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Positive Technologies for Understanding and Promoting Positive Emotions

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Abstract. Information and Communication Technologies (ICTs) have become increasingly present in our lives, and their use has spread considerably. This paper presents a review of the way ICTs can help practitioners and researchers to study, promote, and train positive emotions. It is framed within the field of Positive Technologies: the applied scientific approach to the study of the use of technology to improve the quality of personal experience, with the goal of increasing wellbeing. First, the article presents an introduction to the topic of technologies and positive emotions. Then, it describes how ICTs can aid in monitoring, assessing, promoting, modifying, and training positive emotions. Finally, implications and future directions of the role of Positive Technologies in positive emotions are discussed. The authors conclude that, in the near future, Positive Technologies and the field of positive emotions will interact synergistically, producing an exponential growth in the understanding and promotion of positive emotions.

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One of the distinguishing features of human beings is their ability to create and use tools, and some of the latest tools developed are the Information and Communication Technologies (ICTs). These tools have become increasingly present in our lives, and their use has spread incredibly. "Smart" devices make everything easier, and smartphones are used constantly every day. It is difficult to imagine working without a computer, holiday photos are shared on social media, and YouTube videos make it possible to learn new recipes.

ICTs currently have a strong impact on individuals and their surrounding world. Specifically in Psychology, developments are constantly being designed, tested, and used to improve people's quality of life and wellbeing (Internet-based therapies for depression, Virtual Reality environments to treat phobias, apps to help people flourish, and much more). These developments have had an even greater impact in the specific field of emotions. We could say that there has been an "emotional revolution" in the technology and scientific field, due to the interest in developing technologies that are able to identify, monitor, analyze, and regulate emotions (e.g., MIT Media Lab, 2016). Some of these efforts concentrate particularly on positive emotions, which is one of the focus of Positive Psychology (PP). Based on Seligman and Csikszentmihalyi (2000), PP is the scientific study area that helps psychologists to understand and build factors that allow individuals, communities, and societies to flourish and feel "happy" and "well". Applications and interventions in this field are designed to identify people's strengths and build resilience, engagement, and meaning. It is clear, then, that there is a direct link between PP and technologies, and some approaches help us to conceptualize this association (Botella et al., 2012).

On the one hand, Calvo and Peters (2013) described the term "Positive Computing" as the design and development of technology to support psychological wellbeing and human potential. The authors classified these technologies in three categories: (A) *Preventative technologies*: those that treat obstacles to wellbeing as errors (i.e., redesigning Facebook after research revealed that one of its features encourages cyberbullying); (B) *Active technologies*: those in which a new feature is added specifically to promote wellbeing (e.g., adding a "thanks" button based on evidence that expressing gratitude increases overall wellbeing); and (C) *Dedicated technologies*: those developed specifically to promote one or

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more factors of wellbeing (e.g., mindfulness mobile applications).

On the other hand, Riva, Baños, Botella, Wiederhold, and Gaggioli (2012) and Botella et al. (2012) proposed the term "Positive Technology" (PT), defined as the scientific and applied approach to the study of the use of technology to improve the quality of the person's personal experience, with the goal of increasing wellbeing and promoting strengths and resilience in individuals, organizations, and society. That is, PTs combine the goals of PP with the enhancements of ICTs to foster positive emotions, support individuals in reaching engaging and self-actualizing experiences, and improve social integration and/or connectedness between individuals and groups. In short, to promote wellbeing. This approach establishes a classification of technologies based on the PP conceptualizations, specifically classifying PTs in three levels, depending on their objectives: (A) *Hedonic level* ("the enjoying self"): mood-altering devices, technologies used to induce positive and pleasant experiences; (B) *Eudaimonic Level* ("the growing-self or self-empowerment"): technologies used to support individuals in reaching engaging and self-actualizing experiences; and (C) *Social/Interpersonal level* ("the net-shared-self"): technologies used to support and improve social integration and/or connectedness among individuals, groups, and organizations (see Baños, Etchemendy, Carrillo-Vega, & Botella, 2016; Botella et al., 2012; Riva et al., 2012 for further descriptions).

This paper focuses specifically on PTs that can be useful for assessing, promoting, modifying, and training positive emotions. Each section is focused on a specific area of positive emotion research. Finally, we discuss the implications and future directions of the role of PTs in positive emotions.

PTs for monitoring positive moods and emotions

Today, sensors are increasingly integrated into the products we use daily, allowing activities and experiences to be monitored. Currently, there are many developing technological advancements designed to scan and measure emotions and moods. For instance, devices can assess physiological variables (i.e., skin conductance, heart activity), detect body movements (i.e., walking posture), or recognize facial expression or emotions during speech. It is also possible to measure other relevant variables that are clearly related to mood and emotions, such as physical activity, sleep patterns, or a healthy diet.

The widespread use of smartphones brings new opportunities to measure emotions. Most of them already have embedded sensors to detect users' activity and experiences, and even environmental variables. With technologies such as accelerometers, global positioning systems (GPS), gyroscopes or light sensors, among others, they can collect large amounts of ecologically valid data easily and quickly from large global samples (Miller, 2012). Currently, there are many apps on the market that monitor users' behaviors and give them feedback in order to increase their awareness of how these lifestyle choices impact their personal wellbeing (e.g., IMS Institute for Healthcare Informatics, 2015).

Emotions and experiences can also be monitored through our "digital footprints". As we use the Internet and other ICTs, we leave records and traces behind us (location, visited webpages, social networks…). All these footprints offer complex social and dynamic data that can be useful to develop theories to better understand and predict human emotions and behaviors in context and select optimal interventions depending on the specific characteristics of the situation and the user (Kosinski, Wang, Lakkaraju, & Leskovec, 2016). It is possible, for instance, to predict individual wellbeing through Facebook users' natural language (Schwartz et al., 2016).

In conclusion, ICTs have considerably improved the way we monitor emotions in general, and positive emotions in particular, providing a continuous and reliable record of almost any variable related to them. The foreseeable future will provide even more spectacular innovations that will increase the reliability and validity of these records. These data are likely to be very useful for generating theories and explanatory models of why, when, and how emotions emerge (Saranummi et al., 2013).

PTs for inducing positive emotions

The possibility of inducing emotions in a controlled and experimental way has been a topic of interest in Psychology for many years. In recent decades, a set of procedures have been developed that are able to induce emotional changes in experimental contexts. They are called "Mood Induction Procedures" (MIPs), strategies designed to provoke a transitory emotional state in an individual in a non-natural setting in a controlled manner (García-Palacios & Baños, 1999). MIPs are supposed to create an experimental analogue for the mood that would arise in a certain natural situation. They include a wide variety of methods that have been shown to be effective in achieving changes in the target mood in the context of emotion research, psychological treatments, and the promotion of wellbeing and positive emotions (e.g., Baños et al., 2005).

Virtual Reality (VR) has been proposed as a useful tool to increase the effectiveness and potential of MIPs (e.g., Baños et al., 2005; Baños et al., 2012; Baños et al., 2013; Felnhofer et al., 2015). VR can be considered as an advanced imaginal system that allows users to become

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immersed in a computer-generated environment that is as effective as reality in inducing emotional responses (Riva, Baños, Botella, Mantovani, & Gaggoli, 2016). With this technology, users do not need to rely on internal imagery or their ability to visualize: VR not only generates the (emotional) images, but it also enables the user to directly experience emotions. The use of this technology has additional advantages (Botella et al., 2004; Wilson & Soranzo, 2015). It allows greater control over stimuli presentation and the study of situations that can be impractical or ethically questionable in real life. In addition, complex 3D scenarios can be created with different levels and combinations of multimodal sensory input (allowing audio, haptic, olfactory, and motion to be experienced simultaneously with the graphical environment). It also allows greater variety and more ecological responses and the possibility of examining sophisticated, complex participant behaviors.

VR used as MIP (VR-MIP) could be a useful PT at both "hedonic" and "eudaimonic" levels. Because they can help users to achieve positive emotional states and wellbeing in the short term, they could be considered a "hedonic technology". In addition, people who continue to practice positive emotions regularly could increase other positive strengths, making it an "eudaimonic technology". In fact, VR-MIPs have been examined in some studies with the aim of promoting positive emotions and wellbeing. Our group has developed several systems with these objectives, and they have been validated in different populations with positive results (adolescents, university students, oncology patients, depressed people, isolated astronauts, elderly, etc.) (e.g., Baños et al., 2008; Baños et al., 2012; Baños et al., 2013; Baños et al., 2014; Botella, Baños, Etchemendy, García-Palacios, & Alcañiz, 2016; Etchemendy et al., 2011; Serrano, Botella, Baños, & Alcañiz, 2013; Vara et al., 2016).

In a similar direction, Gaggioli, Chirico, Triberti, and Riva (2016) proposed the use of VR to induce complex positive emotions such as awe, a multifaceted emotion where fear is blended with astonishment, admiration, and wonder. These authors suggest Computer-Mediated Self-Transcendence as a possible new research path. It refers to the use of interactive technologies to promote, facilitate, or enhance peak experiences (out-of-the-ordinary life moments that allow individuals to experience something greater than themselves, reflect on deeper dimensions of their existence, shape lasting spiritual beliefs, and enhance feelings of connectedness). Research on the application of VR to these experiences is promising but scarce. A pioneering example is the "Virtual Space Lab" (Gallagher et al., 2014), a virtual simulation designed to produce the experiences of awe and wonder reported by astronauts during space flights.

Based on all these studies, we can assert that VR-MIPs are very useful tools for promoting and training positive emotions. Moreover, they have shown their utility in the research on positive emotions, providing knowledge about the variables involved in emotional processing. For example, our group is studying the role of body movements in positive emotions and motivation. Specifically, we have examined the effects of an approach body movement (pedaling on an exercise bicycle) combined with joy induction (through VR-MIPs) on cognitions about achieving a personal goal. Preliminary data has shown that there is an influence of body movements on approach motivation when inducing a positive emotion (Vara, Miragall, Cebolla, & Baños, 2016).

Holmes and Mathews (2010) point to the potential of imagery in understanding emotions and emotional disorders, and we think VR can be useful for the same purposes. These authors suggest that imagery can be a powerful tool to promote learning processes, including emotional and behavior learning. Specifically, in emotion processes, imagery seems to play a key role (i.e., it produces a more powerful impact on emotion than verbal processing of the same material). We propose that these possibilities are also present in VR because it is able to produce not only an immersive environment, but emotional experiences as well. Thus, VR may be a promising tool for studying emotions and therapy.

PT for promoting empathy and compassion

Empathy and compassion are two positive emotions that share common attributes: both include the echo of another person's emotional state. Empathy is the ability to share and understand another's "state of mind" or emotion (Ioannidou & Konstantikaki, 2008), whereas compassion is an emotional state produced by another person's suffering that motivates the individual to alleviate this pain (Araya & Moncada, 2016; Feldman Barrett, Lewis, & Haviland-Jones, 2016). The benefits of these emotions for both individual and social wellbeing are well known (Feldman Barrett et al., 2016). VR is currently being studied as a tool to foster and understand empathy and compassion.

Regarding empathy, VR can give users the opportunity to walk in another person's shoes and understand different perspectives, as it provides greater immersion than just a 2D video on a screen. Users can actually *live* another reality. All these features can foster a feeling of empathy for someone else. One example is the study by Ahn, Le, and Bailenson (2013), which analyzed the effect of embodying another person's perceptual experiences (color blindness) on perspective taking and helpful behaviors. They found that participants who embodied the colorblindness perception (through VR) experienced greater "self-other merging"

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and voluntarily made twice as much effort to help people with colorblindness, compared to participants who had only imagined being colorblind. Even the United Nations has used VR to foster empathy. For example, they developed the project "Clouds over Sidra", a short 360° VR film about a girl (Sidra) who lives in a Syrian refugee camp in Jordan and shows users what it is like to live in there (Milk & Arora, 2015). All these examples show VR's potential for promoting empathy, with the resulting individual and social benefits.

Furthering the possibilities of VR, there is a new development that can lead to empathy and compassion induction: "The Machine to Be Another" (www.themachinetobeanother.org). It is a low budget system created by BeAnotherLab that uses multi-sensory stimuli (visual, tactile, proprioceptive, and audio) to induce a body swap illusion. It works using a head-mounted display that shows the perspective of another person (the performer, who holds a first person camera controlled by the participant's head movements). This performer mimics the participants' movements, so that both (performer and participant) move in synchrony. When the latter interacts with the physical space, s/he also receives realistic tactile stimuli. All these features facilitate the body swap illusion: one has the feeling of being in the performer's body, identifying with him/her. This system has many possibilities in working with empathy: the feeling of being in another person's skin (a real person, not an avatar) can enhance feelings of empathy (Collaçao De Oliveira et al., 2016). At this time, there is only preliminary but promising data, based on the statements of users and performers. The authors argue that the system has great potential as a social tool to stimulate empathy and compassion among different groups, and because it is very flexible, it can be used in a wide variety of applications in empathy and compassion research and related topics such as conflict mediation, psychotherapy, and so on.

PTs for studying the body-emotion relationships

As Damasio (1999) and Frijda (1986) remind us, emotions cannot be understood without considering the body: "emotions are a matter of the body: the heart, stomach, intestines, body activity and impulse. They are of the flesh and sear the flesh" (Frijda, 1986, p. 5). So far, we have seen how VR can help to study and promote positive emotions, providing a recreation of external reality through a simulated environment. However, VR can also further the understanding of the inextricable relationship between body and emotions. Thus, it is also possible to use VR to simulate our "internal reality", including the way we perceive our bodies, control them, and affectively react to what happens to them.

According to Riva et al. (2016), the inclusion of the body in VR is possible in at least two ways: through "incarnation" (making users feel their physical body within a virtual environment), or through "embodiment" (making users experience the synthetic avatar as if it were "their own body", that is, as if their physical body had been replaced by the virtual one). "Embodiment" takes place when a virtual body coincides spatially with the participant's real body and the participant sees through the eyes of this body and experiences various degrees of synchronous multisensory correlation – such as visuomotor (Falconer et al., 2014). These body illusions can be very powerful, and they have physiological and psychological consequences (e.g., Barnsley et al., 2011; Peck, Seinfeld, Aglioti, & Slater, 2013).

Because it is possible to create embodiment illusions through VR, this tool can be considered an "embodied technology" (Riva, 2008). Thus, it has different advantages. First, it makes it possible to amplify the "modeling" of learning. During this experience, the avatar is the participant's own body, as well as the learning model (e.g., Aymerich-Franch, Kizilcec, & Bailenson, 2014). Second, we can study the assumptions of "embodied cognition and emotion theories" and analyze the relationships among posture, body movements, body actions, cognition, and emotion. These theories state that our body has a direct influence on our cognition and emotions (Price, Peterson, & Harmon-Jones, 2012). Manipulating our bodies through virtual bodies and environments can greatly amplify the possibilities for research in this field. For instance, in a previous section we stated that we are studying the inclusion of movements in virtual environments to promote positive emotions. Third, VR fosters the experience of simple and complex emotions (for example, using embodiment processes to promote empathy and compassion). We saw some examples in the previous section (Ahn et al., 2013; Collaçao De Oliveira et al., 2016). Finally, VR can be used to alter or model the boundaries of the body and more closely analyze the body agency and ownership processes (Banakou, Groten, & Slater, 2013).

In this regard, a basic question arises: is it necessary to have a realistic virtual body in order to experience embodiment with it? In fact, people psychologically identify with virtual representations that do not necessarily reflect their actual appearances. VR can provide the person with a new self-representation very easily by modifying the appearance of his/her avatar. Transforming the appearance of one's self is a particularly powerful VR application that can cause behavioral, emotional, and attitudinal changes (Aymerich-Franch et al., 2014). For example, Yee and Bailenson (2007) proposed the process called the "Proteus effect" (when an individual's behavior conforms to his/her digital

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self-representation, i.e., a taller or more attractive avatar), and Osimo, Pizarro, Spanlang, and Slater (2015) found that embodying a counselor (Sigmund Freud) while giving self-counseling about a current problem produced a more satisfactory outcome compared to embodying a lookalike representation of oneself.

VR has also been used as an "embodied technology" in the self-compassion field. As mentioned above, "The Machine to Be Another" system can promote empathy and compassion. Other studies have also explored how VR and virtual body illusions can help to promote self-compassion. For instance, Falconer et al. (2014, 2016) used VR to offer people the experience of delivering compassion to themselves. Participants interacted compassionately with a crying child while embodied in an adult avatar. Then, half of them embodied the child avatar and could re-experience their compassionate response from this perspective. The other half watched the compassionate response from a third person perspective. The former group significantly increased their scores on self-compassion, compared to the latter group.

In conclusion, VR is able to induce the illusion of being another person or having another body. It allows manipulations that would be unethical or even impossible when performed in the real world. These manipulations have important psychological consequences and may influence the way people perceive their actions and their consequences (and even themselves). In this regard, VR opens the door to new experimental procedures and new therapeutic strategies that will be explored and developed in the near future.

PTs for training positive emotions

In addition to what has been presented so far, PTs have also been shown to be useful tools for training positive emotions (e.g., Vara et al., 2016; Wrzesien et al., 2015). Positive Psychology Interventions (PPIs) are defined as interventions or intentional activities designed to cultivate positive feelings, cognitions, and behaviors (Sin & Lyubomirsky, 2009), and they can be improved with the use of ICTs. In fact, many PPIs have been developed in the context of PTs (Baños, Etchemendy, Carrillo-Vega, & Botella, 2016). The development of these interventions, especially those delivered online (Online PPIs), has increased spectacularly in recent years. With the increasing use of smartphones, many free applications (apps) are being developed constantly. Specifically in the field of emotions, there are many, and so people in search of greater wellbeing have the opportunity to engage with thousands of downloadable self-help apps (Howells, Ivtzan, & Eiroa-Orosa, 2016). It is not within the scope of this work to summarize all the ways ICTs can train and modify positive emotions (for a review, see Baños et al., 2016; Baños et al., 2017; Bolier et al., 2013; Bolier & Abello, 2014). We will only point out the emerging problems with the validity of all these applications. Not all of them are evidence-based programs, and users do not know whether they are trustworthy or not. There is a "race" between evidence-based interventions and systems (which need time to be developed and validated) and user-level systems developed by individuals or companies without a scientific background (which are more quickly developed and launched). ICTs, and even PTs, also have a "dark side".

Conclusions

PTs play a key role in the field of positive emotions. They allow us to collect large amounts of ecological data in real contexts and analyze many variables through users' digital footprints. There is considerable evidence of the efficacy of PTs in inducing different positive emotions through systems such as VR. The relationship between emotions and the body is a promising field where PTs can contribute substantially, and these technologies have also proven to be efficacious tools for training and regulating positive emotions.

As in other scientific fields, technologies have produced a revolution in the area of emotions. Although ICTs are only tools and not the answers *per se,* they can help us to better respond to the right questions. As ICTs become more complex and dynamic, they allow us to change the questions too. Soon, an inconceivable quantity and variety of data will be available, allowing researchers to delve into the knowledge about positive emotions: how they emerge and how to promote and train them. The question is not only whether the interventions or inductions are effective or not, but also how, why and for whom. Here, technologies will make a significant contribution, and this is an important challenge in this area.

The advancement of technology is a promising field that is already changing our way of living and doing research. It is easy to become enthusiastic about it, but we should also be cautious. In this paper, we have outlined the positive aspects of PTs, but there are also problems and risks. Technology is part of our daily lives, and it advances so quickly that it is impossible to ensure the reliability of all the developments. In addition, collecting such a large amount of personal data is a very delicate task. Privacy protection is becoming more difficult as information is multiplied and shared around the world (Tene & Polonetsky, 2012). There are many other limitations we should consider that have been described in other previous studies (e.g., Botella, Garcia-Palacios, Baños, & Quero, 2009). The best precaution in many cases is the umbrella of science, anticipating possible negative consequences and intervening

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as needed. This should be done with adequate scientific rigor and accurate and strict methodological and ethical control.

Taking these considerations into account, the 21st century represents a new era in which PTs and the field of positive emotions will interact synergistically, producing an exponential growth in the understanding and promotion of positive emotions.

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