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Positive Technology for Healthy Living and Active Ageing

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Abstract. Information and communication technologies are widely and rapidly spreading in people's daily lives. But what is the possible role of the mass proliferation of digital devices in supporting healthy living and active ageing? Are they useful in fostering personal growth and individual integration of the elderly, by promoting satisfaction, opportunities for action, and self-expression? Rather, do they enhance automation, impose constraints on personal initiative, and result in compulsive consumption of information? In this chapter, we suggest that possible answers to these questions will be offered by the "Positive Technology" approach, i.e., the scientific and applied approach to using technology so that it improves the quality of our personal experiences through its structuring, augmentation, and/or replacement. First, we suggest that it is possible to use technology to manipulate the quality of experience with the goal of increasing wellness and generating strengths and resilience in individuals, organizations, and society. Then, we classify positive technologies according to their effects on these three features of personal experience - Hedonic: technologies used to induce positive and pleasant experiences; Eudaimonic: technologies used to support individuals in reaching engaging and self-actualizing experiences; Social/Interpersonal: technologies used to support and improve the connectedness between individuals, groups, and organizations. Finally, we discuss the possible role of positive technologies for healthy living and active ageing by presenting different practical applications of this approach.

Keywords: Positive Technology, Active Ageing, Healthy Living, Engagement, Resilience, Positive Psychology, Intergenerational Reminiscence, Well-Being

Introduction

The development of new communication technologies has changed the way many of us interact and live. Internet communication systems and social networking sites, such as Facebook, Instagram, and WhatsApp, have revolutionized the way younger people communicate. However, this is not the case for people over 65; recent research has shown that they have been largely excluded from this revolution and the benefits it brings [1].

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But what is the possible role of the mass proliferation of digital devices in supporting healthy living and active ageing? Are they helpful in fostering personal growth and individual integration of the elderly by promoting satisfaction, opportunities for action, and self-expression? Rather, do they enhance automation, constraints on personal initiative, and compulsive consumption of information?

In this chapter, we suggest that possible answers to these questions will be offered by the "Positive Technology" approach, i.e., the scientific and applied approach to the use of technology for improving the quality of our personal experience through its structuring, augmentation, and/or replacement [2-7]. Specifically, in the following paragraphs, we discuss the possible role of positive technologies for healthy living and active ageing [8] by presenting different practical applications of this approach.

1. The Relevance of Positive Technology for Active Ageing and Healthy Living

Ageing is associated with decline in physical health, mental well-being and functional abilities. Fortunately, age-related declines can be delayed by improving the quality of the personal experiences of the elderly [9, 10]. A common approach that can be used to reach this goal is lifestyle interventions that promote well-being in older people [9]. In this paragraph we suggest that technology, too, may play an important role in this process.

1.1. From Well-being to Personal Experience

According to the World Health Organization, "Mental Health" is defined as follows [11]:

> "Mental health is a state of well-being in which the individual realizes her or his own abilities, can cope with the normal stresses of life, can work productively, and is able to make a contribution to his or her community."

This definition clearly identifies both well-being and positive functioning as core elements of mental health. But what is well-being?

It is possible to define "subjective well-being" as the cognitive and/or affective appraisal of one's own life as a whole, while the term "psychological well-being" refers to the optimal functioning of the individual and includes concepts such as flow, hope, and resilience [12]. Both definitions, however, have their starting point in the personal experience of the individual: high well-being means that, in some sense, the individual's personal experience is positive.

According to Merriam Webster's Collegiate Dictionary (http://www.merriam-webster.com/dictionary/experience), it is possible to define experience both as "a:) direct observation of or participation in events as a basis of knowledge" (subjective experience) and "b: the fact or state of having been affected by or gained knowledge through direct observation or participation" (personal experience).

However, there is a critical difference between subjective experience and personal experience [6]. If subjective experience is the experience of being a subject (experience as subject), personal experience is the experience that affects a particular subject (experience as object). This simple shift suggests that, independently from the

subjectivity of any individual, it is possible to alter the features of our experience from the outside [5-7].

Cognitive psychology has shown how the characteristics of our personal experience are influenced by the degree of sensory stimulation, sensory perception, and the meanings and values attributed, and the emotions elicited by the experience itself [13]. So, we can have relevant experiences, positive or negative, that, then, we remember for a lifetime and we can have experiences that we forget as soon as they end. Further, most of our experiences are cultural and interpersonal activities in which individual experience is connected to and/or mediated by collective experience [13].

Finally, clinical psychology has clearly shown that personal change occurs through an intense focus on a particular experience [14] By exploring this experience as thoroughly as possible, the subject can relive all of the significant elements associated with it and make them available for reorganization [15].

In other words, personal experience becomes the dependent variable that may be manipulated by external researchers.

2. Positive Technology for Improving the Quality of our Personal Experience

The characteristics of personal experience suggest that it is possible to manipulate its quality with the goal of increasing wellness, and generating strengths and resilience. But how is it possible to achieve this goal?

The emerging discipline of Positive Psychology, which focuses on the bio-psycho-social aspects of cognitions, emotions, and positive experiences [16, 17], provides a useful framework for guiding our efforts. Positive Psychology can suggest how to develop technological systems and applications that foster positive emotions, promote personal growth, and support creativity, thereby contributing to social and cultural development.

Martin Seligman, who is considered the father of the Positive Psychology movement, identified the "three pillars" of the good life in his book "Authentic Happiness" [18]:

- *the pleasant life*: achieved through the presence of positive emotions;
- *the engaged life*: achieved through engagement in satisfying activities and the utilization of one's strengths and talents;
- *the meaningful life*: achieved through serving a purpose larger than oneself.

More recently, Seligman introduced the PERMA model, an acronym for the five pillars of well-being, i.e., positive emotions, engagement, relationships, meaning, and accomplishment [19].

Starting from a similar perspective, Keyes and Lopez posited that positive functioning is a combination of three types of well-being, i.e., 1) high emotional well-being, 2) high psychological well-being, and 3) high social well-being [20].

To summarize, Positive Psychology identifies the three characteristics of our personal experience that serve to promote personal well-being, i.e., affective quality, engagement/actualization, and connectedness.

In the proposed framework, positive technologies are classified according to their effects on these three features of personal experience (Figure 1):

- *Hedonic*: technologies used to induce positive and pleasant experiences;

- *Eudaimonic*: technologies used to support individuals in reaching engaging and self-actualizing experiences;
- *Social/Interpersonal*: technologies used to support and improve social integration and/or connectedness between individuals, groups, and organizations.

For each level we will try to identify critical variables that can be manipulated and controlled to design and develop a positive technology.

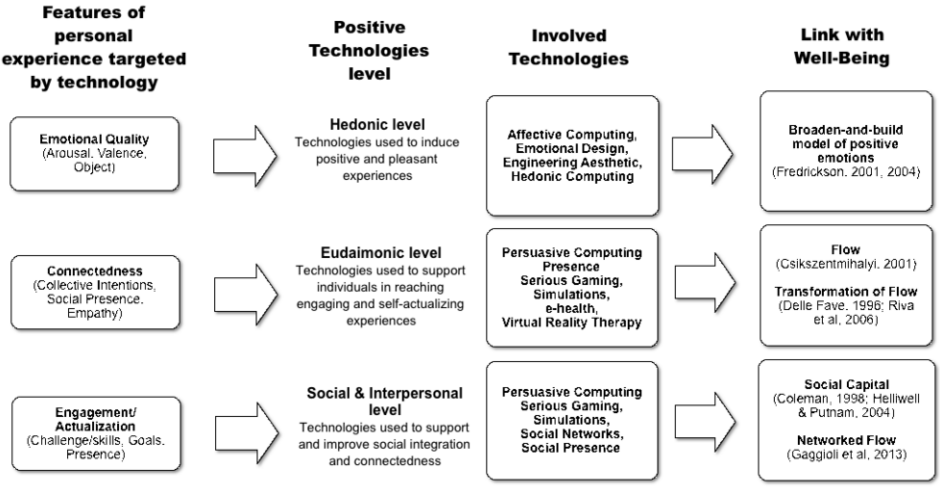

Figure 1. Positive Technology levels (Adapted from [8])

2.1. Hedonic level: using technology to foster positive emotional states in the elderly

The first dimension of Positive Technology concerns how to use technology to foster positive emotional states. According to the model of emotions developed by James Russell [21], it is possible to modify the affective quality of an experience through the manipulation of "core affect," a neurophysiological category corresponding to the combination of valence and arousal levels that endow the subjects with a kind of "core knowledge" about the emotional features of their experience.

The "core affect" arise from a free-floating experience or a specific cause, thus, giving rise to an emotional experience or event. In this view, an emotional response is the attribution of a change in the core affect given to a specific object (affective quality). Simply put, a positive emotion is achieved by increasing the valence (positive) and arousal (high) of core affect (affect regulation) and by attributing this change to the contents of the proposed experience (object).

Key arguments for the usefulness of positive emotions in increasing well-being were provided recently by Fredrickson [22, 23] in what she called the "broaden-and-build model" of positive emotions. According to Fredrickson, positive emotions provide the organism with nonspecific action tendencies that can lead to adaptive behavior [22]. The second proposition of Fredrickson's model concerns the

consequences of positive emotions, i.e., by broadening an individual's awareness and thought–action repertoire, they build upon the resultant learning to create future physical, psychological, and social resources [23].

Different studies have shown that a possible path for improving positive emotions is the use of meditation, in particular mindfulness [24-26]. Mindfulness is a psychological mindset that is focused on being aware of novelty in personal experience and perceiving differences in contexts and events, disrupting stress pathways and possibly having direct beneficial effects on physiological arousal systems [27].

Epel and colleagues, in their review of the effects of mindfulness, suggested that meditative practices improve the endocrine balance toward positive arousal (high DHEA, lower cortisol) and decrease oxidative stress, slowing the rate of cellular aging [24]. They concluded:

> "Thus, meditation practices may promote mitotic cell longevity both through decreasing stress hormones and oxidative stress and increasing hormones that may protect the telomere." (p. 49).

In this process, the role of technology is quite simple, i.e., to facilitate meditation. Our team developed different immersive (computer-based) and non-immersive (tablet-based) virtual reality experiences to improve meditation abilities in untrained individuals [28-32]. The feeling of presence and the immersive visual cue provided by virtual reality (VR) are known to facilitate relaxation, reduce stress, and improve positive emotional states [33-36].

For example, in the "Green Valley" experience, different narratives were presented together with a very relaxing virtual environment showing a mountain landscape around a calm lake. After being immersed in the Green Valley, participants were asked to walk around the lake, to observe nature, and, after few minutes, to virtually sit on a comfortable deck chair and relax[28; 29; 37].

When aimed at relaxation, VR lends itself to be associated with biofeedback training [38, 39]. Biofeedback is a coaching and training technique that helps people learn how to change their physiological response patterns in order to improve their mental and emotional functioning [40]. The person is connected to psychophysiological biosensors and uses the information provided as feedback to increase awareness or consciousness of the changes in the functioning of the body/mind [41].

As recently suggested by different authors [42-44], meditation and biofeedback have the potential for enhancing the functioning of the frontal lobe, which is usually reduced in the elderly.

2.2. The Eudaimonic Level: Using Technology to Promote Engagement and Self-Empowerment in the Elderly

The second level of Positive Technology is strictly related to the eudaimonic concept of well-being, and it consists of investigating how technologies can be used to support individuals in reaching engaging and self-actualizing experiences.

The theory of flow, developed by Positive Psychology pioneer Mihaly Csikszentmihalyi [45], provides a useful framework for addressing this challenge. As discussed in the first chapter, flow or optimal experience, is a positive and complex state of consciousness that is present when individuals act with total involvement. The basic feature of this experience is the perceived balance between high environmental

opportunities for action (challenges) and adequate personal resources in facing them (skills). Additional characteristics are deep concentration, clear rules in and unambiguous feedback from the task at hand, loss of self-consciousness, control of one's actions and environment, positive and intrinsic motivation.

A recent study [46] demonstrated that older adults have the capacity to experience flow when cognitive capacity and intellectual demands are synchronized. Specifically, the older adults who are generally resource-rich have the capacity to be more absorbed by activities of higher cognitive demand as opposed to resource-poor individuals, who are more absorbed with activities of lower cognitive demand.

Here, too, interactive and immersive technologies, such as serious games, robots, or VR, are considered to be the most capable of supporting the emergence of this experience [47-52]. The research that has been conducted to date highlights some key characteristics of technology as a possible source of flow, i.e., (a) *opportunities for action (goals and rules)* – due to its flexibility and interactive and immersive technologies, it provides designers with the possibility of creating a wide range of increasingly challenging situations and tasks; (b) *feedbac*k – interactive and immersive technologies can offer multimodal feedback to individuals' actions and behavior [49, 53]. A study by Belchior and colleagues [54], in which older adults' levels of engagement with a video game training program were investigated, supported this vision. In the study, subjects were more engaged in games that could be adjusted to their skill levels and that provided incremental levels of difficulty.

Starting from these theoretical premises, Riva and colleagues [38, 47, 55] suggested the possibility of using VR for a new type of applications in positive mental health for the ageing based on a strategy defined as "transformation of flow." This strategy is based on a person's ability to draw upon an optimal experience induced by technology and use it to promote new and unexpected psychological resources and sources of involvement.

The proposed approach consists of the following activities (Figure 2). First, using positive technologies to offer an enriched environment that contains *functional*, real-world demands (e.g., finding objects, assembling things, and buying stuff); second, using the technology to provide tasks (challenges) that are to matched to the cognitive capacity of the individual (skills) and to enhance the level of Presence (the feeling of being "inside" the technological experience [56, 57]) to induce an optimal experience; third, allowing cultivation by linking this optimal experience to the actual experience and skills of the subject [55]. The expected effect is a functional reorganization of the brain produced by the broadening of the thought-action repertoire associated with improved self-esteem and self-efficacy.

The first proposed claim, i.e., the possibility of using positive technologies for creating enriched environments offering real world demands, is demonstrated by the Virtual Multiple Errand Test (V-MET) [58, 59]. The V-MET is a VR version of the Multiple Errands Test [60]), which is usually performed at a real shopping mall or in a hospital environment and involves the completion of various tasks with rules that must be followed within a specified time frame. The VR version enables the active exploration of a virtual supermarket in which individuals are requested to select and buy various products presented on shelves. Correlations between Virtual Multiple Errands Test variables (e.g., errors and execution time) and some traditional executive functions measures provide preliminary support for the ecological and construct validity of the VMET. In addition, the performances obtained with the Virtual Multiple

Errands Test provided the ability to distinguish between clinical and healthy populations and between two age-related control groups [58, 59].

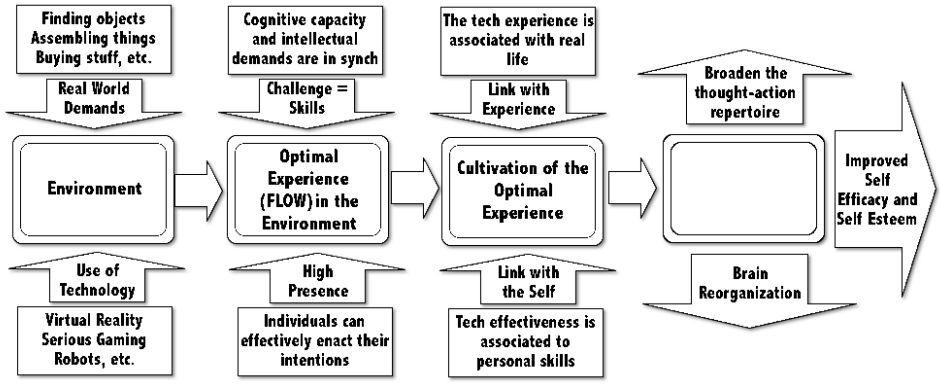

Figure 2: Transformation of Flow

The second proposed claim – the possibility of using positive technologies for fostering optimal experiences in the elderly – was demonstrated by the "V-STORE Project" [61, 62]. The researchers investigated the quality of experience and the feeling of Presence in a group of 10 patients with frontal lobe syndrome involved in VR-based cognitive rehabilitation [61]. They used the ITC-Sense of Presence Inventory Test [63] to evaluate the feeling of Presence induced by the VR sessions. The findings highlighted the association of VR sessions with both positive affect and a high level of Presence.

The third claim – the use of transformation of flow for producing some form of functional reorganization in the elderly who are able to improve their cognitive abilities – received preliminary support by the work of Optale and his team [64, 65]. These authors investigated the experience of elderly individuals with memory deficits engaged in a six-month, virtual-reality, rehabilitative experience, including auditory stimulation and path-finding. The study also included a control group that had equivalent, face-to-face training sessions using music therapy. Only the VR group showed significant improvements in the memory tests, especially in long-term recall with an effect size of 0.7 and in several other aspects of cognition. Thus, the results that were showed that this approach was able to improve memory function [64, 65].

2.3. The Social and Interpersonal Level: Using Technology to Promote Social Integration and Connectedness in the Elderly

The final level of Positive Technology, i.e., the social and interpersonal level, is concerned with the use of technologies to support and improve the connectedness between individuals, groups, and organizations.

Despite the fact that creating and maintaining social relationships is considered a major indicator of well-being and a protective factor for health [66], Western society is characterized by increasing levels of loneliness and lack of social integration. The need for social integration is higher in elderly people. As a consequence, healthcare policies have become increasingly interested in supporting mental health and rehabilitation

programs aimed at overcoming social isolation. Information and communication technologies can have a key role in improving such programs.

An open challenge is to develop an understanding concerning how technology can be used to create a mutual sense of awareness, which is essential to the feeling that other participants are there and to create a strong sense of community at a distance. However, different authors have suggested that it is possible to manipulate the technological experience to enhance social presence, i.e., the feeling of being with others.

Recently, Riva and colleagues [67, 68] suggested that a subject is present within a virtual group if he or she is able to put his or her own intentions (presence) into practice and is able to understand the intentions of the other members of the group (social presence). This implies that, to sustain experiences that are optimal socially (networked flow), the technology must provide the virtual group with the possibility of expressing itself and of understanding what each individual member is doing [69]. In addition, Gaggioli and colleagues [70] posited that the optimal state of the group is achieved when the team develops a "we-intention," in which the actions of the individuals and of the group are merged, and the group acts as an autonomous, self-organizing entity [71].

An interesting example of this approach is the use of technologies to improve inter-generational reminiscence [72]. Inter-generational reminiscence offers the potential for reducing existing barriers between generations by transmitting the heritage of folk traditions and by triggering the interest of younger people concerning their roots [73]. To facilitate this process Gaggioli and colleagues used an interesting approach: a) the elderly narrated their life experiences they liked most or that they found more meaningful to share with their young audience; b) during storytelling, children were encouraged to express their interest towards specific aspects of the reminiscence and ask questions; c) the older adults were asked to collect material (photographs, letters, newspaper articles, etc.) that could help them document the aspects of their memories selected by the young audience; d) to allow further discussion and sharing, older and younger participants reported the content of the most interesting reminiscences in a website, by integrating texts with multimedia objects. Different examples of collected reminiscences are available on the project's website Nostalgia Bits (http://nobits.it/).

Analyses of pre- and post-intervention measures showed that even three two-hour sessions of group reminiscence activities had a positive impact on elderly psychosocial wellbeing: they reported significantly over values of loneliness and an increase in perceived Quality of life. Further, results indicated that following their participation in the program the children's attitude towards the elderly positively changed in a positive way [72].

In a different study, Auburn University's Harrison School of Pharmacy created a Facebook page – Countryside Diabetes (http://goo.gl/ZPqsSE) - to provide ongoing education and support for elderly people affected by diabetes. As reported by the authors, membership and participation to Facebook page continue to grow among the senior population [74].

Following this vision, Morris [75] described how social-networking and pervasive computing technologies can be used effectively to help reduce feelings of social isolation and depression in elderly people. In the approach Morris presented, sensors were introduced into selected elders' homes and used to measure data concerning the numbers of phone calls and visits that occurred. These data were viewed as indicative of public displays of social interactions with relatives and friends. The findings indicated that this strategy was effective in reducing the feeling of social isolation of the elderly [75].

3. Conclusions

Due to advances in treatment and people's living longer, chronic diseases are becoming more common among our population. This is a leading contributor to the increasing burden on our current healthcare system. In fact, over 83% of the money spent annually by the European Union on healthcare is used for the treatment of chronic diseases, such as heart disease, stroke, and cancer [76]. To reduce this burden and sufficiently meet the needs of this growing segment of the population, healthcare organizations must encourage the elderly to take a more active role in caring for their own health and well-being. Technology may offer a solution to this shortcoming. "Positive Technology" [7] focuses on the use of technology for improving the quality of our personal experience, and it suggests specific strategies for modifying/improving each of the different dimensions involved and for generating motivation and engagement in the process [77]. In this chapter, first, we classified positive technologies according to their effects on the features of personal experience (Figure 1):

- *Hedonic*: technologies used to induce positive and pleasant experiences;
- *Eudaimonic*: technologies used to support individuals in reaching engaging and self-actualizing experiences;
- *Social/Interpersonal*: technologies used to support and improve the connectedness between individuals, groups, and organizations.

In addition, we identified critical variables for each level, i.e., regulation of affect (Hedonic); flow and presence (Eudaimonic); and social presence, collective intentions and networked flow (Social/Interpersonal). These variables can be manipulated and controlled to guide the design and development of positive technologies for the elderly. Different examples were presented and discussed.

The use of Positive Technology tools and strategies allows the expansion of healthcare beyond the traditional doctor's office and the hospital to include advanced simulation technologies, such as virtual reality, serious gaming or augmented reality, and spontaneous peer networks that encompass and utilize the properties of Web 2.0, e.g., blogs and online communities, which are among the main fixtures of 21st century living [78]. Prompted by positive technology, the change from a "disease-centered" to a "citizen/client" model based on the engagement of patients in the management of their care will benefit elderly people who are not as mobile as other people. Also, it will benefit those who cannot easily obtain proper care from a doctor's office or a hospital, where healthcare is commonly administered. This change will make the lives of the elderly population easier and more fulfilling as well as reduce the economic burden on our stressed healthcare systems.

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