Order Effects in the Measurement of Auditory Thresholds During Bimodal Divided Attention

Vishakha W. Rawool

Communication Disorders & Special Education, Bloomsburg University, Bloomsburg, PA 17815

Abstract: In this investigation, the subjects responded to warbled tones in two conditions. In the first (attention) condition, the subjects pressed a button every time they heard the tone. In the second (distraction) condition they were asked to respond to the tones by turning their heads towards the loudspeaker while solving a cardboard jigsaw puzzle as quickly as possible. The order of attention and distraction conditions was random. For seven of the subjects, the order of presentation of the stimuli was 4, 2, 1 and 0.5 kHz. For the remaining 7 subjects the order was 0.5, 1, 2 and 4 kHz. The same order was maintained in the attention and distraction conditions. Results showed a significant order, frequency and attention-distraction interaction. Distraction worsened the thresholds at the beginning of the task regardless of the frequency. When lower frequencies (0.5 and 1 kHz) were presented at the end of the task, the thresholds in the distraction and attention conditions were similar. When higher frequencies (2 and 4 kHz) were presented at the end of the task the thresholds were better in the distraction condition when compared to the attention condition.

INTRODUCTION

An earlier investigation (1) revealed that distraction produced by a visual task has adverse effects on the auditory thresholds for some stimuli, whereas it improves the thresholds for other stimuli. The order of presentation for the frequencies (0.5, 1, 2 and 4 kHz) tested in that investigation was the same for both the distraction and the attention condition for all the subjects. Thus, it appeared that the order of presentation of the stimuli as well as the test stimulus frequencies may interact in determining the effect of distraction on auditory thresholds. This investigation was designed to test the effect of order of presentation and stimulus frequency on the differences in auditory thresholds obtained in the attention and distraction conditions.

METHOD

Subjects:
Fourteen subjects in the age-range of 18 to 30 years participated in the study. They yielded normal tympanometric results.

Procedure:
All the testing was conducted in the sound field in a sound-treated booth. The 5 up/5 down procedure available in the commercially available Intelligent Visual Reinforcement Audiology (IVRA) equipment was used in determining the thresholds. In this procedure, computer generated control trials are interspersed among test trials, to get an estimate of the false alarm rate. The thresholds were determined in two test conditions which were presented in random order. In the first (attention) condition the subjects sat quietly and listened for the warble tones. They pressed a button every time they heard a tone. In the second (distraction) condition, they were asked to solve a jigsaw puzzle as quickly as possible and at the same time to respond to the tones by turning their heads towards the loudspeaker. The presentation of test and control trials, presentation of reinforcers and calculation of thresholds was achieved via the IVRA apparatus.

Stimuli:
The auditory sensitivity in sound-field was determined for 0.5, 1, 2 and 4 kHz warbled tones. For 7 of the subjects the order of presentation for frequencies was 4, 2, 1 and 0.5 kHz. For the remaining 7 subjects the order was 0.5, 1, 2 and 4 kHz. The order of frequency presentation was maintained the same through the various test conditions to control for fatigue effects. Counterbalancing with other possible various orders of presentation was not achieved due to the demand for a larger pool of subjects.

Feedback and reinforcemnet:
In all test conditions, each correct response (if the response was given within 9 seconds after stimulus onset), was reinforced by presenting one of two visual reinforcers (animated toys) located near the loudspeaker.
Analyses:
The mixed Multivariate Analyses of Variance was used to evaluate the effects of distraction, order of presentation and stimulus frequency. Further analyses were planned with the Least Significant Difference (LSD) test.

RESULTS
The mean thresholds obtained in each condition are presented in Table 1. The results revealed no main effects. The attention-distraction factor interacted with the order of presentation (p < 0.006). In addition the interaction of frequency, order of presentation and attention-distraction was also significant (p = 0.0000).

| TABLE 1. Mean auditory thresholds (dB HL) for the two test conditions. |
| Order 1 | Order 2 |
|—— |—— |—— |—— |—— |—— |
| 4 kHz | 2 kHz | 1 kHz | 0.5 kHz | 0.5 kHz | 1 kHz | 2 kHz | 4 kHz |
| Attention | 15.9 | 14.4 | 16.7 | 14.4 | 16.1 | 12.3 | 17.6 | 15.6 |
| Distraction | 22.3 | 19.3 | 17.9 | 16.6 | 21.4 | 14.4 | 13.0 | 8.3 |

Further analyses with the LSD test revealed that when the order of presentation was 4, 2, 1 and 0.5 kHz the thresholds were significantly worse for 4 kHz (p < 0.0005) and for 2 kHz (p < 0.05) in the distraction condition when compared to the attention condition. For 1 and 0.5 kHz the thresholds in the distraction condition did not differ significantly from those in the attention condition. When the order of presentation was 0.5, 1, 2 and 4 kHz; the thresholds were worse in the distraction condition for 0.5 kHz (p < 0.003) when compared to the attention condition. The thresholds were similar in the attention and distraction conditions for 1 kHz. For 2 (p < 0.009) and 4 kHz (p < 0.0001) the thresholds were better in the distraction condition.

DISCUSSION
The results show that the order of stimulus presentation is an important factor in determining the effect of distraction on auditory thresholds for the conditions used in this study. Distraction worsens the thresholds at the beginning of the task as can be expected, regardless of stimulus frequency. The effect of distraction on thresholds, however, decreases over time and this decrease is dependent on the stimulus frequency. When lower frequencies (0.5 and 1 kHz) are presented at the end of the task, the thresholds in the distraction and attention conditions are similar suggesting no effect of distraction on thresholds. When higher frequencies (2 and 4 kHz) are presented at the end of the task, the thresholds are better in the distraction condition when compared to the attention condition. Thus, distraction actually improves the thresholds when higher frequencies are presented at the end of the task.

It appears that at the beginning of the task, dual task attention limits can decrease the thresholds as the subject has to pay attention to the thresholds, respond and at the same time attempt to solve the puzzle. It is known that people are limited in their ability to perform two or more tasks simultaneously (e.g., 2). However, as time progresses, intersensory facilitation may occur leading to an improvement in the thresholds. Energy summation (3) and preparation enhancement models (4) have been suggested to explain the phenomenon of intersensory facilitation. The energy summation model suggests that the accessory stimulus (the distracting puzzle in the current study) increases the intensity of the primary stimulus (the warbled tone in the current study). The preparation enhancement model suggests that the stimulus energy in the visual channel (puzzle solving task in the current study) increases the preparedness for responding to the auditory channel. The current results also suggest that the intersensory facilitation is more effective when higher frequencies serve as the stimuli in an auditory detection task. Thus, use of higher frequencies, as alerting signals, in multi-task environments may be beneficial.

REFERENCES