

Who's Afraid of Virtual Darkness – Affective Appraisal of Night-time Virtual Environments

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1 Introduction

We investigated to what extent simulated darkness determines the affective appraisal of desktop virtual environments (VEs).

Computer simulations have become indispensable tools to communicate design and planning impacts and to investigate human perception of built environments (e.g. TAHRANI & MOREAU 2008). Desktop VEs are also increasingly deployed to study the effects of environmental qualities and interventions on human behaviour and feelings of safety in built environments (COZENS et al. 2003, PARK et al. 2008, PARK et al. 2010). The effectiveness of desktop VEs for these applications depends critically on their ability to correctly address the user's emotional, cognitive and perceptual experience. In the real world ambient darkness elicits fear of victimization (BOX et al. 1988) by concealing potential dangers (BLÖBAUM & HUNECKE 2005, GRAY 1987, NASAR & JONES 1997, WARR 1990). Darkness may turn places that are pleasant during daylight into frightening places after dark (HANYU 1997, NASAR & JONES 1997). The innate fear for darkness which most people have also extrapolates to immersive virtual environments (MÜHLBERGER et al. 2007). Although commercial desktop games sometimes deploy low-key lighting to evoke suspense and dread (NIEDENTHAL 2005), it is not yet known if darkness in desktop VEs can also effectively induce fear related emotional responses, and determine the affective appraisal of the VE.

Affective appraisals are judgments concerning the capacity of the appraised environment to alter an individuals' mood (RUSSELL & SNODGRASS 1987). An affective or emotional reaction refers to an internal state (such as fear) that a person feels in relation to the environment (NASAR 2008). Affective appraisals are not necessarily accompanied by an affective or emotional change (RUSSELL & SNODGRASS 1987) Whether a reaction occurs depends on the strength of the stimulus, the relevance the event or environment has for the viewer, and the viewer's affective state and characteristics (e.g. personality). The affective response can be mapped on the two dimensions pleasure and arousal of Russell's circumplex model of affect (RUSSELL 2003). A conscious experience of one's affective state can be described as an integral blend of these two dimensions (and thus as a single point in this map). For instance, fear is an emotion high in arousal and low in pleasure, directed at a specific object or event. Anxiety is generally considered as a mood, also high in arousal and low in pleasure, but objectless.

Here we report two studies that were performed to investigate how simulated darkness determines the affective appraisal of, and emotional reaction to, desktop virtual environments.

In the first study participants inspected a virtual model of a small Italian village, either in daytime or in night-time conditions, and gave their affective appraisals of the environment afterwards. The results of this study showed only a minor effect of simulated darkness on the affective appraisal of the desktop VE. Probable reasons for this result may have been the presence of reassuring effects like auditory cues suggesting social presence, and the fact that the inspection task lacked any personal relevance. As a result, the simulated darkness probably did not evoke any fear related associations.

We therefore performed a second study in which participants were requested to explore either a daytime or a night-time version of a desktop VE representing a typical Dutch deserted rural area. The lack of social presence and the deserted nature of the VE served to evoke victimization related associations. In some conditions an attempt was made to enhance the personal relevance of the simulation, and thereby its emotion inducing capability, by leading the participants to believe that the virtual exploration tour would prepare them for a similar tour through a corresponding real environment. The emotional state of the participants, their mood and feelings of presence in the VE, and their affective appraisal of the VE were measured through self-report.

In this paper we will discuss the results of both studies and their implications for the validity of desktop VEs as an appropriate medium for both etiological (e.g. the effects of signs of darkness on walking behaviour and fear of crime) and intervention (e.g. effects of street lighting) research.

2 Experiment 1: Reconnaissance of a Small Italian Village

Darkness is known to induce unpleasant feelings like fear and anxiety, and this effect is enhanced by prior exposure to a social stressor (GRILLON et al. 2007). We therefore hypothesized that after a stressful experience, participants would score a night-time version of a desktop VE on Russell's (RUSSELL 2003) pleasure-arousal scale as significantly less pleasant and more arousing than its equivalent daytime version.

2.1 Methods

We first exposed 52 young male participants (aged between 18 and 32 years) either to a non-stressful control (reading) task, or to a task that elicits stress: the validated psychosocial Trier Social Stress Test (TSST: KIRSCHBAUM et al. 1993, WILLIAMS & HAGERTY 2004). Then they explored either a daytime or a night-time version of a virtual environment (the Italy level of Counter-Strike[®]), representing a small village with typical Italian architecture, with narrow streets, steep stairs, and with a market place in its centre surrounded by houses. While exploring, the participants heard a simulation of the sound of their footsteps, as well as all sorts of background noise (music, a singing voice, a passing airplane, wind, rumour) through their headphones. Participants were instructed to imagine that they were military scouts situated in an unknown village, whose task it was to perform a reconnaissance of this village. This task served to ensure that they would perform a thorough visual inspection of the VE. The participants were unaware that their affective appraisal of the environment would be tested at a later time. Room lighting remained on for the participant who explored the daytime VE, and was turned off for those who explored

the night-time VE. To objectively assess their anxiety level we measured free salivary cortisol and heart rate. A validated Dutch translation of the state self-report scale (VAN DER PLOEG 2000) from the Spielberger State-Trait Anxiety Inventory (STAI: SPIELBERGER 1985) was administered to assess how anxious participants felt, both before and after the experiment. The affective appraisal of the VE was measured with a semantic questionnaire (RUSSELL & PRATT 1980). Full details of this experiment are given elsewhere (TOET et al. 2009).



(a)



(b)



(c)



(d)

Fig. 1: Screenshots of a village square (a,b) and an alley (c,d) in the daytime (a,c) and nighttime (b,d) virtual environment

2.2 Results and Discussion

The TSST effectively induced distress: free salivary cortisol levels, heart beat rates, and scores on the TSAI were all higher after the TSST than before. We found that on the pleasure-arousal scale used for assessing the appraisal (RUSSELL & PRATT 1980) the desktop VE was considered less pleasant and more unpleasant by the simulated nighttime lighting conditions, but not more arousing. Also acute prior stress did not evoke the expected appraisals, nor did it elicit higher anxiety in the participants during the task in the

VE. Since a prior affective experience can bias the appraisal of the corresponding affective quality of an environment in a direction opposite to the value of the prior experience (RUSSELL & LANIUS 1984), the unpleasant TSST experience may have shifted the appraisal of the VE in the direction of pleasantness, thus counteracting a possible darkness effect. Another reason for the lack of an overall effect of darkness may be the rather friendly atmosphere of the VE. Although the experimental area contained several locations of entrapment (blocked escape) and concealment (blocked prospect), which are factors known to induce fear (FISHER & NASAR 1992a, FISHER & NASAR 1992b, NASAR & FISHER 1993, NASAR & JONES 1997), the presence of simulated artificial lighting focussed on restorative details may have had a reassuring effect (NIKUNEN & KORPELA 2011, NIKUNEN & KORPELA 2009), just like some auditory cues such as music and singing voices which could be heard at some moments during the simulation and which may have suggested social presence. In addition, the unfamiliar task probably lacked any personal relevance, and therefore failed to induce any emotions. As a result, the simulated darkness probably did not evoke any fear related associations.

3 Experiment 2: Exploring a Deserted Dutch polder

In this second experiment participants were requested to explore either a daytime or a night-time VE representing a typical Dutch deserted rural area. The lack of social presence and the deserted nature of the VE were meant to evoke victimization related associations. In some conditions additional information served to enhance the personal relevance of the simulation. We hypothesised that the night-time VE would be appraised as less cosy and more tense than its daytime equivalent, and that increased personal relevance of the VE would enhance its emotion inducing capability and thereby indirectly amplify the effects of simulated darkness on the affective appraisal of the VE.

3.1 Methods

A sample of 72 female volunteers (aged between 17 and 32 years) were requested to explore either a daytime or a night-time version of a VE representing a deserted Dutch polder landscape (Levee Patroller: HARTEVELD et al. 2007) and to draw a map of the area afterwards. The VE contained a small village, with some houses, roads and grasslands next to a large canal. A levee protected the village from the canal. The original version of the simulation was used, which contained no living creatures and only a few dynamic elements (e.g. rain, clouds, undulating water surfaces and a moving gate: HOUTKAMP et al. 2008). In the daytime condition the environment was lit by the sun. In the night-time condition streetlights along the road and stars in the partly clouded sky provided the only illumination. The lack of social presence and the deserted nature of the VE served to evoke victimization related associations. Young females were selected as participants since this group is particularly susceptible to fear of darkness (WARR 1984, WARR 1990). The map drawing assignment merely served to ensure that the participants would cover most of the area, and that they would not simply stay in one part. In some conditions participants were led to believe that the virtual walking tour would prepare them for an unaccompanied tour through a corresponding real environment, in lighting conditions that would either be the same or the opposite of those shown in the simulation (darkness/daylight). This fictitious

follow-up assignment was meant to enhance the personal relevance of the simulation, and thereby its emotion inducing capability. The emotional state of the participants, their mood and feelings of presence in the VE, and their affective appraisal of the VE were measured through self-report. A validated pictorial rating scale (the Self-Assessment Manikin: BRADLEY & LANG 1994) was used to measure emotional state of the participants. A validated translation of the Positive and Negative Affect Scale (PANAS: ENGELEN et al. 2006, PEETERS et al. 1996) was used to measure the mood of the participants. Presence was measured using the Dutch translation of the Igroup Presence Questionnaire (IPQ: SCHUBERT et al. 2001). The affective appraisal of the VE was measured using a differential rating scale that was originally designed to measure ambience in indoor environments with different lighting conditions (VOGELS 2008). It includes four factors (cosiness, liveliness, tenseness, detachment) that are similar to the dimensions arousal and pleasure in Russell's circumplex model of affect (RUSSELL 2003). Full details of this experiment will be presented elsewhere (VREUGDENHIL et al. 2012).



(a)



(b)



(c)



(d)

Fig. 2: Screenshots of a road on a dike (a,b) and a path near a canal (c,d) in the daytime (a,c) and nighttime (b,d) virtual environment

3.2 Results and Discussion

The night-time version of the VE was appraised as less cosy and more tense than its daytime equivalent. In both conditions the VE experience was significantly displeasing by itself, while the simulation of darkness had an arousing effect (measured with the SAM). This result agrees with the earlier finding of Rohrman and Bishop (ROHRMANN & BISHOP 2002) that people appraise a night-time VE as more arousing than a daytime VE.

Although the fictitious follow-up assignment reduced the overall positive mood (measured with the PANAS) of the participants, it did not affect their emotional state (measured with the SAM), and also did not influence their affective appraisal of the VE. Participants who experienced the darkness condition without the suggestion of a similar real-world follow-up task showed significantly higher positive affect (PANAS) than participants who had been informed that they would be requested to perform such a task. In combination with the finding that darkness in the VE had an arousing effect, this result suggests that participants found the night-time VE more arousing than its daytime equivalent when the experience had a further personal relevance. Overall, the degrees of presence and involvement experienced by the participants in this study were rather low.

4 Conclusions

A night-time VE was appraised as less pleasant or cosy and more tense than its daytime equivalent. However, simulated darkness had only minor effects on the emotional state of the viewers (e.g. on their arousal level). Darkness also did not elicit anxiety, even after prior stress. In this respect desktop VE representations differ from immersive night-time VE representations, which are capable to elicit fear related responses. There are indications that the personal relevance of a desktop VE may affect the emotional state of the user (the suggestion of a follow-up task reduced positive affect), and thus influence her affective appraisal of the VE. This finding suggests that it is essential to carefully consider the context in which desktop VE representations are deployed for serious gaming and training as well as for instance the assessment of personal safety in urban areas.

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