Interaction of Age and Attentiion on Driving Performance

Mona Motamedi and Elzbieta B. Slawinski
Dept. of Psychology, University of Calgary, 2500 University Dr. N.W. Calgary, AB, Canada, T2N 1N4

1. INTRODUCTION

The Canadian elderly population will increase in the next forty-five years and with it there will be a marked increase in the number of elderly drivers (65+) (Slawinski and MacNeil, 2002). It has been established that driving abilities gradually deteriorate with age (Szlyk, 1995). The auditory environment influences the performance of young and elderly drivers. The effect is dependent on the level of attention of the driver to the environment (Slawinski and MacNeil, 2002).

Safe and effective driving necessitates detection of important information embedded in a background of continuously changing masking sounds, called distracters. (Slawinski and MacNeil, 2002). This acoustic driving environment can affect driving performance as it forces the driver to shift or divide his/her attention between the road environment and the distracter.

This study investigates the effects of age and attention levels to auditory distracters on ability to detect external vehicular warning signals. Results show that the level of attenuation to a warning signal (target signal) decreased (intensity increased) when participants were attending to the distracter and simultaneously to the warning signals. These observations were true for young and elderly drivers. The effect of age was manifested in a decrease in the level of attenuation for both the attended and unattended conditions obtained for elderly participants.

2. METHOD

2.1 Participants

While data collection is still in progress, the results up to date are shown here with the final results to be reported at a later date. Sixteen younger drivers, represented as Group A (18-31 years old, M = 22.5; SD = 4.39) and nineteen elderly adult drivers, represented as Group B (65-79 years old, M =69.07; SD = 4.41) served as participants.

Analysis of data was done on those who met criteria as described in section 2.2 (fourteen younger drivers and fifteen elderly drivers). All participants had normal hearing as per age. No neurological problems were reported.

2.2 Stimuli

The detection tasks were carried out using a Hewlett Packard (Vectra) platform. Stimuli were presented using custom software and a TDT (Tucker-Davis Technologies) hardware. Two stimuli were used in the detection task: a warning signal (car horn) with a 300 ms duration simultaneously with a continuous distracter (a narrated story). The intensity level of the story was held constant at 67 dB SPL in both conditions.

The initial attenuation of the target stimuli (car horn) was 40 dB; subsequent attenuation levels were chosen by an adaptive psychophysical procedure (3 up and 1 down) as described by Slawinski and MacNeil (2002).

A ten item multiple choice test (questionnaire) was administered following the attended condition. Eligibility criterion to be included in analysis was such that a minimum of three questions had to be answered correctly.

2.3 Procedure

Participants were tested individually in an IAC anechoic chamber. Sound was presented binaurally via Sony stereo headphones. Participants were asked to detect a stimuli (car horn) while a narrated story was played. The detection task included two intervals and the car horn would randomly occur in one of the intervals. Participants were asked to indicate which interval contained the warning sound by pushing one of two corresponding buttons on a response console. An adaptive tracking procedure (3 correct responses followed by an increase in attenuation and 1 incorrect response followed by a decrease in attenuation) was used. Each presentation was composed of 9 reversals [changes in direction of curve (see Figure 1)] after which the subsequent presentation started with an intensity of 10 dB higher than the final intensity level of the previous presentation. For each presentation the first four reversals had a 5 dB step of increase and decrease in intensity while the last five reversals had a 2 dB step. Average of means of three presentations was used as a threshold value for a particular condition.

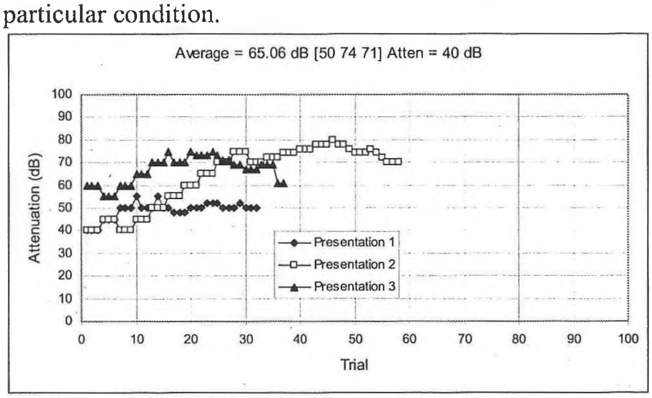

Fig. 1. An example of the output generated for the adaptive tracking procedure

For each participant the detection task was repeated twice: In one detection task, the "attended condition", the participant was asked to attend to the story. In the other detection task, the "unattended condition", the participant was asked not to attend to the story and focus only on the warning signal. The order of the two detection tasks was randomized among the participants so that half the participants were given the "attended" detection task first while the other half were given the "unattended" detection task first.

A mean threshold (the last 4 reversal) was calculated for each of the three presentations of the detection task in the two conditions. The mean threshold of detection (attenuation level) for each participant and condition was computed as the average of the three mean thresholds.

3. RESULTS

The experiment showed a dependence of the obtained attenuation level on the level of attention. For group A, the mean attenuation level obtained for the "attended condition" was 56.58 ± 12.92 dB while the one for the "unattended condition" was 64.27 ± 2.43 dB. For group B, the mean attenuation level obtained for the "attended condition" was 39.02 ± 23.09 dB while the one for the "unattended condition" was 49.19 ± 22.17 dB. Figure 2 shows the levels of attenuation for both groups for the two conditions (attended and unattended).

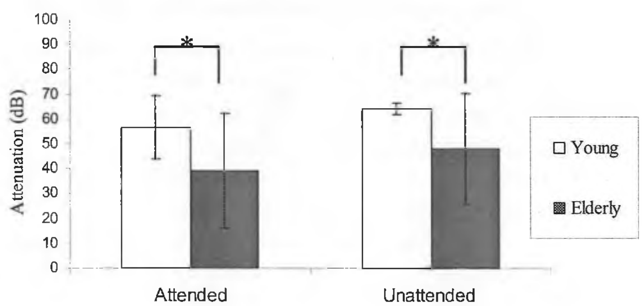

Fig. 2. Young vs. elderly participants attenuation levels in the attended and unattended conditions. (* Significant difference)

A one way ANOVA conducted for the attended condition showed a significant difference between the threshold means obtained for young participants and those obtained for elderly participants $F(1,27) = 5.95$, $p < .05$. A significant difference was also found between young and elderly participants when comparing the threshold means in the unattended condition $F(1,27) = 6.72$, $p < .05$. Levene's test for homogeneity of variances showed a significant difference between the variances of elderly and younger participants in both attended $F(1,27) = 9.64$, $p < .05$ and unattended conditions $F(1,27) = 30.5$, $p < .001$.

4. DISCUSSION

This study confirmed the hypothesis that the detection of vehicular warning sounds depends on the level of attention to the surrounding acoustic environment. Attenuation levels for young and elderly participants decreased when they were asked to attend to the narrated story compared to the condition when they were asked to not attend to the story.

This study also showed that there is a significant difference between the attenuation level obtained for young and elderly drivers. This result supports our hypothesis that detection of vehicular warning sounds in an acoustic environment decreases with age. The results are consistent with those obtained for Slawinski and MacNeil (2002) in which the effect of age on detection of distracters was studied.

Our study also shows that the ability to divide attention diminishes with age. A significant difference was found in the variability of the attenuation levels obtained between young and elderly participants. As is evident from Figure 2, elderly participants have significantly larger variability in both attended and unattended conditions compared to the young participants.

Another very interesting result can be seen in the large variability of the results in the case of the "Attended" condition. For young participants the standard deviation obtained was ± 2.43 dB for the "unattended" condition, while the one obtained for the "attended" condition was ± 12.92 dB. This shows that there is a great variability in how people divide their attention in the "attended" condition. This result, however, was not shown in elderly participants as the standard deviation for the "unattended condition" was ± 22.17 dB while the one for the "attended condition" was ± 23.09 dB. This can be attributed to the results obtained by Slawinski and MacNeil (2002) showing the decrease in the ability to detect vehicular warning sounds embedded in background noise.

5. REFERENCES

Slawinski, E.B.; McNeil, J. F. (2002). Age-Related changes on the Influence of Music on Driving Performance in the Detection of Vehicular Warning. *The Journal of Psychomusicology, 18*(2), *In Press.*

Szlyk, J., (1995). Relative effects of age and compromised vision on driving performance. *Human Factors 37*(2), 430-436.

ACKNOWLEDGEMENTS

The authors wish to thank Dr Jane MacNeil and Samer M. Adeeb for their support with the experiment.