Abstract
The purpose of this study was to compare speech perception performance using a conventional surgical mask with a prototype transparent mask in audio-only and audiovisual conditions in noise. The results may have implications for individuals who are deaf or hard-of-hearing, or for non-native and non-English speakers.

Background
• Protective face masks, especially surgical masks, are essential for certain professionals to wear in their work environment, such as doctors and dentists.
• These masks present difficulties for individuals who are deaf or hard-of-hearing because the masks create a communication barrier for these individuals. The masks cover the nose and mouth areas, which some individuals with hearing loss rely on for visual cues for speech understanding. Although masks create a visual barrier, conventional paper masks have negligible effects on the acoustics of speech (Gardino, Lucks Mendel, & Atcherson, 2008).
• Individuals who are deaf or hard-of-hearing experience difficulty with speech communication if they are in noisy environments, do not use amplification or implant devices, or do not have ready access to an interpreter. Having a transparent mask available for professionals to use may be very beneficial.
• In this study, listeners' speech perception was evaluated using a prototype transparent mask.

Methods
Participants:
• Thirty (30) participants were divided into three equal groups based on severity of hearing loss (normal hearing [M = 34.9: 16.8], moderate SNHL [M = 49.6: 21.6], and severe-to-profound SNHL [M = 48.7: 17.3]).

Stimuli and Setup:
• Connected Speech Test (CST) passages were re-recorded in auditory-only and auditory-visual conditions by a male adult talker while wearing no mask (NM), a conventional paper mask (PM), and a transparent, "see-through" prototype mask (TM).
• CST stimuli were presented in the sound field at 60 dB HL with 4-Talker Babble as background noise presented at 50 dB HL.
• Fig. 1 shows the physical setup for the study as well as example video screen conditions.

Experimental Conditions (Counterbalanced):
• NMA: Audio-only no mask (Lists: 19, 20, 37, 38)
• NMAV: Audio-visual no mask (Lists: 13, 14, 47, 48)
• PMA: Audio-only paper mask (Lists: 21, 22, 1, 2)
• TMA: Audio-only transparent mask (Lists: 9, 10, 11, 12)
• TMAV: Audio-visual transparent mask (Lists: 7, 8, 29, 30)

Measures:
• Spectral and RMS level equivalence was measured across audio passages.
• The participants were instructed to say and/or sign their responses back to the researchers and their performance was scored as percent correct. All percent correct scores on the Connected Speech Test were converted to normalized arc sine units (Zwicker & Schouten, 1984) for later statistical analysis.

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Results
Spectral and RMS level equivalence was measured across the audio passages indicating that the NM passages were significantly higher than the TM and PM passages by about 2-3 dB (F(4, 15) = 6.395, p = .000). CST mean percent correct performance across conditions is shown in Fig. 2.
• Participants with normal hearing performed significantly better (p<0.001) than those with severe-to-profound hearing loss for all types of mask.
• Participants with normal hearing showed no statistically significant differences across the mask conditions.
• No significant difference in performance was found between those with normal hearing and those with moderate hearing loss for the NMA, NMAV, and TMAV conditions suggesting that the addition of visual cues for those with better hearing did not have a great impact on speech perception performance.
• Those with moderate and severe-to-profound hearing loss showed statistically better performance in the NMAV and TMAV conditions compared to the PMA and TMA conditions (p<0.001) indicating that the presence of visual cues through the transparent mask was better than transparent mask with only auditory cues or the paper mask alone.

Discussion
Our findings in the aggregate suggest that there is an advantage of the transparent mask audio-visual (TMAV) condition over all of the audio-only conditions for listeners with hearing loss, as expected. Listeners with moderate and severe-to-profound SNHL in the transparent mask audio-visual (TMAV) condition improved 15% and 22%, respectively, compared to the transparent mask audio-only (TMA) condition. This pattern was also observed for the no mask audio-only (NMA) to no mask audio-visual (NMAV) conditions suggesting the transparent mask was not an impediment to communication.