CAN AGE RELATED DECLINES IN SENSORY PROCESSING ALTER THE NATURE OF MULTISENSORY INTEGRATION IN THE PRESENCE OF ENERGETIC AND INFORMATIONAL MASKING?

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1. INTRODUCTION

Age-related deterioration in one's ability to comprehend speech in noise plays a primary role in the difficulties many older adults experience daily when communicating (CHABA, 1988). Listeners may intuitively look at the talker when experiencing difficulties in order to receive additional visual information when hearing is difficult. Visual cues have been found to facilitate speech perception when the acoustic information is incomplete or ambiguous (Grant and Braida, 1991; Helfer and Freyman, 2005). Previous studies have shown that as the auditory speech information becomes increasingly weak or distorted, the greater the gain exhibited from additional visual cues. According to this phenomenon, which is also referred to as "inverse effectiveness" (Macleod and Summerfield, 1990), it is reasonable to expect older adults to utilize visual cues accompanying the acoustic input when listening is difficult and the talker is visible, and possibly benefit more than young adults from these visual cues. However, the additional visual information provided by the face of the talker requires efficient integration of audio-visual information if this visual information is to enhance speech understanding. Previous studies provide evidence indicating that older adults experience both auditory and visual deterioration in perception of speech information with age (Campbell et al., 2007; CHABA, 1998). Age related declines in sensory processing, both auditory and visual, could alter the nature of multisensory integration. While some studies found no age difference in the ability to benefit from combining auditory and visual speech information (Sommers et al., 2005), others did find significant age differences (Campbell et al., 2007).It is possible that the degree of benefit obtained from visual cues might depend on the type of competing sounds that are present. All sounds, both noise and speech, activates regions along the basilar membrane which energetically interferes with the encoding of the target speech signal. This interference, which takes place whenever there is overlapping energy from several sound sources, is commonly referred to as peripheral or energetic masking. In addition, competing speech from one or more talkers is likely to interfere with the linguistic and semantic processing of the target speech. This interference which is believed to be taking place at more central levels in the auditory pathway (Schneider et al., 2007), is known as informational masking. The benefit provided by visual cues may depend on the degree of energetic and informational masking produced by competing sound sources, which, in turn, may be affected by aging. This study attempts to address the possible effects of age and type of masker on auditory visual speech perception.

2. METHOD

Twenty-four younger and 24 older adults with normal hearing and normal or corrected vision participated in these experiments. All participants were native English speakers in general good health and with no known neurological or cognitive deficits. Prior to the experimental session, participants' vision and hearing was tested as well as their English proficiency using a vocabulary test (Mill-Hill) and a reading comprehension assignment.

The participants were asked to repeat semantically anomalous target sentences with 3 keywords (e.g., "A *house* should *dash* to the *bowl*,") (Helfer, 1997, key words italicized) spoken by a female talker. These sentences are presented against either two-talker anomalous speech (two females), 12-talker babble, or speech-spectrum noise. The target sentences and the background noise are played over loudspeakers which are placed symmetrically in the frontal azimuthal plane at 45 degree angles to the left and right of the listener in a sound-treated booth. Masker signal started 1 second before the onset of the target sentence and continued up to the target sentence offset. Half of the sentences are played when the target sentences are accompanied by videos presenting the talker (Audiovisual); the other half are played over loudspeakers only (Audio). The entire face of the talker is presented to the participant at a natural size. The talker used for this study is a professional actress which was instructed to minimize facial expression to avoid possible bias. Each masker type and condition combination is played at four Signal to Noise Ratios (SNR) levels; and for each individual, the dB SNR corresponding to his or her 50%-correct performance threshold is computed from their individual psychometric functions along with the functions' slopes.

3. RESULTS

The results presented here are preliminary results based on 12 younger and 12 older adults who have completed the study.

Figure 1 presents the thresholds in dB SNR corresponding to 50% correct word-repetition in the audio only condition. This figure suggests that younger and older adults have comparable thresholds in noise but that older adults have higher thresholds than younger adults when the masker is either babble or speech. An ANOVA found significant main effects of masker and age along with a significant interaction between the two.

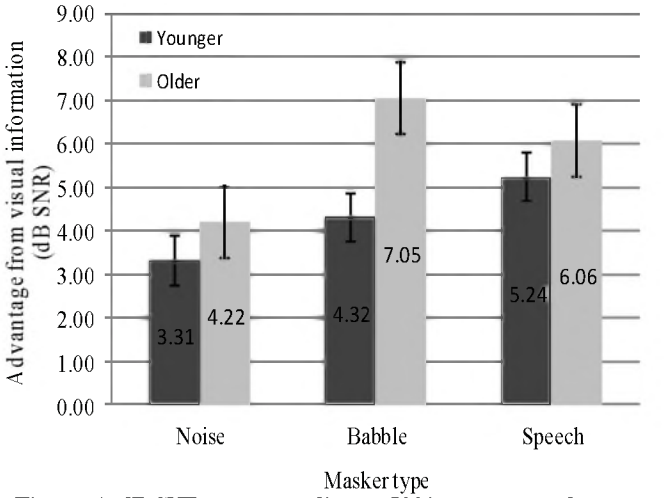

Figure. 1. dB SNR corresponding to 50% correct word-repetition as a function of masker type for younger and older adults in the auditory only condition.

Figure 2 presents the difference in dB SNR thresholds between the audio-visual condition and the audio only condition. This figure indicates that older adults receive greater benefit from available visual information than do younger adults. Indeed the performance in the audio-visual conditions of older adults is virtually equivalent to that of younger adults. While younger adults seem to increasingly benefit from visual cues as the informational masking increases, older adults seem to benefit the most when listening with in babble background noise.

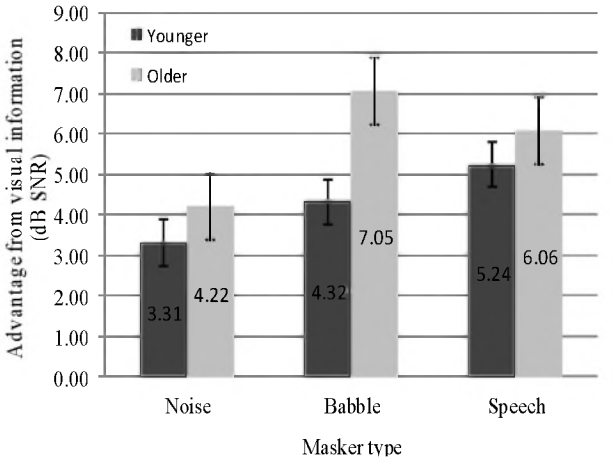

Figure. 2. The advantage in dB SNR (audio only minus audiovisual 50% correct word- repetition threshold) as a function of masker type for younger and older adults.

4. DISCUSSION

A previous study by Helfer and Freyman (2005) investigated the effect of additional visual speech information on the ability to correctly repeat sentences in the presence of either noise or competing speech in young adults. The results of this study showed substantial benefit from visual cues when repeating key word from semantically-meaningful sentences. We wanted to see whether the degree of benefit would be similar for sentences with no contextual support and whether there were age differences in the extent to which visual information facilitated release from masking in the presence of three different levels of informational and energetic interference. Comparing the present results to those of Helfer and Freyman (2005) imply that while the presence of contextual support does not affect the advantage from additional visual information in the presence of background noise, context does seem to increase the advantage in the presence of competing speech. In addition, the present results demonstrate age related differences in the use of visual cues based on masker type. The implications of these age-related differences will be discussed at the meeting.

REFERENCES

Campbell, M., Preminger, J.E., & Ziegler, C.H. (2007). The effect of age on visual enhancement in adults with hearing loss. *Journal of the Academy of Rehabilitative Audiology* , 40, 11 – 32.

CHABA. (1988). Speech understanding and aging. *The Journal of the Acoustical Society of America*, 83, 859 – 895.

Grant, K.W., & Braida, L.D. (1991). Evaluating the articulation index for auditory-visual input. *The Journal of the Acoustical Society of America*, 103, 2677 – 2690.

Helfer, K. S. (1997). Auditory and auditory-visual perception of clear and conversational speech.*Journal of Speech Language and Hearing Research, 40(2),* 432-443.

Helfer, K.S., & Freyman, R.L. (2005). The role of visual speech cues in reducing energetic and informational masking. *Journal of the Acoustical Society of America*. 117, 842–849.

Helfer, K.S., & Freyman, R.L.(2008). Aging and speech-on-speech masking. *Ear and Hearing*. 29, 87–98.

Macleod, A., & Summerfield, Q. (1990). A procedure for measuring auditory and audiovisual speech-reception thresholds for sentences in noise: Rationale, evaluation, and recommendations for use. *British Journal of Audiology*, 24(1), 29 – 43.

Schneider, B.A., Li, L.,& Daneman, M. (2007). How competing speech interferes with speech comprehension in everyday listening situations. *Journal of the American Academy of Audiology*. 18, 559–572.

Sommers, M. S., Tye-Murray, N., & Spehar, B. (2005). Auditory-visual speech perception and auditory-visual enhancement in normal-hearing younger and older adults. *Ear and Hearing* , 26, 263 – 275.

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