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SMARTPHONE FOR SELF-MANAGEMENT OF PSYCHOLOGICAL STRESS: A PRELIMINARY EVALUATION OF POSITIVE TECHNOLOGY APP

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Abstract: In recent years, there is growing interest in the use of advanced technologies for supporting well-being. The aim of this study was to test the efficacy of Positive Technology, the first application for smartphone and tablet that exploits the potential of new technologies and wearable biosensors for the self-management of psychological stress. 68 users who performed guided relaxation or biofeedback exercises for at least 120 seconds were included in the sample. The stress management exercises performed with the application were effective in reducing users' psychological stress level. It is possible to note a significant decrease in the arousal, associated with a concomitant increase in the hedonic valence after the stress management exercises. A decrease in heart rate values was observed, although it was not statistically significant. Although preliminary, overall these data suggest that even a brief stress management exercise carried out on a mobile application might be useful to reduce psychological discomfort.

Keywords*:* Psychological stress; positive technology; mobile phone; arousal; heart rate.

Smartphone para la autogestión del estrés psicológico: Una evaluación preliminar de una aplicación de Tecnología Positiva.

Resumen: En los últimos años, hay un creciente interés en el uso de tecnologías avanzadas para reforzar el bienestar. Este estudio prueba la eficacia de Positive Technology, la primera aplicación para teléfono inteligente y tablet que explota el potencial de las nuevas tecnologías y biosensores portátiles para el manejo personal del estrés psicológico. 68 usuarios realizaron ejercicios de relajación guiada y biorretroalimentación durante 120 segundos como mínimo. Los ejercicios para el manejo del estrés realizados con la aplicación fueron eficaces para la reducción del estrés psicológico de los usuarios. Se observa una reducción considerable en la activación, asociada con un aumento concomitante en la valencia hedónica tras los ejercicios de manejo del estrés. También una disminución en los valores de la frecuencia cardíaca, no fue estadísticamente significativa. Estos datos preliminares sugieren que incluso un breve ejercicio para el manejo del estrés realizado con una aplicación móvil podría ser útil para reducir el malestar psicológico.

Palabras clave*:* Estrés psicológico; tecnología positiva; teléfono inteligente; arousal; frecuencia cardíaca.

INTRODUCTION

Every day, individuals are constantly compelled to deal with several circumstances (for example, having trouble with parents or partner) that may provoke anxiety and psychological discomfort. When a potentially threatening stimulus challenges the individual, a complex response is induced to mobilize several resources to effectively adapt to it. Cohen and colleagues suggested that psychological stress occurs when individuals perceive that these potential threats exceed their adaptive capacity (Cohen, Janicki-Deverts, & Miller, 2007). In their analysis, they highlighted a serious associations between psychological stress and several diseases, particularly for mood disorders and cardiovascular disease (Antoni et al., 2006; Leserman et al., 2002; Rozanski, Blumenthal, & Kaplan, 1999). Indeed, psychological stress has shown a dangerous association with mental

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health, but also with elevated premature mortality (for a recent review, see Russ et al., 2012). On one side, for example, stress is conceived as a critical risk factor for the onset of depressive disorder (Hammen, 2005; Kendler, Karkowski, & Prescott, 1999). On the other hands, stressful life events may influence the pathogenesis of physical diseases by causing above mentioned negative affective states (e.g., strong feelings of anxiety and depression (Hammen, 2005; Wheatley, 1997), which in turn exert crucial effects on biological processes by activating the hypothalamic-pituitary-adrenocortical axis and the sympathetic-adrenal-medullary system) or behavioural patterns that influence disease risk (Segerstrom & Miller, 2004). In particular, chronic stress (e.g., caring for parents with dementia) is considered the most dangerous because it is more likely to lead to long-term dysfunctional emotional and behavioral responses, that influence the vulnerability to physical and psychological disease (Jackson, Knight, & Rafferty, 2010; Marin et al., 2011). However, stressful life events do not affect everyone similarly. The stress response, indeed, depends on the nature and intensity of the stressor, on the social context, and specially on the individuals' ability to appraise and to cope with the stressful events.

In recent years, there is growing interest in the use of emerging advanced technologies in supporting well-being as a crucial key for health promotion (Botella et al., 2012; Riva, Baños, Botella, Wiederhold, & Gaggioli, 2012). As recently suggested by Riva and colleagues (Riva et al., 2012), the advancement in the information and communication technologies (ICT) sector has challenged technology developers, designers, and psychologists to reflect on how to develop *positive technologies* to promote mental health. If Positive Psychology can be defined as the scientific study of well-being to understand human strength and virtues and to promote them to allow individuals, communities, and societies to thrive (Delle Fave, Massimini, & Bassi, 2011; Ryan & Deci, 2001; Seligman & Csikszentmihalyi, 2000; Snyder, 2010), it appears to be a really promising framework to develop advanced technologies for mental health. Specifically, positive technology are those specifically designed to foster positive emotions, to promote engagement in empowering activities and to support connectedness between individuals and groups (Inghilleri, Riva, & Riva, 2014; Riva, Waterworth, & Murray, 2014). This goal is achieved by using technology to manipulate the quality of personal experience in three separate but related ways (Botella et al., 2012; Riva, Baños, Botella, Wiederhold, & Gaggioli, 2012):

(a) *By structuring the personal experience* using a goal, rules and a feedback system; e.g. serious games that simulate real-world events or processes with the purpose of training how to solve a problem.
(b) *By augmenting the personal experience* offering multimodal and mixed experiences; e.g. neurofeedback and biofeedback that allow individuals to become aware of what's going on inside their body, and to control its functioning.
(c) *By replacing the personal experience* with a synthetic one; e.g. virtual reality that allow individuals to be "present" in a synthetic environment as if it were their surrounding world.

Within this perspective, two main groups of positive technologies emerged in a recent systematic review, in relation to the management of psychological stress: virtual-interactive environments and mobile technologies (Serino et al., 2014). Certainly, they may offer different challenges and opportunities for stress management: while virtual environments allow participants to experience meaningful interactions with stressful environments and to learn coping abilities, mobile technologies are suitable for multimedia presentation of contents and are useful to provide assessment of participants in their everyday life. If the potentiality of virtual reality (VR) in reducing anxiety and psychological stress is already known (Choi et al., 2005; Goncalves, Pedrozo, Coutinho, Figueira, & Ventura, 2012; Gorini & Riva, 2008; Ling, Nefs, Morina, Heynderickx, & Brinkman, 2014; Parsons & Trost, 2014), smartphone is a promising new tool to support health interventions. For example, Villani and colleagues tested the

efficacy of stress management protocol delivered through mobile phones with a control group in sample of 30 female oncology nurses (Villani et al., 2011). They argued that the advantages of using a mobile approach to deliver stress management exercises could be an acquisition of coping skills in an autonomous way (Storr, 1990), an ubiquitous and effective support in facing daily stressful situations, an enhancement of individual's acceptance (Cleland, Caldow, & Ryan, 2007).

Moreover, several researchers have started investigating the opportunities offered by wearable biosensors and mobile phones for improving individual well-being (for a recent review, see Kusserow, Amft, & Tröster, 2013). The integrated use of wearable biosensors and mobile phone allows collecting, elaborating and transmitting real-time information related to their psychophysiological state and identifying specific trends (i.e. increasing levels of psychological stress). This approach allows individuals to accurately monitor their psychological health and check their progress with encouraging and motivating feedback enhancing self-efficacy (Bandura, 2005). Gaggioli and colleagues developed and tested the use of PsychLog, a mobile platform that exploits the convergence between mobile phone and wireless wearable biosensors for the collection of psychological, physiological and activity information in naturalistic settings (Gaggioli, Pioggia, et al., 2013). This tool allows administering self-report questionnaires at specific times or randomly during daily life activities. The mobile platform also permits to collect heart rate and activity information from an electrocardiograph (ECG) system equipped with a three-axial accelerometer which transmit data by Bluetooth. By combining self-reports of perceived stress levels with heart rate and activity data, the application makes it possible to investigate the relationship between psychological, physiological, and behavioral variables, as well as to monitor their fluctuations over time.

Based on these premises, Positive Technology was developed as the first application for smartphone and tablet that exploits the potential of new technologies and wearable biosensors for the self-management of psychological stress. This study was aimed to offer a preliminary evidence of the efficacy of a Positive Technology in reducing perceived psychological stress, heart rate values, and feelings of anxiety, assessed as increase of hedonic valence and decrease of arousal.

METHOD

Participants

Overall, 744 users downloaded the Positive Technology app from the Apple Store (in its different iPad/iPhone versions). Totally 138 of these gave the consent to use their data in the MySql database which contains the users' data, for a total of 539 sessions of stress management exercise, both guided relaxation exercises or biofeedback (see below the detailed description of Positive Technology). However, only the data collected from those users who performed at least one session of stress management exercise for at least 120 seconds were considered in the analysis. Applying this inclusion criteria, 68 users were included in the sample. From the selected sample, a total of 196 sessions of stress management exercise were analyzed. Out of these sessions, 63 were performed in combination with a biosensor to collect in real-time psychophysiological data (heart rate data).

Positive Technology

Positive Technology is an application for mobile phone and tablet (free downloadable at: https://itunes.apple.com/app/id770041892) composed of a three-steps to help the individual to learn several effective relaxing techniques and coping abilities to manage psychological stress**:** (1) Guided Relaxation; (2) 3D Biofeedback Training; (3) Stress Self-Tracking. For a detailed description, please see Gaggioli and colleagues (Gaggioli, Cipresso, et al., 2013).

(1) *Guided Relaxation.* In the Guided Relaxation, users can find a guided relaxation

training in 4 phases. It is possible to choose between four different learning medium to support the guided relaxation training: audio, 2D /3D environments and Virtual Reality Island. In particular, six relaxing music traces and 2D/3D environments (from beach or forest to campfire or mountain hiking) are specifically designed to support relaxation accompanied by narratives. These narratives are based on the most effective stress management techniques, such as Autogenic Training (Schultz, 1999) and Progressive Muscle Relaxation (Jacobson, 1938). Finally, users can freely navigate in the engaging Virtual Reality Island choosing between the different relaxing music and putting into practice the stress management techniques they learnt (see Figure 1).

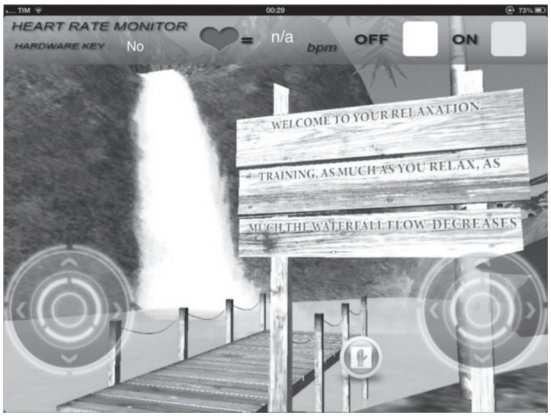

Figure 1. A screenshot of Virtual Reality Island.

(2) *Biofeedback Training.* In the Biofeedback Training, users can learn and train to relax by using biosignals from one's own body within an engaging Virtual Reality Island. This section consists of a portable heart rate monitor connected via Bluetooth interface with the mobile application (the current version of the application supports all commercial cardiac monitoring sensors providing Bluetooth Smart protocol). The heart rate is displayed in form of animated 3D visual feedback to the user: by controlling the respiration rate, variations in the heart rate control the features of the virtual environment, such as the increase or the decrease of the size of a virtual campfire or waterfall (see Figure 2).

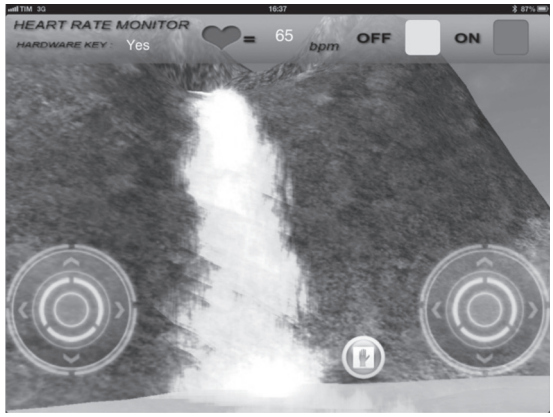

Figure 2. A screenshot of Biofeedback Training.

(3) *Stress self-tracking.* Users have two options to track their psychophysiological state. First, it is possible to report the perceived stress level on a 10-point scale and the arousal-valence levels on a modified version of the Self-Assessment-Manikin (SAM), the non-verbal pictorial assessment scales developed by Lang (Lang, 1980). Specifically, the arousal scale includes 5 values (1=relaxed; 5=excited) and the valence scale includes 5 values (1=unpleasant; 5=pleasant) (see Figure 3).

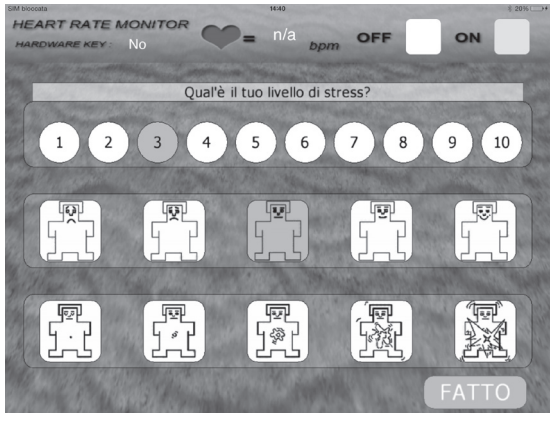

Figure 3. A screenshot of Stress Self-Tracking.

Second, if the application is connected with a biosensors, it immediately captures s heart rate values before and after each stress management exercise (either biofeedback or relaxation). Heart rate values collected by the application are updated on the remote MySql Database through Internet connection. The user can also visualize the history of stress

Table 1. Repeated measure ANOVA results the Positive Technology App. Values are shown as mean *(SD)*

	Pre-exercises	Post-exercises	*F*	*p*	η_p^2
Perceived Stress Level	5.93 (2.55)	4.91 (2.89)	27.26	***	123
Arousal	3.12 (1.28)	3.57 (1.4)	23.51	***	.108
Valence	2.87 (1.16)	3.17 (1.32)	8.57	**	.042
Heart Rate	23 (5.0)	15.5 (5.0)	16.5	n.s.	.441

*** $p < .001$; ** $p < .01$; * $p < .05$.

levels variations by logging into the service website.

RESULTS

Data were exported to Microsoft Excel and analyzed using SPSS version 18 (Statistical Package for the Social Sciences–SPSS for Windows, Chicago, IL, USA).

To investigate the efficacy of Positive Technology, a series of repeated measure ANOVAs were performed using the following dependent variables: perceived stress, arousal, valence and the heart rate. Regarding the perceived stress level, results showed a significant decrease after the stress management exercise [F (1, 195) = 27.25, $p < .001$, $\eta_p^2 = 0.123$]. Findings showed also a significant decrease of arousal [F (1, 195) = 23.50, $p < .001$, $\eta_p^2 = 0.108$] and a significant increase of valence [F (1, 195) = 8.57, $p < .01$, $\eta_p^2 = 0.04$]. There was a pre-post decrease in mean heart rate values, although not statistically significant. Table 1 summarizes the results.

CONCLUSION

The main objective of this study is to investigate the efficacy of Positive Technology, a free mobile application, in supporting individuals in the self-management of psychological stress. Our results showed that the stress management exercises (either biofeedback or relaxation) performed with the application were effective in reducing users' discomfort, as highlighted above all by the significant decrease in perceived psychological stress levels after the session. Moreover, it is possible to note a significant decrease in anxiety level (as shown by the reduction in the arousal level), associated with a concomitant increase in the quality of experience (as shown by the gain in the values of hedonic valence) after the stress management exercises. In addition, a pre-post decrease in heart rate values was observed, although the difference was not statistically significant.

Although preliminary, overall these data suggest that even a brief stress management exercise carried out on a mobile application might be useful in reducing psychological stress. As summarized by Preziosa and colleagues (Preziosa, Grassi, Gaggioli, & Riva, 2009), mobile phone can respond to different clinical needs. First, the incredible diffusion of mobile platforms reduces the digital divide and guarantee the availability of the contents any time and everywhere. Since smartphones and tablet are now widely integrated in both individual and social life, people have the opportunity to perform stress management exercises everywhere, also at workplace where they are particularly helpful to reduce maladaptive stress response. Second, even if the best validated approach for stress management is the cognitive behavioural therapy (CBT) approach (Bisson & Andrew, 2005; Thomson & Page, 2007; Whalley et al., 2011), today there is a call for brief and semi-structured interventions aimed at helping individuals to manage their emotions. In this perspective, smartphones may offer a new platform for delivering stress management programme. Specifically, they offer the possibility to insert interactive feedback, which increase both users' compliance to the treatment and their self-efficacy thanks to the autonomous acquisition of active coping skills.

Finally, smartphones are equipped with several sensing capabilities (i.e., geo-referred data, accelerometer, proximity, ambient light detector, and so on), which permit the detection, recognition, and identification of a number of activities and context information. These data can be used in combination with subjective

self-reports to determine individuals' psychophysiological state. The incredible convergence between ubiquitous computing and wearable biosensors allowing the collection, the aggregation and the real-time visualization into reports of personal health data, opens new chance for health care system, namely the use of "smart tools" (Gaggioli & Riva, 2014).

However, due to the limited number of users wearing the biosensor during the stress management exercises, it was not yet possible to provide significant evidence of the efficacy of Positive Technology in reducing heart rate values.

A future challenge is to include more advanced stress monitoring features, based on the analysis of heart rate variability (HRV) indexes. Indeed, several spectral and temporal or non-parametric methods may be used to compute HRV indexes to specifically evaluate the autonomic nervous system response, as indicators of psychological stress (Ahuja, Agarwal, Mahajan, Mehta, & Kapadia, 2003; Barbieri, Triedman, & Saul, 2002; Kramer, 1999; Lewicki, Tomlinson, & Gillespie, 2006; Malik et al., 1996). A controlled randomized trial, including a control group and standardized outcome measures, is needed to further evaluate the efficacy of Positive Technology in reducing psychological stress in terms of resource optimization and acquisition of effective coping strategies. Above all, this study offers a preliminary evidence of the efficacy of Positive Technology in reducing symptoms of psychological discomfort and improving well-being.

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• Eötvös Loránd University, Budapest, Hungría

Información:
web: http://icba.mat.org.hu

XII International Conference on Applied Psychology

Lugar y fecha:
Tokio (Japón), 28-29 de mayo de 2015

Organiza:
• Word Academy of Science, Engineering and Technology

Información:
Web: www.waset.org/conference/2015/05/tokyo/ICAP/call-for-papers

14th European Congress of Psychology

Lugar y fecha:
Milán (Italia), 7-10 de julio de 2015

Organiza:
• European Federation of Psychologists Associations (EFPA)

Información:
Web: www.ecp2015.it/

45th EABCT Annual congress
A road to hope and compassion for people in conflict

Lugar y fecha:
Jerusalén (Israel), 31 de agosto – 3 de septiembre de 2015

Organiza:
• European Association of Behavioural and Cognitive Therapies
• Israel Association for CBT (ITA)

Información
Web: www.isas.co.il/eabct2015/

IX Congreso de la Asociación Española de Psicología Clínica y Psicopatología

Lugar y fecha:
Valencia (España), 23-24 de octubre de 2015

Organiza:
• Asociación Española de Psicología Clínica y Psicopatología.

Información:
Web: www.aepcp.net

I International Congress of Clinical and Health Psychology with children and adolescents

Lugar y fecha:
Madrid (España), 12-21 de noviembre de 2015.

Organiza:
• AITANA Investigación

Información:
Web: http://psicologiainfantil.umh.es