Physiological and subjective response to injustice

The effects of unjust evaluations on physiological responses and subjective experiences

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***Abstract*— Professionals with high pressure jobs such as police officers and military personnel often have to deal with difficult situations. In order to train such professionals to deal with their emotions and prevent possible anxiety disorders an ambient virtual training environment is being developed. This environment enables the trainee to deal with different scenarios and learn to appropriately regulate his/her emotions. An example of an emotion that can be experienced by emergency service workers is anger or distress caused by feelings of injustice. In this paper an experiment is presented that has as main goal to see whether it is possible to make the trainees feel unjustly treated in a virtual environment and to monitor their physiological response.**

Keywords—experiment; physiological measurement; injustice; virtual environment.

I. INTRODUCTION

Training to cope with negative emotions or stress is important for professionals with a high pressure job, such as employees of the public transport and police officers. One particular type of negative emotion these professionals deal with is distress or anger. This can be caused by feelings of injustice and can have long lasting negative consequences [1]. Furthermore, a feeling of injustice can result in stress and agitated behaviour [2, 8], thereby decreasing the quality of the task performance. A feeling of injustice is used in this research to indicate when a person feels unjustly treated, for example when not treated according to social norms. In scenarios related to the domain of public transport, this occurs in one-on-one situations. For example, a tram conductor who has been insulted by passengers all morning because the tram is late, which is not the fault of the conductor but for instance due to bad weather. Even though his job description is to treat all passengers friendly and remain professional at all times, the conductor may respond in an unfriendly manner to the passengers. So his task performance is decreased by his emotional reaction to the experienced unjust treatment.

The current paper is part of a larger project, in which a Virtual Reality based ambient training environment is developed to improve decision making in stressful situations and reduce associated negative health effects. Learning to deal with an unjust situation would be a useful scenario in such a training environment. In this paper, the possibilities for evoking a feeling of injustice using computer generated stimuli are investigated. In addition the potential physiological response that is expected to accompany this mental state is measured and analysed.

In the next section the background of the presented research will be explained, followed by related work in Section III. In Section IV the methods will be presented, followed by the presentation of the results in Section V. The conclusion can be found in Section VI.

II. BACKGROUND

The research presented in this paper is part of a larger project. This project is called STRESS [19] and is joint work between the VU University Amsterdam - department of Computer Science and the Netherlands Institute for the Study of Crime and Law Enforcement.

Policemen and other professionals face difficult choices during their daily activities. Even though they usually have clear instructions about how to act, these security workers can have difficulties in making appropriate decisions, due to a combination of factors [7, 9, 10, 11, 16]; some situations require improvisation, time to make decisions is often limited, the circumstances (e.g., hostile behaviour, threats) may cause emotions that are not experienced in everyday situations. This could lead to ad hoc decisions that are suboptimal, even despite extensive training [5, 10, 15]. There appears to be a strong need for a better training to cope with such difficult situations. The main aspects such training should focus on are the improvement of the quality of decision making and a better regulation of the emotional response to these situations that can occur on the job.

The STRESS project [19] has as the main goal to develop an intelligent system that is able to analyse human decision making processes, and analyse the causes of incorrect decisions and inadequate emotion regulation. The system will be incorporated in an ambient electronic training environment, based on Virtual Reality (VR), cf. [13, 18]. In this ambient environment, trainees will be placed in a virtual scenario, in which they have to make difficult decisions, while negative emotions are induced. Modern Human Computer Interaction (HCI) techniques will be applied to measure aspects of their mental state (among others, stress level, emotional state, attention, and motivational state) during the scenario. This information will then be used as input for the ambient system,

to determine why the trainee made certain less optimal decisions and to advise him/her how to improve this.

An important asset of the ambient approach is that the system can adapt various aspects of the training (e.g., scenarios, difficulty level, feedback) at runtime on the basis of its estimation of the trainee's mental state. In this way, both of the training goals can be fulfilled: 1) by selecting training scenarios with an appropriate context in terms of difficulty level, and providing useful feedback, the system can improve the trainee´s decision making behaviour, and 2) by selecting training scenarios with an appropriate context in terms of stress level, the system can improve the trainee´s emotion regulation skills.

The research presented in the current paper is a first step to see whether it is possible to increase the level of stress a person experiences in an ambient virtual environment. In this paper the (physiological) effects of feelings of injustice are measured.

III. Related Work

There have been research projects that investigate the physiological and emotional reaction as a response to all kinds of different stimuli.

In Bosse et al. [3] the effect of emotion regulation on subjective ratings has been measured. This paper is part of the STRESS project mentioned in the previous section. Participants were asked to rate the subjective emotional intensity of a set of affective pictures at two different points in time. The participants were divided into three groups. The first group performed a session of content-based virtual training in between these time points, the second group performed virtual training whereby reappraisal strategies had to be applied, and the third group was a control group without any training session. The results are that the reappraisal-based training caused the participants in that group to give significantly lower ratings for the emotional intensity of negative pictures, whereas the content-based training resulted in significantly higher ratings compared to the group without training. Six months later, a second experiment, performed with the same participants, indicated that these effects are fairly persistent over time, and that transfer to pictures with similar characteristics takes place. In this paper pictures were used to measure differences in subjective ratings, while in the current paper the aim is specifically to evoke feelings of injustice and measure these using physiological measurements.

Brouwer et al. [4] propose a combination of virtual environment and bio-neuro-feedback to help treat stress-related disorders. They designed an experiment in which the participants performed a surveillance task in two cities. A bomb explosion and negative feedback were used to induce stress. The participants also had to return to the bombed location and seemed to have performed badly to induce associative stress. The authors used physiological measurements (heart rate variability, cortisol level and EEG). General levels of stress correlated between the participants and (associative) stress was reflected in the measurements as well. In this paper the authors use bio-neuro feedback to help treat stress-related disorders. In the current paper the main goal is to investigate whether it is possible to measure feelings of injustice.

Markovsky [12] performed an experiment that has quite some similarity to the experiment presented in the current paper. In his experiment the test subjects performed a test in which they could earn money based on their performance in a test. After the test the money would be distributed by a so-called manager. After completing the test it was obvious to the participants that they had earned 5 dollar. The group was divided into three subgroups: one group received too much money, one group received the correct amount and the third group did not receive enough money. The groups that received too much or not enough money should feel unjustly treated. During the entire experiment the heart rate and skin conductance level of the participants was measured. There appeared to be no significant difference in heart rate between the groups. However, there was a significant difference found in skin conductance between the group that received the correct amount of money and the other two groups (the overpaid and the underpaid group). The difference between this experiment and the experiment presented in the current paper is that in the current research an ambient environment is used and the goal is to see whether it is possible to evoke feelings of injustice in such a setting.

IV. Methods

A computer task has been designed to invoke a feeling of injustice, while physiological measurements are registered. In the following sections, the experimental procedure and the participants will be described in more detail as well as some hypotheses.

A. Experimental design

Each experiment was divided into two series. For both series, participants had to judge 30 combinations of two pictures showing human faces in sequence. In the first series, the task for group A was to pick the face that looked more happy, while in the second series the more sad looking face had to be chosen. Group B was first given the task to pick the more sad looking face and the more happy looking face in the second series. If the correct face was chosen, this was clearly indicated on a bright green screen. If the wrong photo was picked, a bright red screen indicated the error and participants were set back three combinations and had to first redo those pictures before being able to continue. Subsequently, the current progress was shown after which either the next combination of photos was shown, or an already seen combination in case of a wrong answer. This continued until the last of the 30 combinations was answered correctly or until 20 errors were made. Fig. 1 shows this flow in graphical form.

However, in the second set, some answers were unjustly treated as being incorrect. The chance for this to happen was either 15% or, depending on which percentage was greater, based on the progress i (between 1 and 30) as follows: $i^4/8100$. Therefore, the further along people got, the greater the chance on unjust assessments with the answer to the final combination always being rejected. As the pictures were chosen such that each combination had a clear correct answer and no time limit was imposed, unjust assessments could be easily distinguished from wrong answers.

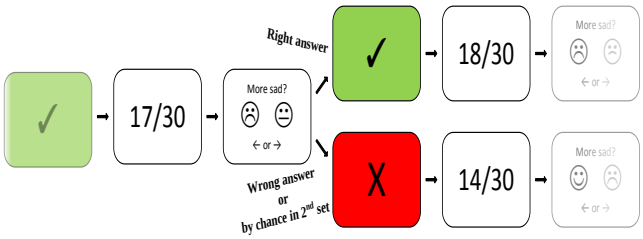


Fig. 1. Graphical impression of experimental design.
Note that in the experiment actual pictures of faces were used.

B. *Participants*

A total of 21 participants between the age of 15 and 61 with an average age of 25.5 years took part in the experiment and were randomly assigned to either group. Each participant was fitted with the Bioplux ECG and EDA sensors measuring heart rate and skin conductance [17]. The heart rate was measured by placing 3 sensors on the skin near the heart. The skin conductance was measured by two sensors that were placed on the index- and middle finger. Due to an abundance of measurement noise with a few participants some data was excluded from analysis, leaving 18 heart rate measurements (9 male and 9 female) and 17 skin conductance measurements (8 male and 9 female) of which respectively 11 and 10 belonged to group A and 7 to group B.

C. *Subjective ratings*

After each series the participants were asked to answer two questions. The answers to these questions were rated on a 6-point scale. The first question was whether the participant found the test difficult. The second question was whether the participant found the test to be stressful. These questions were included to see if the experiment actually had an effect on the subjective experience of the participant.

D. *Hypothesis*

The expectation was that the participants would feel unjustly treated when they were sure that they had given a correct answer but nevertheless received a negative evaluation and set back three places. It is expected this will show in the subjective ratings for stress with a significant increase for the second set. Furthermore, it is hypothesized that this would lead to an increased level of skin conductance in the second set of pictures and no change in heart rate, based on the experiment performed by Markovsky [12]. However, it might also be argued that an increase in heart rate should be expected. Injustice is often accompanied by emotions like anger, sadness or fear [14] which in turn are characterized with an increase in heart rate [6].

V. Results

Before the results of the two different series are analysed, the subjective questions regarding task difficulty and experienced stress were used to investigate possible differences between the two groups. An unpaired t-test showed no reason to belief the order of images had any effect on the subjective experience. Therefore, in the subsequent analyses Group A and Group B are treated as being equal and only the differences between the first (just) series and the second (unjust) series are compared.

A. *Subjective questions*

Each participant was asked about their subjective experience of task difficulty and stress for both the just (1) and unjust (2) series. These results are shown in Figure 2. A paired t-test showed that for both the difficultness and the stressfulness differences between both series are significant ($t(21) = -5.08$, $p < 0.0001$ and $t(21) = -6.11$, $p < 0.0001$ respectively).

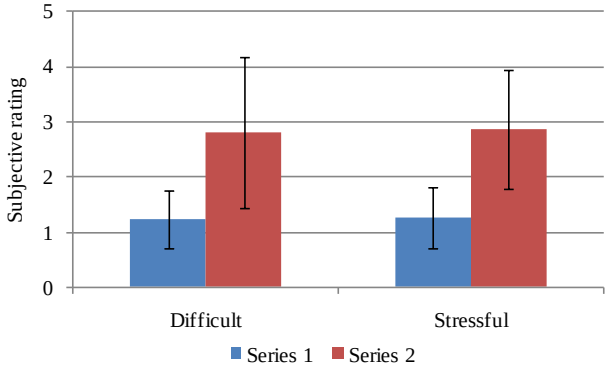


Fig. 2. Average subjective ratings including standard deviation.

B. *Heart rate*

A paired t-test was performed to test whether there is a difference in heart rate between the two sets of pictures. Although a slight decrease of 1,5 beats per minute (bpm) was found, as can be seen in Fig. 3, this decrease appeared not to be significant ($t(17) = 1.81$, $p = 0.088$).

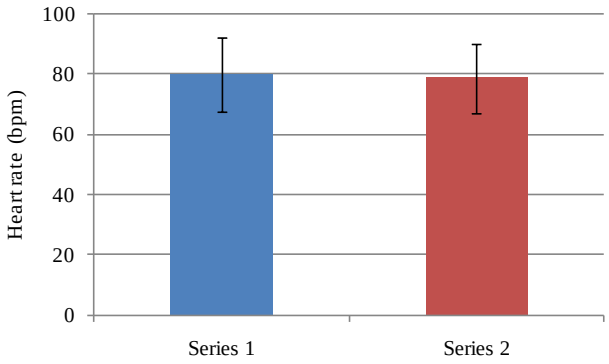


Fig. 3. Average heart rate in both series, including standard deviation.

C. *Skin conductance*

Fig. 4. shows the results of the skin conductance measurements. To test the significance of the 0.81 microSiemens (μS) increase between the two series, a paired t-test has been performed as well. The difference in skin conductance appeared to be significant with $t(16) = -3.52$, $p = 0.0028$. This increase was in accordance with our hypothesis.

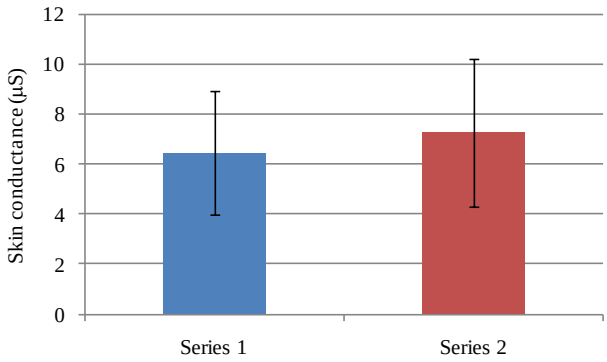


Fig. 4. Average skin conductance in both series.

D. Correlations

Finally, we looked at possible correlations between the subjective questions and the physiological measurements. We calculated for each aspect the difference between the first and the second series and used these differences to calculate the Pearson correlation. Unfortunately, both the differences in heart rate and in skin conductance did not correlate with either the subjective increase in difficulty or stress. However, a significant positive correlation was found between the two subjective questions ($r = 0.569$, $n = 21$. $P = 0.004$).

VI. Conclusion

In this paper the results of an experiment are presented in which the physiological reaction to injustice is measured. The main goal of the experiment was to see whether or not it is possible to increase the level of stress by offering situations of injustice within an ambient virtual electronic environment. This is important with respect to the larger project (STRESS [19]) in which the authors are involved.

The participants in the experiment were presented two series of pictures in which they had to rate the most happy or sad of two pictures. In one of the series the system deliberately judged the choice of the participant incorrectly with a chance that increased as the experiment prolonged.

As expected the level of skin conductance indeed increased during the second set of pictures. Also the heart rate seemed not to be affected by the injustice, which is in line with the experiment by Markovsky [12]. This is an important finding since it shows that the results from physiological measurements from both the real world experiment [12] and the virtual world experiment are similar.

Unfortunately, no correlation between the physiological measurements and the subjective ratings has been found. However, we did find a correlation between the question of the task being difficult and the task being stressful which might be interesting. Initial tests showed no differences between the order of tasks (more sad or more happy), which implies that both tasks are similar. However, the correlation between the two subjective questions implies that unjust assessments not only affect the amount of stress experienced, but also the experienced task difficulty. Thus, injustice can affect the subjective experience of task difficulty, while the task itself is of a comparable difficulty. This finding underlines the importance of training professionals how to cope with unjust behaviour.

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