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Auditory-Visual Integration of Emotional Signals in a Virtual Environment for Cynophobia

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Abstract. Cynophobia (dog phobia) has both visual and auditory relevant components. In order to investigate the efficacy of virtual reality (VR) exposure-based treatment for cynophobia, we studied the efficiency of auditory-visual environments in generating presence and emotion. We conducted an evaluation test with healthy participants sensitive to cynophobia in order to assess the capacity of auditory-visual virtual environments (VE) to generate fear reactions. Our application involves both high fidelity visual stimulation displayed in an immersive space and 3D sound. This specificity enables us to present and spatially manipulate fearful stimuli in the auditory modality, the visual modality and both.
Our specific presentation of animated dog stimuli creates an environment that is highly arousing, suggesting that VR is a promising tool for cynophobia treatment and that manipulating auditory-visual integration might provide a way to modulate affect.

Keywords. Dog phobia, spatial audition, multisensory integration, emotion, and therapy

Introduction

VR-based exposure therapy has successfully treated several specific phobias using gradual confrontation to simulations of real-life anxiogenic situations [3, 4, 5]. Traditionally, studies primarily concentrate on accurate visual rendering of VE, while auditory rendering is often neglected. Consequently, the auditory aspects are often underexploited in the treatment of phobias. Thus, it is not yet clear how VR involving multiple sensory stimulations impacts this procedure. This is in stark contrast with natural environments, where emotional information is perceived via multiple senses. Furthermore, interactions between sensory inputs from all modalities influence perception and behavior in multiple ways. Thus, high-fidelity auditory inputs are also of great importance to evoke accurate affective reactions with virtual stimulations, especially since auditory augmentation of VE improves presence and immersion [1, 2].

This study aims to precisely assess the impact of multisensory stimulation on fear reactions. For this purpose, we investigated the potential of auditory-visual VE

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involving 3D sound for the treatment of cynophobia. The acoustic aspect of this phobia is much more relevant than in some other phobias, providing an ideal target to study how to combine the visual and the auditory stimulus' features to enhance sensory processing and modulate attention.

1. Methods

Upon arrival, all participants provided informed consent to take part in the experiment, previously approved by the local ethical committee.

Each participant was first submitted to an encounter with a virtual dog during a Behavioral Assessment Test (BAT1). After this first BAT, the participant then had to become acquainted with the equipment (training) before navigating within 2 different virtual environments. Then, he/she was again submitted to the encounter with a virtual dog with the same procedure as the first time (BAT2). Finally, the participant completed several questionnaires and was asked by the experimenter to comment on his experience (debriefing).

1.1. Virtual environments

The virtual environment used for the BATs was a simple corridor. The training environment was a garden with trees, a house, tables and benches. The first virtual scene used for the exposure to virtual dogs was again the garden scene. The second environment was an interior virtual scene in a large dark hangar, in which different pieces of industrial machinery are active and noisy.

In the virtual scenes used for the exposure to virtual dogs, several dogs were displayed in a progressive manner. They could be unimodal and static: auditory or visual alone (a dog barking from far or a dog lying down), unimodal and dynamic (looming and receding barking or visual dog standing up when the participant approaches), audiovisual and static (visual dog lying down and growling), audiovisual dynamic (visual dog standing up and growling when the participant approaches).

1.2. Virtual Reality setup

The experiment took place in the immersive space of INRIA in Sophia Antipolis, a four-sided, retro-projected cube with Infitec stereoscopic viewing (BARCO iSpace). The auditory scene was presented through Sennheiser HD650 headphones and the sound stimuli were processed through binaural rendering using selected non-individual Head Related Transfer Functions (HRTF) of the LISTEN HRTF database (http://recherche.ircam.fr/equipes/salles/listen/). The scenes had an ambient audio environment rendered through virtual ambisonic sources and binaural audio rendering. Head movements were tracked using an ART optical system so that visual stereo and 3D sounds were appropriately rendered with respect to the users position and orientation. The participants were equipped with a wireless joystick to navigate in the virtual environment. With this device, they controlled both rotations and translations within the virtual scene.

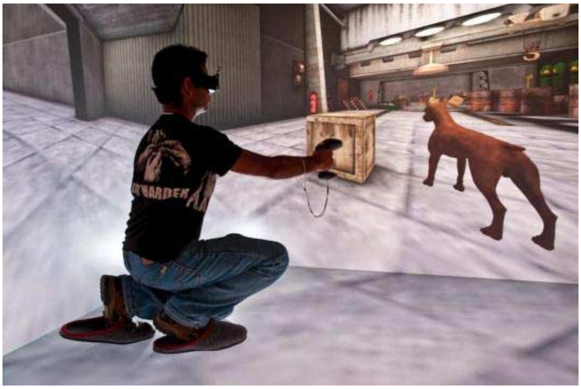

Figure 1. Participant in the hangar virtual environment

1.3. Participants

Participants were recruited on the basis of a questionnaire exploring fear of dogs (possible range for this cynophobia score: 0-42) [6]. One hundred and ten individuals (forty-four females) filled this questionnaire. A mean rating of 10,3 (SD=7,8) was obtained, which served as a basis to select participants to the current experiment. Eleven individuals whose scores on the cynophobia questionnaire were higher than 18,1 (mean + 1 SD) were selected from this pool.

1.4. Questionnaires and Interview measures

We used the State Trait Anxiety Inventory (STAI) to measure anxiety levels [7]. The state portion of the STAI was used upon arrival at the laboratory and after completion of the exposure session. A 22-item cyber sickness scale was used to assess the level of discomfort immediately after exposure [8]. The presence questionnaire from the I-group [9] was presented after immersion.

Anxiety ratings were collected during the BATs and navigation within the two virtual environments with the Subjective Unit of Distress (SUD), a self-report measurement of anxiety on a 0–100 points scale [10]. The participant was asked when facing each dog about his/her level of anxiety.

1.5. Procedure

Each participant was first invited to participate in a virtual reality BAT for the assessment of dog phobia. During this test, the participant was presented with a virtual dog, step by step, until it was extremely close and the participant could look at it from at a 5-centimeter distance. He/she had to rate his/her anxiety at each step. The BAT was scaled from 0 to 14 where 0 is refusal to enter the iSpace and 14 is putting one's face against the face of the virtual dog for more than 5 seconds.

All participants took then part in a training session completed in the garden scene in which no dogs were present. During training, the experimenter interacted with the participant in order to assist him/her in his/her first navigation.

After training the participant was immersed in the garden and hangar environments, aiming to expose him/her to the scenes with virtual dogs. He/she was instructed that there was a frog somewhere in the environments and that his/her task was to explore them to find the frog. The frog was an auditory-visual object and could be both seen and heard. The sound spatialisation played a major role in this scenario, as the participant could rely on the auditory information to locate both dogs and the frog.

After the immersion in the hangar, the participant was exposed to a second BAT.

2. Results and discussion

Two participants had to stop the experiment because of high cybersickness. The measures collected on the 9 remaining participants are presented in table 1. There was no significant difference between the scores on BAT 1 and on BAT 2, probably because we worked with a non-phobic sample.

Table 1. Mean Subjective Units of Distress (SUDs) in VEs and Behavioral Assessment Tests (BATs) scores.

Variable	Mean	Standard deviation
BAT 1 score	13,6	0,73
BAT 2 score	13,4	1,0
SUDs in VE		
SUD in response to unimodal stimuli	14,7	9,3
SUD in response to bimodal stimuli	45,4	26,0

We conducted non-parametric statistics (Wilcoxon test) on the SUDs reported by the participants in the VEs. The participants reported higher anxiety levels in response to auditory-visual stimuli ($p<0.01$), compared to unimodal stimuli.

Our results suggest that our auditory-visual VEs are highly arousing. Moreover it confirms that the fearful stimuli are actually displayed in a progressive way since participants encountered unimodal virtual dogs before bimodal ones in the VEs. It also strongly suggests that manipulating auditory-visual integration might be a good way to modulate affective reactions. Altogether, these results depict auditory-visual VR as a promising tool for the treatment of cynophobia.

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References

[1] C. Hendrix & W. Barfield, The sense of presence within auditory virtual environments, *Presence: Teleoperators and Virtual Environments* **3** (1996), 290−301.

[2] I. Viaud-Delmon, O. Warusfel, A. Seguelas, E. Rio, R. Jouvent, High sensitivity to multisensory conflicts in agoraphobia exhibited by virtual reality, *European Psychiatry* **21(7)** (2006), 501-8.

[3] A. Garcia-Palacios, H. Hoffman, A. Carlin, T. Furness III, C. Botella, Virtual reality in the treatment of spider phobia: a controlled study, *Behaviour Research and Therapy* **40(9)** (2002), 983-993.

[4] M. Krijn, P. Emmelkamp, R. Biemond, C. de Wilde de Ligny, M. Schuemie, C. van der Mast, Treatment of acrophobia in virtual reality: The role of immersion and presence, *Behaviour Research and Therapy* **42(2)** (2004), 229-239.
[5] B. Rothbaum, P.Anderson, E. Zimand, L. Hodges, D. Lang, J. Wilson, Virtual reality exposure therapy and standard (in vivo) exposure therapy in the treatment of fear of flying, *Behavior Therapy* **37(1)** (2006), 80-90.
[6] I. Viaud-Delmon, F. Znaïdi, N. Bonneel, D. Doukhan, C. Suied, O. Warusfel, K.V.N. Guyen et al., Auditory-visual virtual environments to treat dog phobia, *The Seventh International Conference on Disability, Virtual Reality and Associated Technologies with ArtAbilitation* (2008), 119-124.
[7] C.D. Spielberger, R.L. Gorsuch, R. Lushene, P.R. Vagg and G.A. Jacobs, *Manual for the State-Trait Anxiety Inventory (STAI), Form Y*, Consulting Psychologists Press, Palo Alto, 1983.
[8] I. Viaud-Delmon, Y.P. Ivanenko, A. Berthoz and R. Jouvent, Adaption as sensorial profile in trait anxiety: a study with virtual reality, *J Anxiety Disord*, **14** (2000), 583−601.
[9] T. Schubert, F. Friedmann, H. Regenbrecht, The experience of presence: Factor analytic insights, *Presence Teleoper Virtual Environ*, **10** (2001), 266−281.
[10] J. Wolpe, *The practice of behavior therapy (2nd ed.),* Pergamon, New York, 1973.