A VR-Based Serious Game to Regulate Joy in Adolescents: A Comparison of Different Devices

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Abstract. Adolescence is a crucial period to learn Emotional Regulation (ER) strategies to prevent future psychological problems. This work is aimed to test the efficacy of GameTeen System (GT-System), a serious game that teaches ER strategies to regulate joy (VAS scale) and perceived arousal (FAS scale) in a non-clinical sample of adolescents. We conducted a between-participants experiment in which participants (N = 63) played a joy induction game, and then an ER game using one of three types of devices (computer, smartphone, and RGB-D camera). Results revealed that GT-System was only effective in increase perceived arousal after the joy induction game and decrease after the ER game. Statistically significant differences were found between devices conditions after the joy induction game (more intense perceived arousal was reported by participants in RGB-D camera). This finding highlights that the type of device could be an important variable in the efficacy of serious game.

Keywords: Adolescents · Emotional regulation · Joy · Serious games · User interface

1 Introduction

Emotional dysregulation (ED) has been defined as "the difficulties in the intensity, frequency, and duration of emotional responses, as well as difficulties modulating emotional experiences in effective and adaptive ways" [1]. Adolescence is a crucial developmental period in where there are more typically problems of ED [2]. For this

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reason, learning Emotional Regulation (ER) strategies is considered an important component in the treatment of psychological disorders in childhood and adolescence [3].

Serious games have become a powerful tool to provide training in ER strategies to adolescents. For example, *RAGE-control* ("Regulate and Gain Emotional Control") [4], *ROC* ("Reach Out Central") [5], and *SPARX* ("Smart, Positive, Active, Realistic, X-factor thoughts") [6] have proved effective computers applications to teach ER strategies (i.e., relaxation techniques, cognitive behavior skills) in adolescents with emotional problems (i.e., aggressiveness, anxiety, depression).

Until now, few serious games teach ER strategies in non-clinical samples, and they have been more focused on adolescents with mental health problems. GameTeen System (GT-System) is a Virtual Reality (VR) system designed to train, evaluate, and monitor emotions and ER strategies that adolescents applied in their daily life [7]. Emotions are induced through a serious game, and subsequently participants have to learn and apply two ER strategies through other games focused on slow breathing and distraction. A previous study has shown that GameTeen games have been effective to increase and decrease frustration [7].

In order to study the user's experience in games, the "interface embodiment" is receiving special interest in the last years [8]. In this line, in a previous study we have analyzed the effect of the type of interface device (computer, smartphone, and RGB-D camera) on the efficacy of our GT-System to induce and reduce frustration [9]. The results showed differences among devices, and those participants who used the RGB-D camera (interacting with the full body), experienced less frustration after the induction game. We concluded that the participation of the body affected the users' emotional experience, and the type of device is a crucial variable in the efficacy of serious games.

In the present study, we explore the efficacy of GT-System to regulate a "positive" emotion (joy), and the influence of the type of user interface embodiment on users' emotional experience. The specific objectives are: 1) to validate the GT-System ("*joy induction game*") for teaching ER strategies ("*breathing strategy game*") in adolescents, and 2) to analyze the impact of user interface embodiment in the users' emotional responses. We expect that:

H1. The GT-System ("*joy induction game*" and "*breathing strategy game*") will be effective to induce and regulate joy and perceived arousal.

H2. Participants in the RGB-D camera condition will report more intense joy and perceived arousal than in the other two interface conditions (computer and smartphone).

2 Materials and Methods

2.1 Participants

The sample consisted of 63 volunteers (37 males) of a public High School (N = 51) and a Summer School (N = 12) aged from 10 to 16 years old (M = 13.62; SD = 1.27). Parent's informed consents were signed prior to their inclusion. Participants were

randomly assigned to one of the three conditions: Computer (CC; N = 31), Smartphone (SC; N = 20) and RGB-D Camera (RCC; N = 12).

2.2 Instruments

The following quantitative measures were used:

- *Visual Analogue Scale* (VAS) [10]. It measures joy mood on a Likert scale from 1 (not at all) to 7 (completely).
- *Felt Arousal Scale* (FAS) [11]. It measures perceived arousal through a series of stylized drawings of faces on a Likert scale from 1 (very sleepy) to 5 (very alert).

2.3 Mood Induction and ER Procedure

- *Joy induction game:* It is a VR-based game, designed to induce positive mood (joy) in participants. The scene simulates an amusement park scene with many colorful balloons that appear in the sky continuously for 3 min. The objective is to prick the maximum possible number of balloons with different types of ammunition. Moreover, feedback messages (i.e., "You are achieving the goal") are displayed every 30 s during the game (see Fig. 1).
- *Breathing strategy game* [7]: It is a VR-based game, where users have to follow the movement of a virtual feather, which goes up and down during 45 s.

For a more detailed description of the technical characteristics, see [9].

2.4 Procedure

Sample was recruited from the High School and Summer School. Researchers invited the students to participate in a virtual experience. The study was approved by the Internal Review Board at the University of Valencia. In order to randomly assign participants to one of the three conditions (CC, SC and RCC), the Random Allocation Software program was used. Participants fulfilled VAS and FAS scales before and after

Fig. 1. Pictures of *joy induction game*.

the *joy induction game*. If joy scores exceeded 3 points or more on VAS and 2 or more on FAS, participants played the *breathing strategy game*. The experiment lasted about 20 min.

2.5 Statistical Data Analyses

In order to explore the efficacy of the GT-System and the influence of the type of different interface devices on the emotional experience, a repeated measures mixed ANOVA was performed, with the moment (pre-induction phase, induction phase, regulation phase) as within-factor and the group (CC, SC, and RCC) as between-factor. Analyses were performed using SPSS 22.0 (IBM) for Windows.

3 Results

3.1 Efficacy of the Mood Induction (*Joy Induction Game*) and ER (*Breathing Strategy Game*) Procedure

(a) Vas Scale (joy). A 3 × 3 ANOVA did not revealed a main effect for moment, indicating that the games were not effective in increasing and decreasing joy, $F(2, 120) = 2.18$, $p > .05$, $\eta_p^2 = .03$. No statistically significant differences were found between groups, $F(2, 60) = 2.27$, $p > .05$, $\eta_p^2 = .07$. Moreover, there was not a significant moment x group interaction effect, $F(4, 120) = .28$, $p > .05$, $\eta_p^2 = .01$ (see Table 1 and Fig. 2).

(b) FAS Scale. A 3 × 3 ANOVA revealed a main effect for moment, indicating that the games were effective in increasing and decreasing perceived arousal, $F(2,120) = 24.95$, $p < .001$, $\eta_p^2 = .29$. Statistically significant differences were found between groups, $F(2, 60) = 3.33$, $p < .05$, $\eta_p^2 = .1$. Moreover, there was a significant moment x group interaction effect, $F(4,120) = 2.86$, $p < .05$, $\eta_p^2 = .08$ (see Table 2 and Fig. 3). According to Cohen's (1988) indications, the effect size was moderate ($\eta_p^2 > .06$). Post-hoc analyses using Bonferroni correction indicated that the mean for perceived arousal differs depending on the moment and the group. After the induction

Table 1. Descriptive statistics for joy VAS.

Joy on the VAS scale						
	Pre-induction phase		Induction phase		Regulation phase	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Computer	5.03 (1.05)	4.61, 5.46	5.29 (1.19)	4.90, 5.68	5.16 (1.10)	4.75, 5.57
Smartphone	4.85 (1.19)	4.32, 5.38	5.05 (1.05)	4.56, 5.54	4.85 (1.22)	4.34, 5.36
RGB-D camera	5.03 (1.18)	4.65, 6.02	5.83 (.83)	5.20, 6.46	5.75 (1.05)	5.09, 6.40

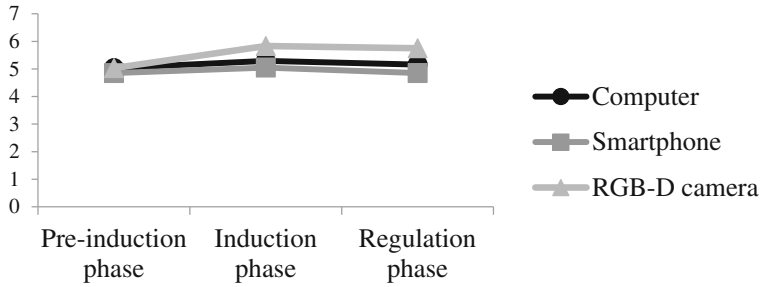

Fig. 2. Mean scores for joy on the VAS scale (out of 7) for different interface devices (computer, smartphone and RGB-D camera) in three experimental phases.

Table 2. Descriptive statistics for perceived arousal FAS scores.

Perceived arousal on the FAS scale						
	Pre-induction phase		Induction phase		Regulation phase	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Computer	2.06 (.85)	1.70, 2.43	2.54 (.96)	2.20, 2.90	1.94 (.81)	1.65, 2.22
Smartphone	2.55 (1.19)	2.09, 3	2.55 (1.05)	2.11, 2.99	1.55 (.76)	1.19, 1.91
RGB-D camera	2.83 (1.11)	2.24, 3.42	3.42 (.90)	2.85, 3.98	2.17 (.83)	1.70, 2.63

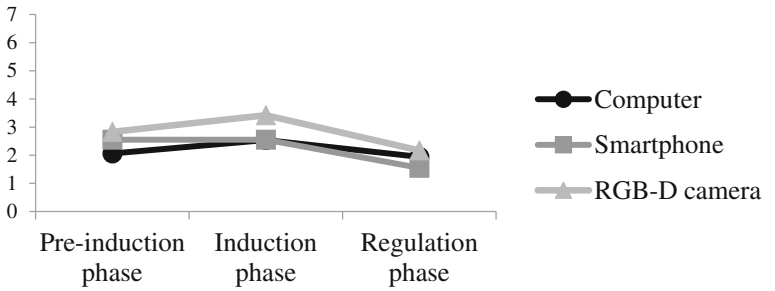

Fig. 3. Mean scores for perceived arousal on the FAS scale (out of 5) for different interface devices (computer, smartphone and RGB-D camera) in three experimental phases.

phase, perceived arousal increased significantly in the CC and RCC groups ($p < .05$) than the SC group. However, after the regulation phase, perceived arousal decreased significantly in all groups ($p < .05$).

4 Discussion

The objective of this study was to test the efficacy of the GT-System taking account a new mood induction procedure (MIP) ("*joy induction game*") for teaching ER strategies ("*breathing strategy game*") in a non-clinical population, and to analyze the role of different interface devices. The first hypothesis assumed that the GT-System would be efficacious in inducing and regulating joy and perceived arousal on all devices, and the second hypothesis assumed that these measures would be more intense for the RCC group. Regarding joy (VAS scale), the GT-System was not effective in increase this emotion after the MIP and decrease after the ER procedure (*breathing strategy game*) on all groups. Whereas for perceived arousal (FAS scale), results were different depending on the interface device. Only in the CC and RCC groups, perceived arousal increased significantly after the MIP. However, it decreased significantly in all groups after the ER procedure. Therefore, the first hypothesis was supported partially in terms of perceived arousal. Also the second hypothesis was supported partially for perceived arousal (it was more intense in the RCC group and also in the CC group after the MIP).

The fact that the GT-System has not been effective in inducing and regulating the target emotion (joy) could be explained by the high initial levels of joy (VAS scale) scores in the pre-induction phase on all groups. This result is not in line with previous studies that showed GT-System as an effective tool to regulate a negative emotion, frustration (the scores of frustration on the VAS scale were lower in the pre-induction phase on all groups) [7, 9].

Regarding perceived arousal, the results of the present study point out that the type of interface device can affect the user's experience. The differences between CC and RCC groups with respect to SC group after the induction phase could be due to differences in the degree of sensory richness (i.e., from larger screen in CC and RCC groups to smaller screens in SC group), or the involvement of the body (motor system) in interacting with the interface (i.e., from moving the mouse in the CC group, moving the finger in the SC group to interacting with the whole body in the RCC group). The decrease in perceived arousal (FAS scale) after the breathing strategy game in all groups is in accordance with previous literature showing that ER techniques (i.e., relaxation skills) during the games are effective in reducing intense emotional states that involve very high arousal values [4–6].

In general, the GT-System ("*joy induction game*" and "*breathing strategy game*") could be a useful tool to teach ER strategies in a non-clinical sample of adolescents, particularly in regulating perceived arousal. It allows them to develop the ability to identify and modify arousal during the games.

Adolescence is crucial period to learn to control and manage the emotions in adaptive way to avoid episodes of ED. The technologies could be an important channel to disseminate ER programs because they are so close to adolescents, who use them the most [12].

This research has some limitations. First, the sample size of the RCC group (N = 12) is smaller than the CC (N = 31) and SC (N = 20) groups. Second, the sample was composed of non-clinical adolescents, and so this study should be replicated in

clinical patients (i.e., depression). Third, follow-ups would be necessary to corroborate that the short-term benefits obtained here, maintain over time.

In future studies, the sense of being in the game ("presence"), and physiological measures, such as heart rate or the galvanic skin response could be analyzed. In this sense, physiological measures could increase the potential of ER training through serious games, by providing biofeedback to the participants and therefore making them more aware of how the game is affecting their emotions and their physiological status.

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