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Celik, Emine; Persson Waye, Kerstin; Pedersen, Christian Sejer; Møller, Henrik

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Influence of Recording/Playback Technique on Subjective Evaluation of Loudness, Annoyance and Unpleasantness

Emine Çelik, Kerstin Persson Waye, Christian Sejer Pedersen, Henrik Møller

Department of Acoustics, Aalborg University, Denmark
Fredrik Bajers Vej 7 B5, DK-9220 Aalborg Ø, Denmark
emc@acoustics.auc.dk

Abstract

Different techniques for recording and playback are used today when evaluating subjective responses to sounds. Little is known on how the different techniques affect the subjective perception and overall response. One previous study found that for wind turbine noise, binaural playback is more natural and less unpleasant in comparison to mono playback [1]. The present study was carried out to investigate if there is a difference in subjective perception and response related to loudness, annoyance and unpleasantness between mono recordings played back through a loudspeaker, and binaural recordings played back via headphones. To test this we used sounds that differed with respect to temporal and frequency characteristics as well as spatial characteristics, and we used different durations of exposure.

1. Introduction

In previous studies of perception and response to sounds, several methods have been adopted both with regard to recording techniques (monophonic versus binaural recordings), playback techniques through headphones or loudspeakers and subjective evaluation techniques. Little is known on how these techniques affect the subjective perception and overall response. One previous study [1] found that for wind turbine noise, binaural playback is more natural and less unpleasant in comparison to mono playback. The present study was carried out to investigate if there is a difference in subjective perception and response related to loudness, annoyance and unpleasantness between mono recordings played back through a loudspeaker (standard technique in annoyance experiments), and binaural recordings played back via headphones (a more recent technique giving a more realistic experience especially for spatial properties of the sound) and to evaluate whether the perception differed depending on temporal and/or frequency characteristics of the sound. To test this, sounds that differed with respect to temporal, spatial and frequency characteristics were used. The experiment also investigates various psychometric methods for achieving responses from subjects, and different durations of the exposure were used.

2. Methods

2.1 Subjects

Fifty four paid volunteers (27 male and 27 female) aged between 18 and 30 participated in the experiments. Audiometric tests (according ISO 8253-1) ensured normal hearing within 15 dB at the octave band frequencies 125 Hz to 4 kHz and 20 dB at 8 kHz. For the audiometric test a Madsen Orbiter 922 audiometer (automatic mode - ascending method) was used. Their subjective sensitivity to noise was recorded before the experiment using a questionnaire developed by [2].

2.2 Stimuli

Three types of stimuli were used in the experiments: noise from road traffic (RT), indoor activity sound (S) and a low frequency ventilation noise (V). The stimuli included both steady (V) and non-steady (RT, S) noise. The signals were recorded with two different techniques: monophonic and binaural, and each noise was played back at 3 different levels (2 levels in Experiment 3). The recordings were done with a Harmonie 01 dB system using an artificial head [3] with G.R.A.S 40 AD microphones and Danish Pro Audio 4037 preamplifiers for the binaural recordings and a G.R.A.S 40 EN microphone for the monophonic recordings. The outdoor sound (RT) was recorded simultaneously with the two techniques, however with a distance of 1.5 m (along the road/track) between the artificial head and the mono microphone to avoid mutual disturbance of the sound field. The low frequency ventilation sound (V) was recorded during two periods, each with either the artificial head or the mono microphone in position. Use of the same position for the indoor recordings was necessary because of standing waves in the room, and the non-simultaneous recording was permissible because of the stationary character of the sound. The indoor activity sound (S) was recorded simultaneously with the two technique' with a vertical distance of 20 cm between the artificial head and the mono microphone.

1.3 Exposure room and playback setup

The experiments were carried out in a room that is partly furnished as a listening room, the monophonic recordings were presented through a loudspeaker (Genelec