in participating.

Impact

The general claim resulting from the speech perception in noise research is that bilingual individuals, in comparison with monolinguals, have more difficulties with speech perception when the acoustic environment includes extraneous noise, which, in our estimation, is nearly all the time. The extant literature sheds doubt on this claim, particularly regarding simultaneous and early sequential bilinguals. Thus, currently there is a discourse supporting a bilingual disadvantage that may not be warranted. We believe that a large-scale replication of Reetzke et al. (2016) can shed light on the topic, furthering our knowledge of both bilingualism and speech perception in noise.

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