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EFFECT OF HEAD MOTION ANIMATION ON IMMERSION AND CONVERSATIONAL BENEFIT IN TURN-TAKING CONVERSATIONS VIA TELEPRESENCE IN AUDIOVISUAL VIRTUAL ENVIRONMENTS.

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ABSTRACT

In hearing aid technology, algorithms with high spatial selectivity, direction of arrival estimation and algorithms driven by user behavior require natural user behavior for both the development and evaluation. Here we present a method to increase the ecological validity of gaze and head movement behavior in a laboratory setup. Laboratory studies as a complement to field studies are necessary if a precise measurement technique is to be used, and to achieve the best possible control over measurement conditions. By using virtual reality, an experiment can be tested in different virtual environments with little effort, e.g., to test hearing device benefit in various typical communication situations.

In this study, an interactive turn-taking conversation in triads was conducted. The test participant sat in the laboratory, equipped with sensors to record movement behavior. The interlocutors were actually in other rooms. Both their audio signal and the movement behavior were recorded and transmitted to the laboratory with a very short delay. The audio signal was fed into the acoustic simulation of the virtual environments, while the head movement data controlled virtual avatars in real time. It was shown that in this way natural motion and communication behavior of the test subject can be achieved.

Keywords: *hearing device, self motion, hearing device evaluation, virtual reality*

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1. INTRODUCTION

The benefit of current state-of-the-art hearing devices in complex acoustic scenarios is still limited [1, 2]. This is partly due to the fact that standard measurements oversimplify acoustic scenes. This problem can be overcome by evaluating devices in scenarios for which they were designed, such as under adverse listening conditions and during interactive conversations.

Virtual environments (VE's) allow for more realistic, yet complex and controllable conditions [3,4]. The aim of this study is to increase subject engagement and thus the ecological validity of the device evaluation by using more realistic avatar animations in interactive conversations via virtual audiovisual environments [5]. The research question of this study is to what extent the additional transmission of head movements to conversational avatars affects communication effort in VE scenes.

2. METHODS

2.1 General design and apparatus

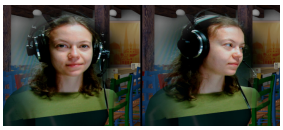
The participant sat in a virtual reality lab. The two experimenters were in separate rooms. The participants were connected in a virtual acoustic scene using a low-delay network audio connection. Head movements were captured by motion sensors and transmitted to the lab in real time. For one condition, a network video link was provided to transmit the images of the experimenters to the participant in each condition. The conditions could be controlled remotely via a graphical user interface. The participants' task was to engage in a causal conversation with the experimenters. Each condition lasted about 5 minutes.

2.2 Virtual Environment

The conversation was set virtually in a pub environment based on a real location in Oldenburg [6]. A diffuse background noise was added. The sound level was 71 dB SPL C-weighted. The Toolbox for Acoustic Scene Creation and Rendering (TASCAR) [7] was used to simulate the virtual acoustic environment, as well as for session management, data logging, and interfacing with all sensors and data streams.

The Blender game engine, version 2.79b [8], was used to render the visual environment. Animation data was sent from TASCAR to Blender via OSC. Avatar lips were animated using a speech-based real-time lip simulation method [9].

Table 1. Test conditions.

static 	automatic head movement 
transmitted head movement 	transmitted video 

2.3 Test conditions

Four different levels of animation realism were presented as test conditions, see Table 1 for an overview. The condition with the lowest level of animation realism was with static heads of the avatars ("static"), followed by automatic head movements, controlled by speech onsets of the three interlocutors ("automatic head movement"). The next level of animation realism was achieved by transmitting the head movements from the experimenters to the avatars ("transmitted head movement"). The highest level of animation realism was the transmitted video, embedded in the VR ("transmitted video").

2.4 Participants

Seven participants participated in this pilot study. They were all students at the University of Oldenburg and had no reported hearing impairment and normal or corrected-to-normal vision. All were fluent German speakers.

2.5 Communication effort

Communication effort was assessed using a questionnaire after each condition. The data shown here is the rating of "I was able to listen easily", measured on a 7-point scale ranging from -3 to 3. Values of 3 referred to "no effort", values of -3 to "very difficult".

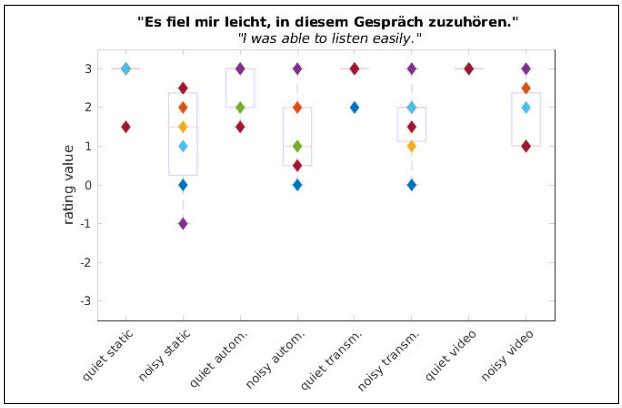


Figure 1. Communication effort, question "I was able to listen easily". Values of 3 indicate no effort. The effort in noise is reduced with increasing level of animation realism. The diamonds show individual data, the rectangles indicate inter-quartile ranges.

3. RESULTS

The communication effort was rated as very easy in all quiet conditions (see Figure 1). In noise, the rating depended on the simulation level. With increasing simulation level, i.e., when moving from "static" via "automatic" and "transmitted" to "video", the communication effort tended to be rated as easier.

4. CONCLUSIONS

This study revealed an interaction between noise and visual conditions on communication effort. Specifically, in noisy environments it was easier to communicate with increasing realism of the head movement simulation. Therefore, implementing natural head movements in conversational avatars, e.g. by transmitting head movements of remote interlocutors, may be useful for interactive experiments in virtual environments.

5. ACKNOWLEDGMENTS

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