



**EFFECTS OF AUDITORY DISTRACTORS ON SPEECH RECOGNITION AND LISTENING EFFORT IN ADULTS**

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The influence of task difficulty on cognitive load is often evaluated using measures of speech recognition and listening effort. In general, the addition of competing noise increases task difficulty, resulting in degradation of speech recognition and increased effortful listening (Peelle, 2018). In addition to increased task difficulty due to noise, the presence of a novel or unexpected stimulus can cause an involuntary orienting of attention away from the auditory object of interest (Cusack et al., 2004; Haywood & Roberts, 2010). This auditory distraction has the potential to cause challenges in various listening environments.

Lavie's perceptual load theory (PLT) suggests that the remainder of the listener's cognitive resources (i.e., those not devoted to the primary task) are used to automatically process task-irrelevant information (i.e., distractors; Lavie, 1995). Therefore, in listening environments with competing noise, PLT would suggest that the listener would be less susceptible to distraction because fewer additional processing resources remain available to process extraneous, potentially distracting, stimuli. The opposite is also true - for a primary task requiring a lower processing load (i.e., an easy task), adults are more likely to be distracted by novel stimuli because they have more unused cognitive resources (Fairnie et al., 2016).

The purpose of this study was to measure the effect of auditory distraction on speech recognition and listening effort by adding auditory distractions to previously established measures of speech recognition and listening effort (Gustafson et al., 2014; McGarrigle et al., 2019). Based on PLT, we hypothesized that distractors would show greater effects on speech recognition and listening effort in a low-load listening condition (e.g., quiet) compared to a high-load condition (e.g., competing noise).

**Methods:**

To date, 10 adults have participated; however, we expect to test a total of 15 participants. Participants are young-adult listeners (18-25 years) with typical hearing and no existing attention difficulties.

Target stimuli are 773 monosyllabic words, spoken by three talkers (two female; Bonino & Malley, 2019). Competing noise includes a single, recording of continuous, multi-talker babble containing simultaneous conversations between three children (one female) and two adult talkers (both female; Nagaraj et al., 2020). Auditory distractors are randomly selected from a corpus of 120 environmental sounds (e.g., throat clearing, aluminum can opening) originally recorded by Marcell et al. (2000) and trimmed to be 0.5 s in duration by Murray et al. (2006). These stimuli

were selected to reflect routine classroom listening situations where competing noise might be a child or adult talker and auditory distractions could originate from a wide variety of sources.

A custom MATLAB script is used to control the selection and presentation of stimuli as well as recording and analyses of responses. Each 25-word list of target stimuli is generated by randomly selecting 25 of the 773 words, talker is also randomly selected for each of the 25 words within the list. To decrease expectation of the distractor's onset and to allow for attention to be involuntarily shifted toward the distractor, timing of distractor presentation is randomly jittered between 0 and 0.25 s preceding the onset of the target stimulus. Responses are recorded using a Shure SM58 unidirectional microphone, placed on a table microphone stand approximately 8 in away from the participants' mouth. The participant's response to each target stimulus is saved as a .wav file and used to measure the VRT.

Target stimuli are presented to the left ear at 65 dB SPL via Sennheiser HD25 headphones. Testing is conducted in quiet and in competing noise presented bilaterally at 60 dB SPL (+5 dB SNR). Participants are instructed to repeat the stimuli presented to their left ear, and to ignore any distractors. Distractors are presented at 65 dB SPL to the right ear on a random selection of 6 of 25 trials.

After a practice task conducted in quiet with no distractors, two word-lists are presented in each condition (quiet, +5 dB SNR) with no distractor present to measure baseline speech recognition and VRT performance. Experimental testing includes eight word lists, four for each condition (quiet, +5 dB SNR) with distractors present in 24% of the trials. The presentation order of the 11 word lists is pseudorandomized to avoid order effects.

Listening effort is quantified using Verbal Response Time (VRT): the time elapsed from the target word onset to the onset of the verbal response. Speech recognition is measured as the percentage of words correctly repeated.

### **Preliminary Results:**

Preliminary data (n=5) were analyzed using repeated-measures ANOVA. Word recognition scores showed a significant main effect of noise ( $F(1,4) = 10.32, p = .033$ ) and no significant main effect of distractor ( $F(1,4) = 0.52, p = .51$ ). However, the noise x distractor interaction was significant ( $F(1,4) = 11.96, p = .026$ ). Consistent with Lavie's PLT, distractors degraded speech recognition in quiet ( $p = .022$ ) but not noise ( $p = .107$ ). Verbal response times showed no significant main effect of noise ( $F(1,4) = 2.54, p = .186$ ) or noise x distractor interaction ( $F(1,4) = 1.2, p = .335$ ), but did result in a significant main effect of distractor ( $F(1,4) = 334.7, p < .001$ ). These findings show that verbal response times were longer in distractor trials than non-distractor trials – this pattern was consistent, regardless of listening in quiet or in noise.

### **Implications:**

Preliminary VRT findings are consistent with researching showing that distractors can cause attention shifts that direct cognitive resources away from the primary task, ultimately increasing the time required for task completion (Parmentier et al., 2008). When considered with our finding that speech recognition was not influenced by distractors in the presence of noise, these results suggest listeners were expending greater effort to maintain performance in the face of

distractors. Future work will implement this paradigm with child participants to improve our understanding of how distractions in classrooms might influence speech recognition and listening effort.

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<https://doi.org/10.1097/AUD.0000000000000494>