IS THE INFLUENCE OF AUDITORY TRAINING ON BEHAVIORAL AND ELECTROPHYSIOLOGICAL MEASURES OF TEMPORAL RESOLUTION DIFFERENT IN YOUNGER AND OLDER ADULTS?

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Abstract

The deterioration in the ability to process rapid changes in auditory input may play a primary role in the difficulty many older listeners experience perceiving speech. In young adults, perceptual skills have been found to improve with practice. However, there is very little information on the degree to which practice improves performance on perceptual tasks in older adults. Younger and older adults were trained for 10 sequential 1-hour sessions on a between-channel gap detection- task (a gap between 2-kHz and a 1-kHz noise bands). Performance on this task was assessed one day and one month after the last training session. We also tested the extent to which the benefits of training generalized to other frequencies and to the untrained ear. In addition, pre- and post-training Evoked Potential Response (ERP) measures were obtained to assess cortical changes in the response to temporal gaps induced by training.

In general, perceptual skills in a number of modalities have been shown to improve with practice (e.g. Wang et al., 1995; Hauptmann and Karni, 2002). However, only a handful of studies have examined the effects of training in auditory perception, with the majority of them focused on improving spectral processing. Because hearing is also a temporal sense, it would be useful to determine the extent to which practice can improve temporal acuity. Moreover, the few studies related to the effects of training on temporal acuity have almost exclusively been conducted using young adults (e.g. Wright et al., 1997). Because older adults are the ones most likely to exhibit deficits in auditory temporal processing, it is of some practical importance to determine whether these deficits can be reduced by training.

The deterioration in the ability to process rapid changes in auditory input plays a primary role in the difficulty many older adults experience in perception of speech (e.g. Versfeld and Dreschler, 2002). A common task used to assess auditory acuity involves the detection of temporal gaps (gap detection, GD) in otherwise continuous sounds. In a previous study (Avivi, 2010) both younger and older participants to detect a temporal gap in a steady-state, quarter-octave band noise. This is referred to as a within-channel task because the two markers defining the gap were the same narrowband noise. In Avivi (2010) study ten older and ten younger adults completed 10 days of training detecting silent gaps in a narrow-band noise centered at 1 kHz. One day after training was completed, gap detection thresholds were measured to assess learning. Additionally, generalization to a similar task using a different frequency (2 kHz), and to between-channel gap detection where the two markers (first and second) had different center frequencies (2 kHz-1 kHz) were both tested. Retention was examined 1 month later. Thirty-six additional participants were divided into 3 control-groups, one for each condition, to determine base-line performance (no training involved).

The main conclusion of this study was that older adults can benefit just as much as young adults, if not more, from training. In both young and older adults the within-channel training generalized to a different frequency (2 kHz). However, the generalization to between-channel GD (2 kHz-1kHz) was only partial. Furthermore, generalization remained unchanged in both age groups after a month.

The findings of the previous study support the existence of significant auditory learning, even in the later stages of life, in spite of age-related changes in the auditory systems and suggest that auditory training may be able to ameliorate the degree of age-related deterioration of auditory skills. However, further investigation is required in order to determine what has been learn and whether training may also improve GD thresholds when the markers defining the gap are between channel (e.g, when the center frequencies of the bands of noise constituting the two markers fall in different auditory filters or channels).

In the current experiment, younger and older adults are being trained in a between-channel GD task (2kHz-1kHz) to determine whether or not such training will result in improved detection thresholds. It is worth noting that between-channel GD necessarily involves more central processes in the sense that the task cannot be accomplished without the integration of information coming from two different channels. Between-channel GD is also more likely to be related to speech perception than within-channel GD (e.g, some phonetic distinctions such as between /b/ and /d/ are based on the duration of the stop before activating the vocal cords). To determine the contribution of cortical processes in training, pre- and post-training Evoked Potential Response (ERP) measures were obtained. By comparing the ERP results measured in the younger adults to those measured in the older adults we hope to better assess whether the auditory GD training affected both age groups in a similar manner.

Figure 1 illustrates both control and training conditions. In the training conditions following an ERP session, participants experienced 10 consecutive sessions of training followed by a second ERP session and a generalization session one day later. In addition, a one month follow-up session was conducted to assess retention of training effects. Figure 1 also specifies the baseline conditions measured. Note that each baseline condition involves separate groups of participants.

Training: 10 days Retention

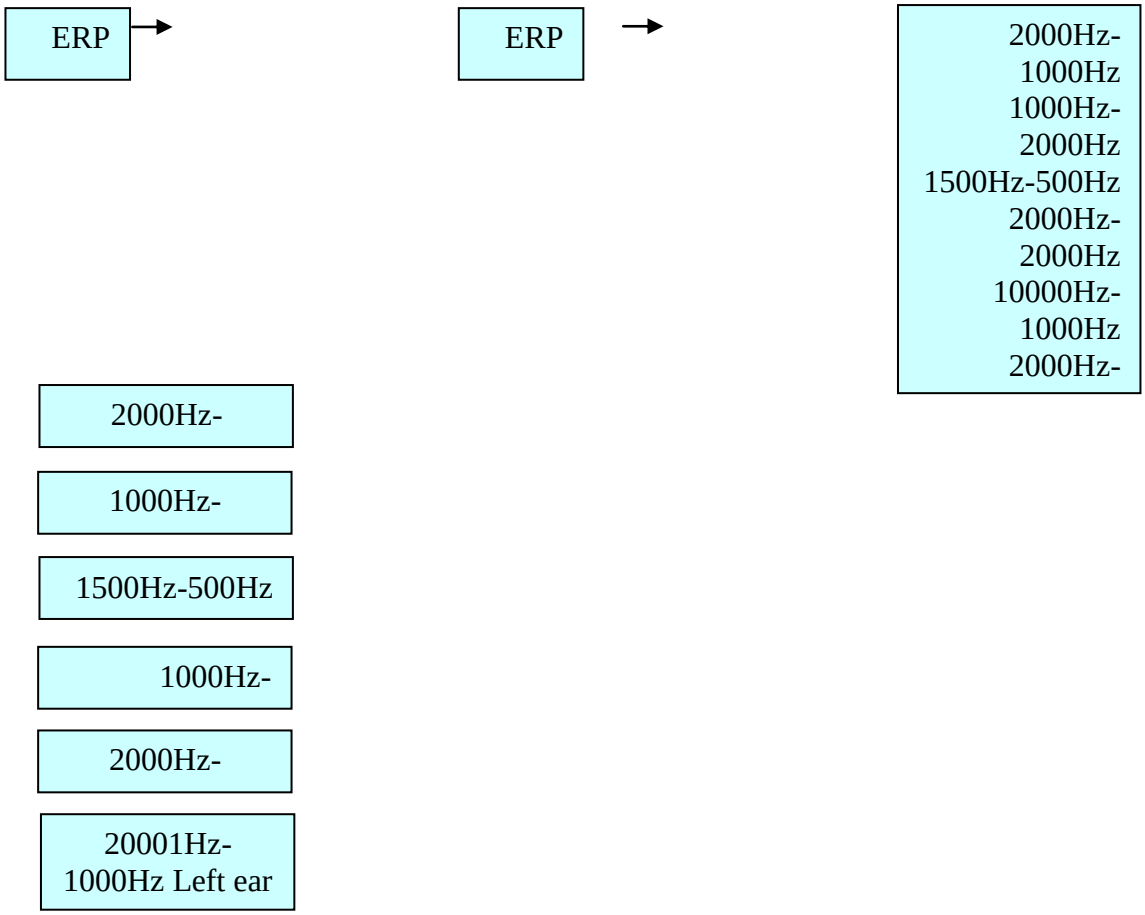

Fig. 1**.** A Schematic illustration of the procedure conducted for both control and training conditions.

Figure 2 plots GD average thresholds as a function of training day for the 11 younger adults and 3 older adults who have so far completed all sessions. These tentative results indicate that initially there is a substantial difference between younger and older adults in GD thresholds, but that thresholds improve in both age groups over training. More importantly these tentative results suggest that training reduces the age difference in between-channel GD thresholds. If this latter result holds up when the full complement of participants are tested, it suggests that training can substantially improve older adults' temporal processing abilities, which could potentially have an impact on speech perception.

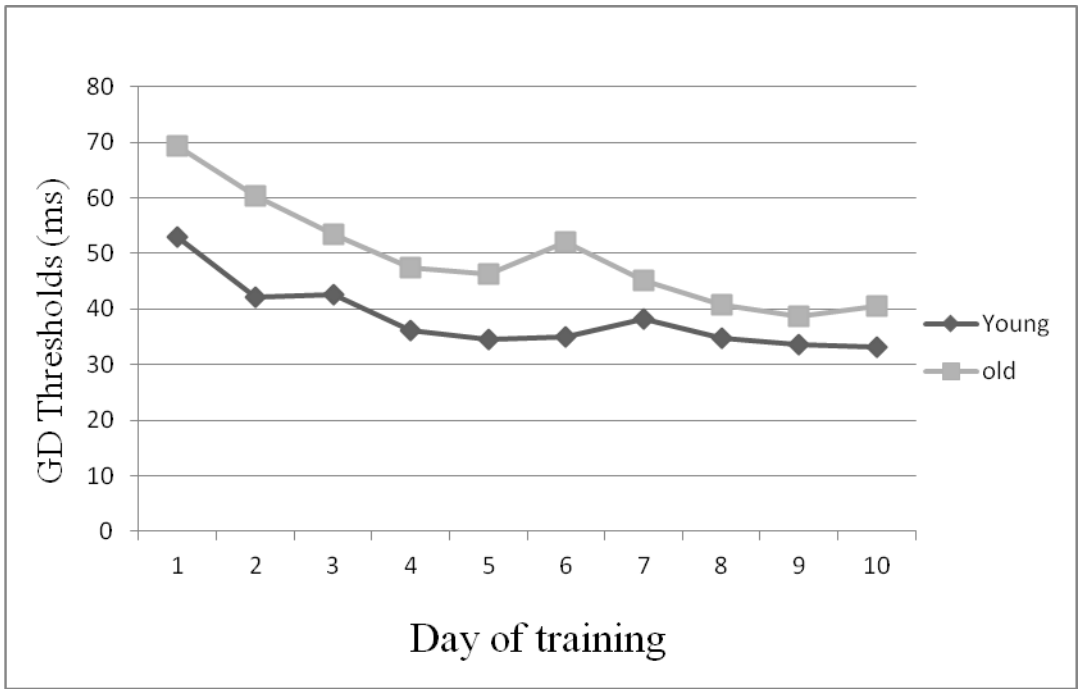

Fig. 2. Average GD thresholds (ms) calculated for each of the 10 training days with separate lines for each age group.

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References

Avivi, M. (2009). *The influence of auditory training on temporal resolution in normal hearing older adults in comparison to younger adults.* Unpublished master's thesis, Tel-Aviv University, Tel-Avivi, Israel.

Hauptmann, B. and Karni, A (2002). From priming to learn: The saturation of repetition priming and the induction of long-term memory. *Cognitive brain research, 13*, 313-322.

Versfeld, N.J. and Dreschler, W.A (2002). The relationship between the intelligibility of time-compressed speech and speech in noise in young and elderly listeners. *Journal of the Acoustical Society of America, 111(1*), 401-408.

Wang, X., Merzenich, M. M., Sameshima, K., & Jenkins, W.M. (1995). Remodeling of hand representation in adult cortex determined by a tactile stimulation. *Nature, 378*, 71-75.

Wright, B.A., Buonomano, D.V., Mahncke, H.W. and Merzenich, M.M (1997). Learning and generalization of auditory temporal-interval discrimination in humans. *Journal of Neuroscience: The Official Journal for the Society of Neuroscience, 17(10),* 3956-3963.