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Comparing intentional switching of auditory selective attention in children and adults in an experiment suited for children

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Abstract

A remarkable part of children's development and education happens in educational institutions. Acoustic environments in these institutions are usually highly complex and noisy, hence it is demanding to identify relevant target speakers and to ignore irrelevant sounds. Previous research has analyzed auditory selective attention in adults, both in dichotic and binaural listening environments. Until now, there is little knowledge of auditory selective attention in children. In the present work, the original paradigm was adapted by using a task suited for children which included child-oriented elements. Further, the subject's anthropometric sizes were considered for an aurally-accurate reproduction of the acoustic scene. Twenty-four adults and twenty-four children participated in an experiment on auditory selective attention. Noise and noise-free conditions and various target-distractor distributions in the room were analyzed among others. The result of this experiment revealed significant differences between adults and children, especially in the way auditory attention was influenced by noise.

Keywords: Auditory selective attention, complex acoustic scenes, binaural reproduction

1 BACKGROUND

Children differ from adults, both considering their anthropometric sizes and their hearing ability. Current noise assessments in educational institutions are executed using measurement and evaluation methods based on results obtained from research with adults. There is little knowledge whether these observations can be directly transferred to children. It is important to better understand the differences in listening abilities under different acoustic conditions between children and adults. One interesting cognitive ability of hearing is auditory selective attention which enables one to locate relevant target speakers and to ignore irrelevant sound sources at the same time. This ability is helpful in highly complex acoustic scenes existing e.g., in educational institutions. Until now, there is little knowledge of auditory selective attention in children and how it develops over childhood.

The goal of this work is to provide a child-suited paradigm to examine auditory selective attention of children in comparison to adults and to provide an aurally-accurate presentation of a spatial acoustic scene which also takes the different anthropometric head and ear sizes of children into consideration.

2 MATERIAL AND METHODS

A listening experiment with 24 young adults, aged 18 to 28 years, and 24 children, aged 6 to 10 years, was conducted. For this purpose, a paradigm on intentional switching of auditory selective attention, originally developed for adults in dichotic listening environment and then extended to a binaural listening setup (1), was adapted for children by adding child-oriented elements and a feedback system. The previously employed digit-word categorization task was simplified for children by substituting it with an animal categorization task.

The listening experiment took place in the mobile hearing laboratory "MobiLab" (2) developed in the Teaching and Research Area of Medical Acoustics, RWTH Aachen University. The MobiLab is a modified trailer

including an acoustically optimized hearing booth, which can be easily placed at the primary school where participants were available for on-site listening experiments. To ensure an aurally-accurate perception of the virtual acoustic scene, an individualized set of head-related transfer functions (HRTF) was calculated based on the participant's individual head dimensions by modifying the ITD cues (3) and the HRTF set of the ITA artificial head (4). A static binaural reproduction via open headphones was chosen for this study using a robust headphone equalization (5).

3 RESULTS AND CONCLUSION

Response times and error rates were compared between the age-groups, and between the variables attention switch, congruency, target-distractor-position combination, and noise/no noise. Results of young adults were comparable to previous research and showed comparable effects, hence the adapted paradigm could be validated to examine auditory selective attention. Further, a significant difference between the age groups could be observed in reaction time and in error rates. Children tends to react slower and to make more mistakes than adults. However, the flexibility in auditory selective attention of adults and children were comparable except for certain spatial conditions. Additionally, a speed-accuracy effect could be noticed for children in the noise/no noise condition which was not observed for the adults to the same extent.

The results suggest that the modified paradigm is suitable to analyze auditory selective attention of adults and children. Furthermore, the study revealed a higher sensitivity to noise and spatial effects in cognitive processes of children in comparison to adults. There is a need to further investigate the impact of different noise impacts on the cognitive process of children.

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