Study Title: **Comparing central auditory processing performance in bilinguals using L1 vs. L2 materials**

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Study Protocool

The proposed study is a repeated measures experimental design in which participants will complete prescreening measures and APD tests in both English (L2) and Spanish (L1). Participants' performance on APD tests will be compared between L1 and L2 to determine if the language used in the test materials impacts auditory processing performance.

Upon arrival participants will complete the consent process in which the PI will describe in detail all study procedures, risks and benefits of the study, and the lack of negative consequences should the participant choose to withdraw from the study or cease participation during data collection. Once the consent form has been signed, the participant will complete a basic hearing evaluation to ensure all inclusion criteria are met. This will include:

- Otoscopy - to ensure normal external ear anatomy and no visual abnormalities, infection, or damage are present in the external ear or eardrum
- Tympanometry - to assess middle ear health and function
- Air and bone conduction - to assess hearing sensitivity across a range of frequencies (i.e., octave frequencies from 250-8000 Hz)
- Speech recognition threshold (SRT) - to determine the lowest level at which the participant can recognize and repeat a two-syllable word accurately

If during the hearing evaluation a hearing loss is found, the participant will be appropriately counseled regarding the hearing loss and referred for diagnostic testing. These individuals will not qualify to participate in this study.

Language proficiency in both Spanish and English will be assessed via questionnaire and an online proficiency test offered by Transparent Language (https://www.transparent.com/learn-spanish/proficiency-test.html). These proficiency tests will assess grammar, vocabulary, and reading comprehension in each language. To be considered proficient in a given language, participants must score above 80% on the assessment (Mendel & Widner, 2016).

If a participant meets all inclusion criteria (normal results for all above-mentioned tests and below-specified demographics), auditory processing tests will be completed. Each participant will be tested twice, once in Spanish and once in English, using dichotic digits, competing words, and competing sentences (scoring sheets included). Descriptions of these tests are as follows:

- Dichotic digits. This test is a binaural integration task to assess the patient's ability to integrate information being presented to both ears. During this test, the participant will be presented with four numbers (1-10 excluding 7), two in each ear simultaneously. The participant will be asked to repeat all four numbers; the order of repetition is not important.
- Dichotic word listening test (DWLT). During this test, two words are presented, one in each ear. The participant is instructed to repeat the word presented at the target ear (specified in test instructions), while they ignore the word in the opposite ear. This is an assessment of the participant's ability to separate relevant information from unwanted, distractor information. The word presented in the target ear will be presented at a lower presentation level than the word presented in the opposite ear.

- Synthetic sentence identification (SSI) test. During this test, two complete sentences are presented, one in each ear. The participant is instructed to only repeat the sentence presented at the target ear (specified in test instructions), while they ignore the sentence in the opposite ear. The sentence in the target ear is presented at 35 dB SL, while the ignored sentence is presented at 50 dB SL. This assesses the participant's ability to separate information coming into both ears and the ability to ignore unwanted information.

The presentation of the Spanish and English test materials will be counterbalanced across participants to minimize fatigue and practice effects. Following completion of tests, the test results will be discussed with the patient. If any indication of hearing loss or auditory processing deficits are identified, the participant will be notified and appropriate recommendations for more thorough evaluations and treatment will be provided.

Data Analysis

Mixed linear regression models will be used to evaluate performance differences between L1 and L2 on APD assessments. Post-hoc adjustments will be used to correct for multiple comparisons. Correlations will also be conducted to investigate relationships between auditory processing performance and demographic variables including language proficiency.

Based on the proposed analyses, an a priori power analysis was conducted to estimate the required sample size. The power analysis (t-test estimates, 2-tailed, $\alpha = 0.05$, power = 0.90; G*Power 3.1; Faul et al., 2007) revealed a sample size of 19 participants would be sufficient to detect large effect sizes ($d = 0.8$), similar effects as reported in studies using similar paradigms (Desjardins et al., 2019; Lopez et al., 1997).