Classification of simple sensory events in younger and older adults: Are they different.

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In a number of listening tasks, including speech, listeners have to be able to identify and keep track of a number of different stimuli (the absolute identification problem). The following research was undertaken in an attempt to determine if younger and older adults differ in terms of their ability to identify and keep track of simple auditory stimuli as the number of stimuli increases. In the first experiment, younger and older adults were tested for their ability to identify pure tones varying only in intensity. The capacity to keep a large number of tones in mind was evaluated by increasing the number of intensities to be identified from 2 to 8 intensities. In the second experiment, the ability of younger and older adults to identify 4 tones varying in intensity was tested. After determining how well younger and older adults could identify these four tones, we added a fifth tone that differed in intensity from the original 4 by as much as 50 dB. Some theorists (Hasher & Zacks, 1988) claim that older and younger adults differ in their ability to inhibit unwanted information from entering working memory and interfering with task relevant processing. When the added tone differs significantly in intensity from the original four tones, it is likely to have a very distinct sensory representation. Therefore, any tendency for this tone to interfere with the identification of the original four could be attributed to higher-order, non-sensory processes. Adding such a tone to the set should disrupt the processing of the older adults more than that of the younger adults. Thus, in the second experiment, we expected to see the older adults' identification of the original 4 tones be more disrupted by the addition of the 5th tone than the younger adults' identification.

Experiment 1

Method

Participants

Ten younger adults (mean age = 22.30) and 10 older adults (mean age = 69.00) participated in this study. All participants conformed to the following audiometric profile: thresholds ≤ 25 dB HL for all frequencies ≤ 2 kHz (allowances were made if a single frequency was 30 dB HL); ≤ 35 dB HL at 3 kHz; and ≤ 45 dB HL at 4 kHz.

Stimuli

Eight intensities (52, 58, 64, 70, 76, 82, 88 and 94 dB SPL) of a 1-kHz tone (5 ms rise/fall time) were used in this experiment. Each tone was generated on a microcomputer and presented via headphones (TDH 49) through the Tucker/Davis System 3 sound system. The tones were presented binaurally to each participant.

Procedure

Participants completed the 2 (70, 76 dB SPL) and 4 tone (64, 70, 76, 82 dB SPL) portions of the experiment in their first session. The 6 (58, 64, 70, 76, 82, 88 dB SPL) and 8 tone conditions were completed in later independent 1 hour sessions. Listeners were informed that they would be hearing a series of tones and that they were to identify each tone with a button press. The softest tone was always identified by the left most button on the array, while the loudest tone was always identified with the right most button on the array with array size varying with number of stimuli. Intermediate tones were identified with intermediate buttons with intensity increasing from left to right.

Participants first completed a practice session consisting of 20 trials using a set size of two stimuli. Following the practice, the participant then identified tones in 50 trial blocks with the number of blocks being equivalent to the number of tones (2, 4, 6, or 8).

Feedback was provided by a 200 ms light which indicated the correct response following the participant's button press.

Results and Discussion

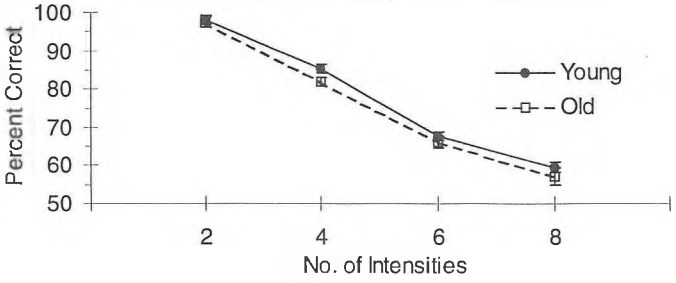
Percentage of correct responses for each tone were tabulated and an overall percentage correct score was calculated. Figure 1 graphically depicts the accuracy results of this study as a function of number of tones and age group. As can be seen in this figure, the performance of the older adults was almost identical to the performance of the younger adults. This was confirmed by a 2 age (younger vs. older) x 4 tone condition (2 vs. 4. vs. 6 vs. 8 tones) ANOVA with percent correct as the dependent measure. In this analysis, neither the main effect for age, nor the interaction between age and tone condition were significant ($F(1,18)=2.26$, $p>.15$, and $F(1,18)<1.0$, respectively).

Despite the hearing differences between younger and older adults, older adults were able to identify and keep track of a large number of tones differing only in intensity. Furthermore, while accuracy declined as the number of tones increased, younger and older adults demonstrated a similar pattern of decline. The older adults were no more influenced by the increased number of tones than were the younger adults.

Experiment 2

In Experiment 2, we first evaluated the performance of younger and older adults on a set of four 1 kHz tones (25, 30, 35, and 40 dB SPL). We then added a fifth tone. The sound pressure level of this fifth tone varied across sessions from 45 to 90 dB SPL. When the fifth tone was added to the original four, we expected performance on the original four to decrease. As the intensity separation between the added tone and the original four increases, the source of the performance decrement should become more cognitive in nature. In the first session, individuals were required to identify 4 tones. Over the course of seven more sessions, participants were required to identify 5 tones, four of which were the exact same intensities they identified in the first session and one tone was of the same frequency and duration, but differed from the original 4 in intensity. The intensity of the 5th tone ranged from 45 dB (5 dB above the highest of the original 4 tones) to 90 dB, 50 dB above the highest of the original 4 tones.

Figure 1
Percent Correct as a Function of Age and # of Intensities



Method

Participants

Ten younger adults (mean age = 21.6) and 10 older adults (mean age = 71.8) participated in this study. All participants met the same hearing criteria as was used in Experiment 1.

Stimuli

In every session, four 1-kHz tones were presented. These tones differed in intensity with the four intensities being 25, 30, 35, and 40 dB SPL. In addition, in sessions 2-7 a fifth tone was added. This tone was also a 1-kHz tone ranging in intensity from 45 to 90 dB. The exact intensities included for the 5th tone were: 45, 50, 55, 60, 70, 80, 90.

Procedure

All participants were tested in the 4 tones alone condition first. In the first session, participants completed a practice session of 40 trials and then completed 4 blocks of 50 trials each. In sessions 2-7, each participant completed a practice sequence of 50 trials followed by 5 blocks of 50 trials each.

On every trial, the computer randomly selected a tone from the set of 4 tones (5 tones in sessions 2-7) and presented that tone to the participant. The participants then pressed the button representing the tone they thought they heard. Upon the button press indicating each participant's response, a light above the correct button would flash for 200 ms.

Results and Discussion

Figure 2 presents the mean percent correct responses for younger and older adults. These data represent the percent correct on the original 4 tones only as a function of the intensity of the added 5th tone. As can be seen in this figure, adding a 5th tone disrupts the accuracy for the original 4 tones. This is true for both younger and older adults. However, there is no difference between the accuracy of the younger and the older adults. A 2 age (younger vs. older) x 8 condition (base 4 alone vs. add 45 dB vs. add 50 vs. add 55 vs. add 60 vs. add 70, vs. add 80 vs. add 90) ANOVA confirmed this finding. While adding the fifth tone did make it more difficult to identify the original four tones as indicated by a significant condition effect, $F(7,126)=34.13$, $MSE=24.73$, $p<.0001$, there was no overall age effect, $F(1,18)=.12$, $MSE=50.37$, ns, nor was there an interaction between age and condition, $F(7,126)=.55$, $MSE=24.73$, ns. Thus there is no indications that older adults are more disrupted by the addition of the fifth tone, independent of its intensity.

General Discussion

Over the course of the two experiments reported here, younger and older adults were tested for their ability to identify and keep track of tones varying only in intensity. In the first experiment, we tested the ability to identify up to 8 intensities. There was no difference between the younger and older adults in their ability to classify this number of intensities. In the second experiment, we tested the influence of added a 5th intensity on the ability to identify the same 4 tones. Adding a 5th intensity made it more difficult to identify the original 4 tones. In addition, as the intensity of the added tone increased, identification of the original 4 tones became more difficult. However, as was the case in the first experiment, younger and older adults did not differ in terms of their ability to identify the 4 tones with an added 5th tone. This was contrary to some of the theories of cognitive aging. In particular, to the extent that performance was based on cognitive factors, the inhibition hypothesis predicted that adding stimuli to the identification set would disrupt the processing of the older adults more than the processing of the younger adults, when the added stimulus was significantly different from the original four. Given these results, there is little evidence to support the notion that identification of simple auditory events changes with age. Thus, it is unlikely that the speech processing difficulties of the older adults (CHABA, 1988) are related to their ability to identify and keep track of very simple auditory events.

References

CHABA (Committee on Hearing, Bioacoustics, and Biomechanics). (1988). Speech understanding and aging. Journal of the Acoustical Society of America, 83(3), 859-895.

Hasher, L. & Zack, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. The Psychology of Learning and Motivation, 22, 193-225.

Figure 2

Percent Correct as a Function of Age and Added Intensity