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Positive technologies for promoting emotion regulation abilities in adolescents

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CONTENTS

ABSTRACT

The research question in the present empirical contribution concerns if and how new technologies can support adolescents in stress management and in enhancing their emotion regulation abilities, proposing an innovative technology-enhanced approach.

In recent years there is a growing interest in the use of emerging advanced technologies in supporting well-being and health promotion. Within the conceptual framework of Positive Technology, referring to those technologies specifically designed to foster positive emotions, to promote engagement in empowering activities and to support connectedness between individuals and groups, Riva, Waterworth, and Murray (2014) pointed out that they can improve the quality of personal experience in three separate, but related, ways: by structuring, by augmenting, or by replacing it (Riva, Baños, Botella, Wiederhold, & Gaggioli, 2012). Within this perspective, two main groups of positive technologies emerged, in relation to the management of psychological stress: virtual-interactive environments and mobile technologies (Serino et al., 2014).

As to the emotion regulation domain, the training protocols that have thus far been developed to promote emotion regulation do not integrate new technologies (CASEL, & LSS, 2003; Harlacher, et al, 2010). Indeed, existing training protocols that employ innovative technologies so as to foster social and emotional learning in adolescents are not specifically focused on emotion regulation (Ben Moussa, et al., 2009; Lim, 2011). Furthermore, research in this domain has primarily tested the efficacy of these training protocols through assessment strategies designed with one type of measurement technique at a time, although most recent theories highlight that emotions are multidimensional and multicomponent processes. The latter speaks to the need for multi-modal assessment methods (Scherer, 2001).

With the above in mind, the efficacy of positive technologies was tested in a sample of youth between the ages of 12-18. Two empirical studies were carried out with the aim on the one side, to test the efficacy of the Positive Technology App in inducing relaxation (PTA; Riva, 2013) and, on the other side, to test and to evaluate the efficacy of selected sessions of the BEAR training protocol (Pat-Horenczyk et al., 2012) in the technology-enhanced adaptation.

The Positive Technologies employed have been developed through a user-centered design, combining together different technological components such as gamification aspects, virtual characters and wearable physiological sensors.

Overall, results show the efficacy of positive technologies not only in reducing perceived psychological stress and feelings of anxiety, but also in promoting engagement and motivation, as

well as in improving the awareness of body sensations and the well-being of young users.

In terms of general impact and anticipated benefits, this project aims at making progress in the state of the art of methodological solutions for the training of stress management and emotion regulation abilities, with the final goal to propose a useful tool for the improvement of these competences in adolescents.

The thesis is organized in three main parts:

The first part is dedicated to the theoretical background of the present contribution.

In chapter 1, the classic biological view of stress and health will be introduced, underlying the important shift from omeostasis to allostasis. The conceptual framework of emotion regulation and the related concept of coping will then be discussed, analyzing the ways in which they are both related to stress management. In the second part of the chapter, an overview of the earliest works on temperament is provided, particularly linking imitative and observational learning to the concept of emotion and emotion regulation. The theoretical basis of emotional competence is then introduced, focusing on the model of Saarni. Lastly, an overview of programs for enhancing emotional competence is offered, with a specific focus on the training program chosen for the development of the technology-enhanced protocol introduced in the presented empirical study: the Building Emotion and Affect Regulation (BEAR) program (Pat-Horenczyk et al., 2014).

Then, in chapter 2, starting from an introductory analysis of the concept of well-being as it has being framed by positive psychology, the Positive Technology paradigm and the concept of personal experience will be analysed focusing on how new technologies can manipulate its three features: Hedonic, Eudemonic and Social/Interpersonal. The chapter with then shift to focus on the main new technologically advanced tools used in the present empirical contribution – virtual reality, biosensors and mobile technologies – due to the possibilities that these tools may offer in the enhancement of stress management and emotion regulation abilities, and some practical examples of their application will be presented.

The second part of the thesis, “Design and development”, is focused on the development of the technology-enhanced protocol. Each of the four phases will be deeply analyzed: the user need analysis; the adaptation of the BEAR to a technology enhanced protocol; the definition of functional requirements; the integration of the technological components.

The third part of the thesis is dedicated to the empirical contribution. In chapter 4 the first study on the Positive Technology App will be introduced, then in chapter 5 the second study on Emoregulator will be presented.

In the “Conclusions”, main findings and indications for future researches and expected impact are discussed.

PART 1:
THEORETICAL BACKGROUND

CHAPTER 1.
STRESS, EMOTION REGULATION AND EMOTIONAL COMPETENCE

In the first section of this chapter the classic biological view of stress and health will be introduced, underlying the important shift from omeostasis to allostasis. This shift allowed for the realization that the appropriate regulation of thoughts and emotions not only decreases the likelihood of a pathogenic activation of stress responses due to psychological factors, but also increases the likelihood that adaptive behavioural responses in response to a psychological stressor are selected. The conceptual framework of emotion regulation and the related concept of coping will then be discussed, analyzing the ways in which they are both related to stress management.

In the second part of the chapter, an overview of the earliest works on temperament is provided, particularly linking imitative and observational learning to the concept of emotion and emotion regulation. The theoretical basis of emotional competence is then introduced, focusing on the model of Saarni and on the exploration of the relevance of emotional competence for positive youth development. Lastly, an overview of programs for enhancing emotional competence is offered, with a specific focus on the training program chosen for the development of the technology-enhanced protocol introduced in the presented empirical study (See Chapter 5): the Building Emotion and Affect Regulation (BEAR) program (Pat-Horenczyk et al., 2014).

1.1 THE PHYSIOLOGICAL STRESS RESPONSE

1.1.1 Current theories and researches

The study of stress is now close to a century old, having been spawned by the work and insight of Cannon and Selye. In the initial years of the field, the subject was entirely the purview of biologically oriented scientists, and it was not until some decades later than the transition began to the present point, where the subject is as much the domain of psychologists (Sapolsky, 2007).

Cannon formalized long-standing ideas regarding physiological regulation with the term ”homeostasis”: all physiological endpoints have an ideal level, for example an ideal body temperature, heart rate etc. and the physiological regulation aim is to achieve a state of homeostasis, or “homeostatic balance” in which as many of these endpoints are optimized as possible. For the researchers anchored in the homeostasis concept, a “stressor” was defined as anything that perturbs homeostatic balance, while the “stress response” was defined as the neural and endocrine adaptation that re-establish homeostasis. It was not until the work of Selye, beginning a decade later, that this was shown to be only half of the story (Sapolsky, 2007).

Selye introduced an element under-explored by Cannon and colleagues: the chronic exposure to stressors, and he observed a very different picture than the view of the stress response as being purely adaptive and beneficial (Sapolsky, 2007). Selye observed pathology: the emergence of peptic ulcers, enlargement of adrenal glands and atrophy of immune organs (Selye, 1936a, 1936b). This was the first evidence of stress-related disease. His most important contribution was to show that a remarkably diverse array of stressors could all cause the same triad of pathologies and the key commonality of these stressors was their cronicity. In trying to explain why chronic stressors could prove pathogenic, Selye speculated that a prolonged physiological stressor triggered a state of endocrine “exhaustation” in the organism (Selye, 1979). In effect, the stress response fails, leaving the organism undefended against the stressor. However, virtually no evidence has emerged supporting the notion of an exhaustion stage, the idea that the stress response can become depleted as a result of chronic stressors. Instead, in face of prolonged stressors, the stress response continues to be mobilized robustly and, over time, the stress response itself become damaging. This is the most important concept of the field (Munck et al., 1984).

The work of Cannon showed that in the face of an acute stressor, the stress response is vital to successful adaptation to challenge. However, as shown in the work of Selye, in the face of a chronic stressors, the stress response itself can become pathogenic across a wide array of organ systems. A stress related diseases are not the direct consequences of an overabundance of stressors, or of a failure of the stress response, but instead, are the result of over-activation of the stress response.

This raised a critical conundrum: most physiological stressors, if severe enough to activate the stress response to a magnitude that would prove damaging if prolonged, would kill the organism long before the stress response itself would become damaging. Moreover, no degree of homeostatic imbalance, no matter how severe, can give rise to the broad and varied collection of slowly emerging pathologies. Thus, when could stress ever be prolonged enough to cause the slow emergence of these stress-related diseases, rather than relatively rapid death? And the answer, which ushered in a psychological perspective in the field is now clear: the prolonged stressors that produce disease through chronic activation of the stress response are those that are overwhelmingly psychological rather than physical in nature (Sapolsky et al., 2007).

1.1.2 Psychological activators and moderators of the stress response

The importance of psychological factors in stress-related disease became clear by the late 1950s, beginning with work of Mason and carried on for example by Levine, Seligman and Weiss (Mason, 1968). Studies done during the Mason era showed that the stress response can be activated by certain psychological context, even in the absence of any physiological stressor. As demonstrated by studies of Coover, Ursin & Levine (1973), loss of senses of control and predictability in the absence of loss of physiological homeostasis, can activate the stress response. The activation of the stress response in the absence of any physical challenge to homeostasis was profoundly bewildering to stress physiologists (Selye, 1975). This bewilderment was made even stronger by Mason's (1975a, 1975b) that physical stressors activate the stress response only insofar as they induce a sense of loss of control, predictability and so on (Sapolsky, 2007). As emphasized by Selye, this extreme view could not be the case, because a robust stress response is activated by a surgical incision in anesthetized individuals (Selye, 1975a, 1975b). nonetheless, the findings generated by Mason school decisively made the idea that stress and health can be understood in purely physiological terms untenable (Sapolsky, 2007).
On the other hand, a second aspect considered were the psychological moderators of the stress response. The researches demonstrates the importance of some other variables, such as the sense of control (Houston, 1972), another variable concerns the perception of whether things are worsening or improving, amid the identical external physiological stressor (Sapolsky, 1992).
These studies show that psychological context can modulate the linkage between a physiological stressor and the magnitude of the subsequent stress-response (Sapolsky et al., 2007).
Such findings raised the issue of whether psychological context could modify the primary response of the body to a physiological stressor. In other words, when an optimal psychological context

reduced the stress response caused by a physical stressor, would that be because the stressor was now less of a challenge to homeostasis, or for the same extent of loss of homeostasis, because less of a stress response, would be mobilized? There is little evidence that psychological context could make a physical stressor less homeostatically challenging (Sapolsky, 2007). This is seen in a recent study examining the neural processing of pain, and of the psychological context in which the pain occurs (Wager et al., 2004). Subsequent studies have expanded on the idea that psychological context can modulate the stress response. Some demonstrate the importance of factors such as novelty or discrepancy from expectation, showing their partial similarity to variables such as control and predictability (Haidt & Rodin, 1999). Collectively, these findings represented landmark challenges to the purely physiological school of thinking about stress and health.

Summarizing the findings described till now, we can say that, psychological stressor can activate the stress response in absence of a physiological stressor. Mor,eover psychological context can alter the linkage between a physiological stressor and the stress response Further, psychological stress is at the core of understanding why chronic stress is pathogenic. As such, the regulation of thought and emotion is extremely important for health. In the next paragraphs this aspect will be explored.

1.1.3 From omeostasis to allostasis

The issue of thought and emotion regulation becomes relevant in the allostatic view. The new concept of “allostasis”, a recent trend in physiology, represents a more modern and expansive version of the homeostasis concept. One difference between the two concept concerns set points. The hoemostatic realm of thinking focuses on the idea that there exist single optimal set points for each measure, for example, an ideal blood pressure, or body temperature. Allostatic thinking in contrast, emphazises that an optimal set point for any physiological measures can differ dramatically by circumstance. But it’s the second difference between the two, that is the most pertinent. In the concept of homeostasis, homeostatic imbalance is solved locally; while allostatic imbalance is viewed as being solved with more global responses (Sapolsky, 2007). The allostatic concept it’s a more accurate description of physiology than is the homeostatic concept. What is important here is the recognition that the solution to a physiological challenge, in some circumstances, can involve behaviour. This raises an important problem. Specifically, it is difficult to fix one aspect of physiology without potentially having adverse effects in some other domain of balance, and the more varied the allostatic compensations, the more likely it is that something else will be impaired in the process (Sterlin, 2003).Within the context of psychological regulation, behavioural means of correction can be among the most far-flung.

This fact becomes relevant in considering stress and health. Allostasis teaches that sometimes a stressor, including a psychological one, can be dealt with by behavioural means, and in some circumstances, that behaviour can prove more damaging than the stressor itself. For example, the habitual consumption of alcohol to solve psychological stressor of anxiety may provide a local solution, since for example it decreases the immediate state of anxiety, but it may have more serious adverse global consequences, as the cirrhosis of the liver, and moreover, it may worsen the primary source of loss of homeostasis, the anxiety. This might be through local means, such as the fact that while alcohol is anxiolytic when blood alcohol levels are rising, it is anxiogenic when levels are falling, also it can have indirect means, such as increased anxiety about job stability due to alcohol-induced absenteeism (Sapolsky, 2007).

This leads to a key point, namely, that the behavioural coping responses that are at least adaptive in the long run are often the easiest and most tempting in the short run.

This underline an important concept that represents the beginning of the present empirical contribution: the appropriate regulation of thoughts and emotions not only decrease the likelihood of pathogenic activation of the stress response due to psychological factors, but also increases the likelihood that the behavioural responses to psychological stressors that are chosen are adaptive ones (Sapolsky, 2007). In the next chapter the concepts of emotion and emotion regulation will be deepen.

1.2 EMOTION REGULATION: THE CONCEPTUAL FRAMEWORK

1.2.1 The process model of emotion regulation

On its own, the phrase “emotion regulation” is crucially ambiguous, as it might refer equally well to how emotions regulate something else, such as thoughts, physiology, or behaviour (regulation by emotions) or to how emotions are themselves regulated (regulation of emotions). However, if a primary function of emotions is to coordinate response systems (Levenson, 1999), the first sense of emotion regulation is coextensive with emotion. Gross and Thompson (2007) refers to the second sense, in which emotion regulation deals with the heterogeneous set of processes by which emotions are themselves regulated. Starting from a multicomponential conception of emotions, they developed a process model of emotion, underlying that emotion regulatory processes may be automatic or controlled, conscious or unconscious, and may have their effects at one or more points in the emotion generative processes. Because emotions are multicomponential processes that unfold over time, emotion regulation involves changes in “emotion dynamics” (Thompson, 1990), or the latency, rise time, magnitude, duration and offset of responses in behavioural, experiential or physiological domains. Emotion regulation may dampen, intensify, or simply maintain emotion, depending on an individual's goals. Emotion regulation also may change the degree to which emotion response components cohere as the emotion unfolds. Further, emotion regulation refers both to intrinsic process (emotion regulation in self) and to extrinsic processes (emotion regulation in other). In particular there are some characteristics of emotions as multicomponential processes that relate to emotion regulation. First, emotions arise when an individual attends to a situation and sees it as relevant to his or her goals. Is this meaning that gives rise to emotion. As this meaning changes over time, the emotion will also change. Second, emotions are multi-faceted, whole-body phenomena that involve loosely-coupled changes in the domains of subjective experience, behaviour, and central and peripheral physiology (Mauss et al., 2005). Third, the multi-system changes associated with emotion are rarely obligatory. Emotions do possess an imperative quality – which Frijda (1986) has termed "control precedence" – meaning that they can interrupt what we are doing and force themselves upon our awareness. The malleability of emotion has been emphasized since James (1884), who viewed emotions as response tendencies that may be modulated in a large number of ways. It is this third aspect of emotion that is most crucial for an analysis of emotion regulation, because it is this feature that makes such regulation possible (Gross & Thmpson, 2007). Referring to those aspects, Gross and Thompson (2007) identified three specific features in the process model of emotion:

(a) The dynamic aspect of emotion and emotion regulation, signalled by the feedback arrow in Figure 1 from the emotional response back to the situation. This arrow is meant to suggest the dynamic and reciprocally-determined nature of emotion regulation as it occurs in the context of an ongoing stream of emotional stimulation and behavioural responding. Similar feedback arrows might also be drawn from the emotional response to each of the other steps in the emotion-generative process. Each of these in turn influences subsequent emotional responses.

(b) The distinction between antecedent-focused and response-focused emotion regulation. A given instance of emotion regulation is antecedent-focused or response-focused with respect to a given cycle through the emotion generative process. Emotion regulation efforts that target pre-pulse processes (in any given cycle of the emotion-generative process shown in Figure 1) are antecedent-focused, whereas emotion regulation efforts that target post-pulse processes are response-focused.

(c) Emotion regulation can also occur in parallel at multiple points in the emotion generative process. Using many forms of emotion regulation might in fact be the modal case. This approach of "throwing everything you've got at it" makes sense. There are many different ways of influencing the emotion-generative process, and if one wants to make a big change in a hurry, it may be useful to try several things at once. Thus, what individuals do to regulate their emotions – such as going out to a bar with friends in order to get their mind off a bad day at work – often involves multiple regulatory processes.

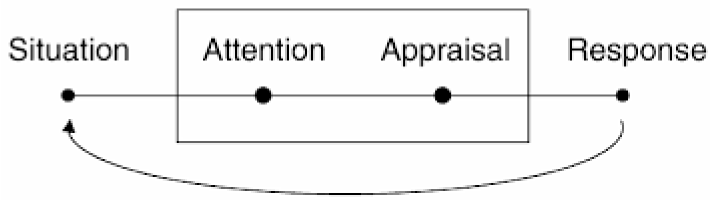


Figure 1. Recursion in emotion shown using a feedback loop in the modal model

1.2.2 Emotion and emotion regulation as interdependent process

The notion of emotion regulation presupposes that it is possible (and sensible) to separate emotion generation from emotion regulation (Gross and Thompson, 2007). However, emotion regulation is so tightly intertwined with emotion generation that some theorists view emotion regulation as part and parcel of emotion (Campos et al., 2004; Frijda, 1986). But, both common sense and its academic counterpart – the modal model -- suggest the need to distinguish between emotion and emotion regulation (See fig. 1).

But making a distinction between emotion and emotion regulation is difficult, because emotion regulation often must be inferred when an emotional response would have proceeded in one fashion, but instead is observed to proceed in another. For example, a still face in someone who typically expresses lots of emotion may be rich with meaning, but the same lack of expression in someone who rarely shows any sign of emotion is less strongly suggestive of emotion regulation (Gross & Thompson, 2007). However, recent advances in neuroimaging have made it possible to begin to assess whether (particularly in the context of explicit manipulations of emotion regulation) there are differences either in the magnitude or regional locus of brain activation associated with emotion alone versus emotion in addition to emotion regulation (Ochsner et al., 2004). Emotion regulation also may be inferred from changes in how response components are interrelated as the emotion unfolds over time (e.g., a dissociation between facial expression and physiology, suggestive of suppression). At the highest level, emotion and emotion regulation processes (and all other psychological processes for that matter) co-occur in the same brain, often at the same time. The question of whether two sets of processes are separable (e.g., emotion and memory; emotion and emotion regulation) is therefore a question about the value of distinguishing processes for a particular purpose (Gross & Thompson, 2007).

Gross and Thompson (2007) believe that a two-factor approach that distinguishes emotion from emotion regulation is a useful approach for analyzing basic processes, individual differences, and fashioning clinical interventions. That said, they also believe that it is crucial to be as explicit as possible about the grounds for inferring the existence of emotion regulation in any given context.

They hypothesize that (a) emotion regulation often co-occurs with emotion, whether or not emotion regulation is explicitly manipulated; and (b) emotion regulation engages some (and perhaps many) of the same brain regions that are implicated in emotion generation. Given the nascent understanding of both emotion and emotion regulation processes, they believe it is appropriate to be very cautious indeed when inferring whether emotion regulation processes are operative in a particular context. At the same time, however, they argued that the question "Is emotion ever not regulated?" is misleading, in that it suggests an all or none affair. A conception of varying amounts and types of emotion regulation seems more appropriate. Gross and Thompson (2007) considered that a process-oriented approach will bring closer to understanding the causes, consequences, and underlying mechanisms. Moreover, such a process oriented approach is well-suited to the study of developmental changes in emotion regulation, and encourages investigators to examine the interaction of external and intrinsic influences. Starting from these assumptions, they elaborated a process model of emotion regulation, redrawing the modal model and identifying five points at which individuals can regulate their emotions.

1.2.3 Emotion regulation strategies and patterns of emotion regulation

Gross and Thompon (2007) identified five families of emotion regulation processes: situation selection, situation modification, attentional deployment, cognitive change, and response modulation (Gross, 1998b). These families are distinguished by the point in the emotion generative process at which they have their primary impact. They underlined between-family differences (e.g., the difference between cognitive change and response modulation). However, there are also higher order commonalities. For example, the first four emotion regulation families may be considered antecedent-focused, in that they occur before appraisals give rise to full-blown emotional response tendencies, and may be contrasted with response-focused emotion regulation, which occurs after the responses are generated (Gross & Munoz, 1995). There are also considerable within-family differences. The five families of emotion regulation processes, more precisely are (See fig.2):

(a) Situation Selection is the most forward-looking approach to emotion regulation. This type of emotion regulation involves taking actions that make it more (or less) likely that one will end up in a situation one expects will give rise to desirable (or undesirable) emotions. Situation selection requires an understanding of likely features of remote situations, and of expectable emotional responses to these features. There is a growing appreciation of just how difficult it is to gain such an understanding. Looking backward in time, there is a profound gap between the "experiencing self" and the "remembering self" (Kahneman, 2000). In particular, real-time ratings of emotion experience (e.g., how I'm feeling at each moment throughout an emotional film) diverge from retrospective summary reports (e.g., how I felt during the film) in that retrospective reports are predicted by peak and end feelings, but are curiously insensitive to duration. Looking forward in time, people profoundly misestimate their emotional responses to future scenarios (Gilbert et al., 1998; Loewenstein, 2007). In particular, people overestimate how long their negative responses to various outcomes (e.g., being denied tenure, breaking up with a partner) will last. These backward- and forward-looking biases make it difficult to appropriately represent past or future situations for the purposes of situation selection. Another barrier to effective situation selection is appropriately weighing short-term benefits of emotion regulation versus longer-term costs. This form of extrinsic emotion regulation is important throughout life, but is most evident in infancy and early childhood when parents strive to create daily routines with manageable emotional demands for their offspring.

(b) Situation Modification refers to efforts made to directly modify the situation so as to alter its emotional impact constitute a potent form of emotion regulation (Gross & Thompson, 2007). Given the vagueness of the term "situation," it is sometimes difficult to draw the line between situation selection and situation modification. This is because efforts to modify a situation may effectively call a new situation into being. Also, although we have previously emphasized that situations can be external or internal, situation modification has to do with modifying external, physical environments (Gross & Thompson, 2007), while efforts at modifying "internal" environments are part of cognitive change, as we will see after.

Situation selection and situation modification help shape the individual's situation. However, it is also possible to regulate emotions without actually changing the environment. Situations have many aspects, and (c) *Attentional deployment* refers to how individuals direct their attention within a given situation in order to influence their emotions. Attention deployment is one of the first emotion regulatory processes to appear in development (Rothbart, Ziaie, & O'Boyle, 1992), and appears to be used from infancy through adulthood, particularly when it is not possible to change or modify one's situation. Infants and young children not only spontaneously look away from aversive events (and towards pleasant ones), but their attentional processes can also be guided by others for purposes of emotion management. Attention deployment might be considered an internal version of situation selection (Gross and Thompson, 2007).

The two authors (2007) identified two major attentional strategies: distraction and concentration.

Distraction focuses attention on different aspects of the situation, or moves attention away from the situation altogether, such as when an infant shifts its gaze from the emotion eliciting stimulus to decrease stimulation (Rothbart, 2007; Stifter & Moyer, 1991). Distraction also may involve changing internal focus, such as when individuals invoke thoughts or memories that are inconsistent with the undesirable emotional state (Watts, 2007).

Concentration draws attention to emotional features of a situation and Wegner and Bargh (1997) have termed this "controlled starting" of emotion. Attentional deployment thus may take many forms, including physical withdrawal of attention (such as covering the eyes or ears), internal redirection of attention (such as through distraction or concentration), and responding to others' redirection of one's attention.

Even after a situation has been selected, modified, and attended to, an emotional response is by no means a foregone conclusion. Emotion requires that percept be imbued with meaning and that individuals evaluate their capacity to manage the situation.

(d) Cognitive change refers to changing how one appraises the situation one is in so as to alter its emotional significance, either by changing how one thinks about the situation or about one's capacity to manage the demands it poses (Gross & Thompson, 2007). One form of cognitive change that has received particular attention is reappraisal (Gross, 2002; John & Gross, 2007; Ochsner & Gross, 2007). This type of cognitive change involves changing a situation's meaning in a way that alters its emotional impact, for example, leading subjects to reappraise negatively valence films has been shown to result in decreased negative emotion experience. For children, cognitive appraisals related to emotion are significantly influenced by their developing representations of emotions, including the causes and consequences of these emotions (Terwogt & Stegge, 2007). This development has implications for children's efforts to manage emotion. Not surprisingly, parents, and later peers and other caregivers, are highly influential in children's developing emotion-related appraisals.

In contrast with other emotion regulatory processes, (e) *Response modulation* occurs late in the emotion generative process, after response tendencies have been initiated. Response modulation refers to influencing physiological, experiential, or behavioural responding as directly as possible. Attempts at regulating the physiological and experiential aspects of emotion are common. Drugs may be used to target physiological responses such as muscle tension (anxiolytics) or sympathetic hyper-reactivity (beta blockers). Exercise and relaxation also can be used to decrease physiological and experiential aspects of negative emotions, and, alcohol, cigarettes, drugs, and even food also may be used to modify emotion experience. Another common form of response modulation involves regulating emotion-expressive behaviour (Gross, John, & Richards, in press).

In conclusion, as stated by Gross and Thompson (2007) “adaptive response alternatives” may vary significantly in different situations. For example, crying is likely to be maladaptive for toddlers in some situations (e.g., when resisting mother’s request) but to accomplish valuable goals in others (e.g., calling attention to sudden danger or an older sibling’s aggression). Thus it is not the emotional response per se that is adaptive or maladaptive, but the response in its immediate context. Second, evaluating broader individual differences in emotion regulatory capacities must likewise incorporate attention to the contexts in which the individual’s emotions are expressed and the potentially adaptive consequences of these emotions. Third, cultural values are significant in determining what constitutes “adaptive response alternatives” for expressing emotion for persons of any age. Response modulation must be considered within the broader cultural context in which emotion is experienced, expressed, and regulated (Gross & Thompson, 2007).

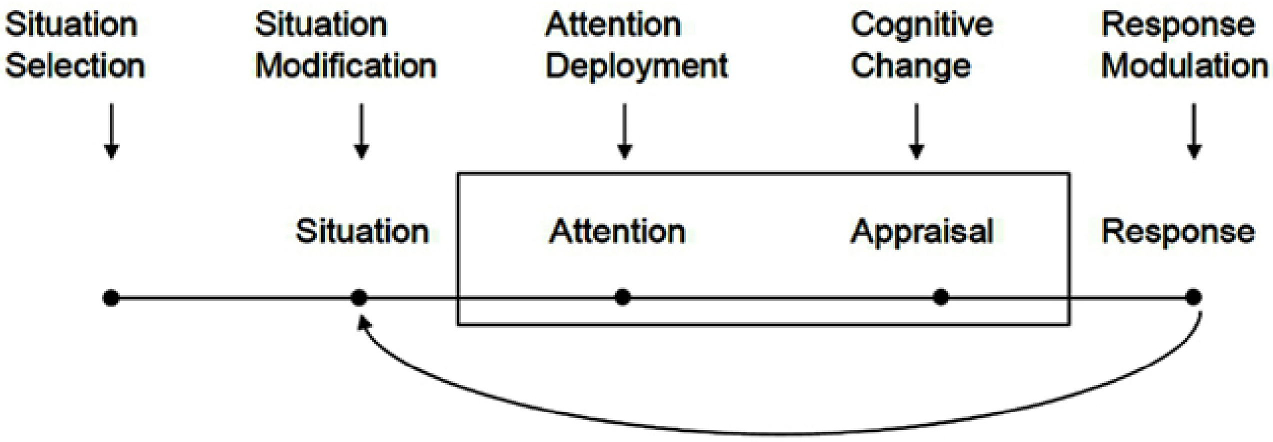


Figure 2. A process model of emotion regulation that highlights five families of emotion regulation strategies.

1.2.4 Emotion regulation and emotional coping

Emotion regulation is related to some constructs of affect regulation which includes (among other things) four overlapping constructs: (a) emotion regulation, (b) mood regulation, (c) psychological defences, and (d) coping (Gross & Thompson, 2007).

Moods are typically of longer duration and are less likely to involve responses to specific "objects" than emotions (Parkinson et al., 1996) and in comparison with emotion regulation, mood regulation and mood repair are more concerned with altering emotion experience than emotion behaviour (Larsen, 2000). Defences typically have as their focus the regulation of aggressive or sexual impulses and their associated negative emotion experience, particularly anxiety. Defences usually are unconscious and automatic (Westen, 2007), and are usually studied as stable individual differences (Cramer, 2000). Coping has many possible points of convergence and divergence with emotion regulation, we will now focus on them, underlying the relationship between the two constructs and in which way they are both related to the stress management. In fact, the skills needed to cope with stressful events and chronic adversity and to regulate emotions, including emotions that arise in response to stress, are fundamental and pervasive aspects of development.

We can see that the concepts of coping and emotion regulation share several important elements. First, both coping and emotion regulation are conceptualised as processes of regulation. In their conceptualisation of coping, Compas et al. (2001) note that regulation includes efforts to initiate, terminate or delay, modify or change in form or content, redirect the focus, or modulate the amount or intensity of a thought, behaviour, emotion, or physiological response. By definition, regulatory processes are also at the core of emotion regulation. For example, Thompson (1994) noted that emotion regulatory processes include monitoring, evaluating, and modifying emotional reactions, especially their intensity and duration. Second, both coping and emotion regulation include controlled, purposeful efforts. This is reflected in the early work of Lazarus and Folkman (1984), who viewed coping as purposeful responses that are directed towards resolving the stressful relationship between the self and the environment. These responses are represented in goal-directed processes in which the individual orients thoughts and behaviours towards the goals of resolving the source of stress and managing emotional reactions to stress. Compas et al. (2001) recognise that both automatic and controlled processes are enacted in response to stress, but argue that coping is limited to responses that are volitional, purposeful, within conscious awareness, and goal-directed. Similarly, Gross (2013) views emotion regulation as part of a continuum from automatic processes to explicit, conscious, effortful, and controlled regulation. Third, coping includes emotion regulation under stress. Because emotion regulation is conceptualised as an ongoing process that occurs under both stressful and non-stressful circumstances (Gross, 2013), coping can be conceived as a special case of emotion regulation under stress (e.g., Eisenberg et al., 2010). And fourth, coping and emotion regulation are conceptualised as temporal processes that unfold and may change over time.

These similarities notwithstanding, coping and emotion regulation are distinct in several ways. First, emotion regulation includes both controlled and automatic processes, whereas coping includes only controlled volitional processes. Second, coping exclusively refers to responses to stress, whereas emotion regulation encompasses efforts to manage emotions under a much wider range of situations and in reaction to a wider range of stimuli (Compas et al., 2001; Folkman & Moskowitz, 2004). Emotion regulation includes processes directed towards positive and negative emotions that arise under normative, non-stressful circumstances (e.g., Webb, Miles, & Sheeran, 2012). Therefore, it follows that emotion regulation occurs in a much wider range of circumstances than only those that are stressful. Third, as highlighted in the definition offered by Thompson (1994) emotion regulation may include both intrinsic processes (i.e., emotion that is regulated by the self) and extrinsic processes (i.e., emotion that is regulated by an outside factor). Although coping may involve extrinsic factors (e.g., social support), it is only carried out by the person experiencing stress. Fourth, research on emotion regulation and coping has focused on different developmental stages. While extensive research has examined emotion regulation in infants and young children, coping has almost exclusively been studied in later childhood, adolescence, and adulthood. Research on the developmental course of these regulatory strategies is still in its early stages (for reviews, see Skinner & Zimmer-Gembeck, 2007; Zimmer-Gembeck & Skinner, 2011), and how the structure of coping may change across different developmental periods with the emergence of new capacities (e.g., language, locomotion, executive function) is not well understood.

We can conclude that Coping and emotion regulation are closely related but distinct constructs. However, the relationship between these constructs is complex. On the one hand, emotion regulation is a broader construct than coping as it encompasses ongoing emotional events, whereas coping is a subset of emotion regulation that is enacted in response to stressful events or circumstances. On the other hand, coping includes a broader array of regulatory efforts than emotion regulation within the context of stressful encounters, and emotion regulation is a subset of responses to stress. Thus, coping is both broader and more specific in its focus than emotion regulation. This suggests that an important focus of research could be the relations between coping that is enacted under stress and emotion regulation under non-stressful circumstances.

1.3 THE ENHANCEMENT OF EMOTIONAL COMPETENCE

1.3.1 Learning emotions: imitative and observational learning

Rothbart and Bates (2006) define temperament as “constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity and attention;” understanding these differences is essential for a broad understanding of emotion regulation (Rothbart & Sheese, 2007). Historically, temperament has linked individual differences to the underlying constitution of the person (Rothbart, 1989). Current research however, suggests that both biological and environmental factors are important throughout development and may have different effects during different periods of the life span (e.g., Jafee et al., 2005). Temperament is increasingly considered to be a multiply determined outcome of both biological and experiential processes (Rothbart & Posner, 2006). Basing on these premises, when seeking to understand emotions we must therefore consider imitative and observational learning.

Emotions, like other skills, are learned through experience. In *classical conditioning* (Pavlov, 1927) events deemed unfavourable become associated with negative emotions. Learning associations between events and emotional responses also extend to *operant conditioning* (Skinner, 1974), where connections between positive and negative emotional responses and reward and punishment mechanisms are investigated. However, the most important road to emotional learning is considered to be the observation and imitation of others through social interactions. In fact, we learn from our surroundings to recognize and interpret emotional clues, especially in unknown situations, and learn to label, express, adjust, communicate and share emotional experiences (Anolli, 2011).

Beginning with *imitation,* this skill implies the ability to reproduce the sequence of actions of a model, understanding the model’s intention and anticipating his/her final outcome (Chartrand, Bargh, 1999). Imitation occurs through the repetition of what others *do* and the ability to reproduce what others *want to do* (Anolli, 2011). Furthermore, imitation is based on the principle of "social similarity," which is the mindset of treating others in a similar way to oneself (Meltzoff, 1995; Meltzoff, Moore, 1997). Imitation also can involve various aspects of emotions, such as facial expressions, social sharing and the categorization and/or regulation of voice and gestures). For example, when we look at the face of someone who is afraid, it is likely that we will mirror his/her expression. The ability to imitate others emotions plays a vital role in the discriminative ability of their emotional expressions (Niedenthal, Brauer, Halberstadt et al., 2001). Imitation is a mindset that appears very early in childhood, with even infants being able to reproduce the facial expressions of an adult. This predisposition continues over time and is particularly strong at around the age of nine months with the appearance of intentionality and then with the phenomenon of social reference. Imitation should be regarded as the royal road for cultural learning and for the acquisition of a multicultural mind, and also plays a facilitating role in identifying processes, criteria and benchmarks through which to understand the emotional milieu of a new culture. Through imitation we can also understand the meanings, intentions and purposes that underlie specific behaviours. In this way, emotions become an opportunity and a way to understand others (Anolli, 2011).

In addition, imitation is a favoured technique of *observational learning*, thanks to the actions of *mirror neurons* (Rizzolati et al., 1996; Rizzolati & Craighero, 2004; Rizzolati & Sinigaglia, 2006). In fact, thanks to a common neural code that allows for the transfer of information from perception to action, observing an emotional expression promotes the ability for one to plan and subsequently formulate one's own expression (Anolli, 2011). The observation of emotional behaviour selectively activates the mirror neurons of the ventral premotor cortex, cingulate cortex and the insula. This can make the viewer feel as if he/she is experiencing the other individual's emotions. Understanding is therefore based on the possibility to establish a psychological equivalence between what others feel and what the observer is feeling (Gallese, 2003; Rizzolati & Sinigaglia, 2006). The circuitry of mirror neurons implement very powerful observation and imitation devices that allow for the immediate consonance and resonance of other's emotional experiences, whether these emotions belong to a viewer's own culture or are part of a different culture (Gallese, 2008). In particular mirror neurons are very effective in the recognition of emotional expressions (facial, vocal patterns, gestures etc.) and in processes of empathy (Decety & Jackson, 2004; Gallese, 2003; 2008).

Having discussed the important influence of both temperament and the environment on emotions and on the two kind of learning previously described, in the next section the concept of emotional competence will be explored with particular attention given to the model of Saarni.

1.3.2 The development of emotional competence: the model of Saarni

Saarni (1999) proposed the construct of emotional competence as a set of affect oriented behavioural, cognitive and regulatory skills that emerge over time as a person develops in a social context. Individual factors, such as cognitive development and temperament, do indeed influence the development of emotional competencies; however, the skills of emotional competence are also influenced by past social experience and learning, including an individual's relationship history, as well as the system of beliefs and values in which the person lives. Thus, we actively create our emotional experience, through the combined influence of our cognitive developmental structures and our social exposure to emotion discourse (Saarni, 2001).

Saarni’s (1999) explication of emotional competence focuses on the skills that are necessary for navigating the demands of the immediate social context. These responses are adaptive and help the individual (a) reach goals, (b) cope with challenges, (c) manage emotional arousal such that effective problem solving can be undertaken, (d) discern what others feel and to respond sympathetically as the case may be, and (e) recognize how emotion communication and self presentation affect relationships.

More specifically the author considers eight skills, which are: 1-Awareness of one’s emotional state, including the possibility that one is experiencing multiple emotions. 2-Recognizing others’ emotions, basing on situational and expressive cues. 3-Skill in using the vocabulary of emotion and expression in terms commonly available in one’s subculture. 4-Empathy, that’s to say empathic and sympathetic involvement in others’ emotional experiences. 5-The recognition of the distinction between emotion felt and emotion expressed outwardly both in oneself and in others. 6- Coping strategies or coping with aversive or distressing emotions by using self-regulatory strategies. 7-Awareness of the role of emotional communication in relationships. 8- Capacity for emotional self-efficacy, that’s to say that the individual views her/himself as feeling, overall, the way he or she wants to feel. That is, emotional self-efficacy means that one accepts one’s emotional experience, whether unique and eccentric or culturally conventional.

It should be emphasized that these skills are interdependent in their manifestation. Moreover, the skills of emotional competence may also be developmentally variable. That is, their manifestation in young children is more concrete, more situationally bound, and less likely to be articulated by the child. By adolescence, emotional competence skills are integrated with social competencies, and issues of identity, moral character, and the combined effects of aspiration and opportunity are more explicitly acknowledged as significant by youth. The development of emotional competence skills is a developmental process such that a particular skill manifests differently at different ages. With young children, emotion knowledge is more concrete, with heightened focus on observable factors. Young children’s emotion expression and emotion regulation are less well-developed, requiring more support and reinforcement from the social environment. Elementary school children advance in their ability to offer self-reports of emotions, and to use words to explain emotion-related situations. As children mature, their inferences about what others are feeling integrate not only situational information, but also information regarding prior experiences and history. Older children are also more able to understand and express complex emotions such as pride, shame or embarrassment. By adolescence, issues of identity, moral character and the combined effects of aspiration and opportunity are more explicitly acknowledged as significant by youth. The skills of emotional competence do not develop in isolation from each other and their progression is intimately tied to cognitive development and emotional competence is not a trait that resides inside the child, but rather characterizes a set of skills that are learned (but not always applied) to dynamic encounters with the social environment (Buckley, Storino & Saarny, 2003).

Emotional competence as an organizing construct lends itself well to the paradigmatic shift toward an examination of positive asset-based development rather than a deficit-based model, which is oriented toward what to avoid, prevent, minimize, or suppress in human functioning. This vision is well connected to the Positive Psychology framework that will be introduced in the next chapter. In fact, the skills related to emotional competence may be viewed as building blocks toward positive development in childhood and adolescence. Strengths in the area of emotional competence may help children and adolescents cope effectively in particular circumstances, while also promoting characteristics associated with positive developmental outcomes, including feelings of self-efficacy, prosocial behaviour and supportive relationships with family and peers. Furthermore, emotional competence serves as a protective factor that diminishes the impact of a range of risk factors.

But all this is possible only in the case where the child is provided with a good social support from the environment in which it is inserted (Zeidner et al. 2003). In general terms, therefore, the development of the emotions would be inseparable from the development of the self and relationships with others in the environment (Bidlowski, 2004).

An ever-increasing amount of research provides support for the role systemic, ongoing, social-emotional education plays in optimal cognitive and behavioural development (Bear, Manning, & Izard, this issue; Elias et al., 1997). Nevertheless, some disagreement exists regarding the role that schools should play in addressing aspects of development beyond academics, including physical, social, and emotional functioning (Walsh, Buckley, & Howard, 1998). Some argue that the schools are increasingly burdened with carrying out functions previously ascribed to the family and community, thus distracting the school from pursuing its educative mission. Although recent evidence suggests that social and emotional functioning significantly predicts academic investment (Roeser, van der Wolf, & Strobel, 2001) and positive social behavior (Izard et al., 2001), empirical studies investigating emotional competency programs in improving school performance or behaviour are limited (e.g., Mayer & Cobb, 2000). Furthermore, intervention programs most often emphasize broad social competencies as opposed to emotional competencies.

In the next paragraph different approaches will be introduce with a focus on the Building Emotion and Affect Regulation training, chosen as the basis for the present empirical contribution.

1.4 PROMOTING EMOTIONAL COMPETENCE

1.4.1 Overview of the programs developed for promoting emotional competence

While elements of emotional competence are implicit in many social competence intervention strategies, emotional competence itself is rarely directly emphasized (Greenberg, Kusche, Cook, & Quamma, 1995). Broadly defined, most indirect approaches fall under the umbrella of Social and Emotional Learning (SEL) programs that encourage attainment and proficiency of relevant skills necessary for social and emotional competence. The Collaborative to Advance Social and Emotional Learning (CASEL), an international organization dedicated to social and emotional learning, is one specific example of a program that is predicated on the framework of SEL (for an overview of this framework, see Elias et al., 1997; Payton et al., 2000). A number of resources also exist for school psychologists interested in information on various SEL curricula. In addition, several published reviews provide descriptions of SEL programs (see Weissberg & Greenberg, 1998), and the CASEL Website (www.CASEL.org) provides an up-to-date catalogue of over 100 nationally available SEL programs. Among the various existing programs that focus on different aspects of emotional development, the following have been validated and are widely used, particularly in the USA: the Emotional Literacy in the Middle School (ELMS) (Maurer and Brackett, 2004), the Lions Quest (Melvin Jones, 1917), the Best of Coping (Frydenberg & Brandon, 2002, 2004), and the Providing Alternative Thinking Strategies (PATHS) program (Greenberg et al.1993).

ELMS was specifically designed for children between the ages of 10-13 who have begun middle school or are preparing for the transition to a middle school environment. The goal of the program is to encourage students to become emotionally literate. The program fosters social skills by teaching students self and social awareness, empathy and healthy communication. It is also geared towards developing emotion-related skills; indeed, students are taught to recognize, label, understand and express feelings. Finally, it aims to promote overall academic learning by enhancing vocabulary, comprehension, abstract reasoning, creative writing, critical thinking and problem-solving skills.

Lions Quest is a life-skills program dedicated to creating family-school-community partnerships for positive youth development. For 25 years, Lions Quest has assisted educators and other adults in guiding young people’s healthy development through program materials and staff development workshops in life skills, character education, drug prevention, and service-learning. Lions Quest comprehensive life skills programs—*Skills for Growing* (grades K–5) and *Skills for Adolescence* (grades 6–8)—have demonstrated effectiveness in changing the knowledge, attitudes, and beliefs that lead to violence and substance abuse, and in strengthening the factors that protect young people from harmful, high-risk behaviours. Skills for Adolescence is composed of one unit, which discusses emotions, with a particular focus on anger. Skills for Action focuses on effective communication, analysis and problems solving, goals achievement, working well in a team, and the peaceful resolution of conflicts.

The Best of Coping program primarily teaches different way of coping. It is divided into four Sessions. Session 1 is the theoretical introduction to the concept of coping; session 2 works on positive thinking, and aims to make young people more aware of how they can change their way of thinking; session 3 puts an emphasis on what not to do with regards to coping strategies; and session 4 works on communication skills.

The *PATHS* program is another noted curriculum program (Kusche & Greenberg, 1994). The PATHS curriculum seeks to improve social and emotional competence through the development of self-control, emotional awareness and understanding, peer-related social skills and social problem solving for preschool and elementary school children (K–5). In addition to structured lessons, the PATHS approach encourages integration into the larger school system and daily generalization activities. Originally used with deaf children, the PATHS curriculum has subsequently been incorporated into the Fast Track program, which is a long-term, multi-component intervention for children at risk for antisocial behaviour (Conduct Problems Prevention Research Group, 1999). Studies of the various versions of PATHS indicate that it positively impacts the affective skills of regular and special education children (Greenberg et al., 1995), deaf children (Greenberg & Kusche, 1993, 1998), and children with conduct problems (Conduct Problems Prevention Research Group, 1999).

Most of these initiatives focus on specific problematic social and/or emotional issues, such as bullying or drugs, rather than on more general emotional competence or specific emotion regulation skills.

Evidence-based programs for developing emotion regulation integrate components of psycho-education, cognitive-behavioural skills, and techniques for arousal modulation, relaxation and mindfulness (SPARCS: DeRosa and Pelcovitz 2009; TARGET: Ford and Russo 2006; HATS: Gurwitch and Messenbaugh 2001). Mindfulness has become a central component in emotion regulation enhancing interventions, attracting growing attention over the past two decades. Mindfulness is congruent with ER, as it involves intentionally bringing one's attention to the internal and external experiences occurring in the present moment without judgment, simply by paying attention to the experience at hand (Linehan 1993). By implementing mindfulness skills, children learn to ''be'' in the moment, to control their internal states while becoming more attentive to their thoughts, emotions and physical sensations. One of the many positive outcomes of mindfulness is the increase in ER, as found among adults, adolescents and children (Arch and Craske 2006; Gratz and Roemer 2004; Meiklejohn et al. 2012). In a recent meta-analysis, Webb et al. (2012) suggest that mindfulness involves reinterpreting an emotional experience, by being non-judgmental, and thus leads to cognitive reappraisal, which, according to Gross and Thompson (2007), is one of the most important components of emotion regulation.

However, ER skills are typically not the main objective of most of the existing and validated programs, as showed before, and also, the adolescents are not the main end users. One notable exception is the program developed by Ford and Russo (2006), entitled Trauma Affect Regulation: Guide for Education and Therapy (TARGET), which focuses on affect regulation skills in young people and adults. The TARGET program aims to reduce PTSD symptom severity and related affective and cognitive impairments without trauma memory processing (Ford et al. 2008). This program was developed for adolescents and adults and does not address the needs of younger children (Pat-Horenczyk et al., 2014). Another program that focuses on self-regulation and resilience skills was recently presented by Watson et al. (2014), who described a 12-week manualized group intervention that targets social competence, affect and behaviour regulation, flexibility, problem solving skills, and proactive orientation among anxious children. Children participating in the intervention reported significant improvement in their positive and negative emotion affect, as well as in their emotional control. Nonetheless, this program is aimed at anxious children only, and although it incorporates components of self regulation, this is not the main topic that the intervention addresses (Pat-Horenczyk et al., 2014).

As emerged from the overview of programs, they are not centred on the emotion regulation abilities, the focus of the present empirical contribution and also, it has emerged a certain lack in Italy of such programs specifically aimed at adolescents. Among the training analyzed, one has emerged as the most comprehensive and suitable for the development of the technology-enhanced protocol: the Building Emotion and Affect Regulation (BEAR) (Pat-horenczyk, 2014).

1.4.2 The Building Emotion and Affect Regulation (BEAR) program

The *BEAR* program is a group intervention for developing emotion regulation abilities in traumatized children. The program was developed by the Israel Centre for the Treatment of Psychotrauma (ICTP) The basic model can easily be adapted to other programs for school-aged children and not only for traumatized children. The program is both theory- and evidence-informed (DeRosa and Pelcovitz 2009; Ford and Russo 2006; Lahad 1993; Miller et al. 2007; Pat-Horenczyk et al. 2004), and incorporates components from several evidence-based interventions, including mindfulness and cognitive behavioural strategies.

The BEAR program is an eight-session protocol designed for group work, with children between the ages of 7–12 years, but it can be adapt to other ages. The sessions are structured around the following core components (Pat-Horenczyk, 2014):

A-Mindfulness exercises:

In line with the accumulating evidence for the contribution of mindfulness to enhancing emotion regulation, each BEAR session includes several mindfulness exercises. Each BEAR session begins and ends with ‘‘Minute for Myself’’ (M&M), a short mindfulness exercise based on the ‘‘S.O.S’’ exercise in the TARGET protocol which is used to reinforce the idea of self-awareness and self-modulation in children (Ford and Russo 2006). ‘‘M&M’’ is based on a dual-purpose meditative technique, which reinforces slowing down and becoming mindful of one’s own experience at a particular time (sensations, thoughts, tension), followed by monitoring and rating his or her internal state on a visual scale. Additionally, each session includes a mindfulness exercise which correlates with the topic for that session. For example, in the third session, which focuses on physical regulation, the children practice mindfulness through touch and texture.

B- Psycho-education:

Each BEAR session includes a psycho-educational message, corresponding with the topic of that session. For example, the fifth session, which focuses on Emotion Regulation, includes a discussion regarding identifying different kinds of emotions and the relationships among emotions, body, thoughts and cognitions.

C- Experiential exercises:

The protocol was designed with experiential exercises incorporating the main massage in fun and creative ways. This was done to encourage children’s engagement and enjoyment and to ensure a more effective learning process.

D- Narrative approach:

Narrative approaches and techniques are commonly used for treating of trauma (RLH, Kagan 2007; National Child Traumatic Stress Network 2010; STAIR/ NST; Silva et al. 2003; TF-CBT, Medical University of South Carolina 2005). To fit in with a narrative approach, each BEAR session includes an ‘‘I-BOX’’ activity, a creative exercise intended to provide the children with a personal space for continuity and building their own narrative. Each child is given a cardboard box and told that it is his/her personal ‘‘treasure chest’’ for storing personal items acquired throughout the sessions, that he or she will eventually keep after the group.

E- Opening and closing rituals:

Each session begins and ends with the same opening and closing rituals, including: lighting and blowing out a candle, the M&M technique (described above), and ‘‘checking in’’ and ‘‘checking out’’ exercises (in which each participant shares one word that comes to his/her mind at the moment, and the facilitator says an opening and concluding statement about the session). These are similar to the opening and closing rituals in the SPARCS protocol (DeRosa and Pelcovitz 2009). The rituals create a clear setting for the group space as separate from what happens outside the group, as well as a sense of continuity and belonging to the group.

Each session will be now shortly described, explaining the particular aims.

Session 1: Becoming a Group

This session focuses on forming a group by having children introduce themselves and actively work together to develop group rules and conventions. The aims and objectives are to increase awareness of self within the group as well as awareness of others, to introduce the topic of locating resources for coping through experiential exercises, play and fun, to create a clear beginning and ending for each session by using group rituals, to create a comfortable and safe environment for the children to share and socialize through rules and group norms.

Session 2: Resources

The session focuses on learning about different resources and the different ways each one of us copes with stress. The aims and objectives are to connect between resources and coping skills, practice mindfulness as a way of coping, to learn ways of coping with stress according the BASIC PH model (Lahad, 1993).

Session 3: Physical Regulation - part 1

The session focuses on experiential exercises to demonstrate different aspects of physical regulation. The aims and objectives are to increase awareness of bodily sensations as an essential aspect in emotion regulation, to learn how to relax, to create an imaginary safe place.

Session 4: Physical Regulation - part 2

The session focuses on practicing relaxation coping skills for physical regulation. The aims and objectives are to increase awareness to body sensations and the connection to feelings, to become aware of the different experiences when the body is tense and relaxed, to learn different grounding and relaxation skills.

Session 5: Cognitive and Emotional Regulation

This session focuses on enhancing the awareness of the impact of emotion and thoughts in stressful situations. The aims and objectives are to learn to cope and tolerate emotions even if it is not comfortable, to develop awareness to feelings and on how thoughts and feelings influence one another, to practice regulation skills to prevent a flood of emotions (such as: diversion and adopting a flexible attitude), to affect expression.

Session 6: Cognitive Behavioural Regulation

This session focuses on increasing awareness of thoughts in reaction to stress. The aims and objectives are to understand that emotions, thoughts, and behaviours influence one another, to learn about the inter-relationship between cognitions and emotions and how to distinguish between rigid and flexible thinking.

Session 7: Interpersonal Regulation

This session focuses on empathy and listening. The aims and objectives are to demonstrate the importance of social support, to learn empathic listening, to notice the difference between internal and external emotional expressions.

Session 8: Social Support: Helping Others and Seeking Help

This session focuses on helping others and seeking help from others. The aims and objectives are to encourage help-seeking and altruistic behaviour and to learn how to use them as coping strategies.

Recently three Panda groups were conducted in Israeli schools and two additional groups are planned to be implemented in children's homes. Ten BEAR groups were also conducted and evaluated in Singapore (N=73, mean age=10.52, SD=1.53). The training was well received by children, caregivers and facilitators. The children reported high enjoyment of the program, learning positive coping strategies, and elevated help-seeking behaviour. The caregivers reported an increase in emotion regulation, ($p=0.001$, Cohen’s d=0.437) and positive coping ($p=0.003$, Cohen’s d =0.389), as well as a decrease in general distress among the participants (p =0.036, Cohen’s d =0.266). This study provides promising preliminary evidence for positive outcomes. Of course, there is a need for randomized controlled studies and further evidence from implementation of the BEAR program in other cultural contexts (Pat-Horenczyk et al., 2014).

The BEAR (Building Emotion and Affect Regulation) intervention has a special focus on enhancing emotion regulation. It incorporates the latest developments in the field including mindfulness techniques, cognitive behavioural strategies and narrative interventions, all used in a creative and playful manner and it found to be the most comprehensive program, including those analyzed, in order to work and improve the emotion regulation abilities in adolescents. For all this reason it was chosen to be adapted for a technological version and to be used in this empirical contribution.

CHAPTER 2

THE ROLE OF POSITIVE TECHNOLOGIES IN PROMOTING EMOTION REGULATION ABILITIES

An ever-increasing amount of research provides support for the systemic and ongoing role that social-emotional education plays in optimal cognitive and behavioural development (Bear, Manning, & Izard, this issue; Elias et al., 1997). Further the need to integrate social-emotional learning as part of a school initiative designed to support the healthy psychosocial development of children and adolescents has been internationally recognized. However, when seeking to construct and implement such programming, schools must consider that today's teenagers are "digital natives," which means that educators must, be familiar with – and know how to use – their student's "language." Today's students constantly interact with digital technology. As a result, today's generation has developed cognitive and learning specific styles, which differ from those of the previous generation (Michael & Chen, 2006; Palfrey & Gasser, 2008). Schools must take this into account so as to play their educational role in an effective way.

The emerging field of positive psychology provides a useful framework for guiding this new educational perspective. In fact, positive psychology programs can offer insight on how to develop technological systems and applications that foster positive emotions, promote personal growth and contribute to social and cultural development.

Starting from an introductory analysis of the concept of well-being as it has being framed by positive psychology, this chapter will analyse the Positive Technology paradigm and the concept of personal experience focusing on how new technologies can manipulate its three features: Hedonic, Eudemonic and Social/Interpersonal. The chapter with then shift to focus on the main new technologically advanced tools used in the present empirical contribution – virtual reality, biosensors and mobile technologies – due to the possibilities that these tools may offer in the enhancement of stress management and emotion regulation abilities, and some practical examples of their application will be presented.

2.1 NEW TECHNLOGIES AND WELL-BEING

2.1.1 The Positive Psychology shift

Positive Psychology (PP) is a nascent discipline whose general goals are to understand human strengths and virtues and to promote these strengths to allow individuals, communities and societies to flourish (Riva et al., 2012). Martin Seligman and Mihaly Csikszentmihalyi officially announced the birth of Positive Psychology in 2000. Within the first twenty-first century issue of the *American Psychologist*, the two authors identified an epistemological and theoretical limit for the modern psychology in the emphasis given to the study of human shortcomings, illnesses and pathologies. Therefore, psychology was perceived as "half-baked" (Lopez & Snyder, 2011) and a change in its focus from repairing deficits to cultivating human flourishing took place.

It gradually became clear to several scholars that the almost exclusive focus on pathology neglected the possibility of understanding normal and optimal functioning. This trend has resulted in a shift in emphasis toward the study of the factors that allow individuals and communities to thrive: the strengths' perspective (Riva et al., 2012). In this way, Positive Psychology emerged as the scientific study of "positive personal experience, positive individual traits, and positive institutions" (Seligman, 2003; Seligman & Csikszentmihalyi, 2000). By focusing on human strengths, healthy processes and fulfilment, Positive Psychology aims to improve the quality of life, as well as to increase wellness and resilience in individuals, organizations and societies. Rather than representing a new formal sector or a new paradigm, Positive Psychology is a novel perspective to studying human behaviour that encompasses all areas of psychological investigation (Delle Fave, Massimini, & Bassi, 2011). PP, as strengths' perspective, was influenced by some philosophical traditions in the reflection about happiness and well-being. According to Parfit (1984), there are three different theories regarding well-being: hedonism, desire theories and objective list theories. Hedonists identify well-being with experiences of pleasure; desire theorist equate well-being with the satisfaction of one's desires; while, according to objective list theories there are items, such as knowledge or friendship, constituting well-being that consist nearly merely in pleasure experience nor in desire-satisfaction. Hedonism and desire theories are subjective approach, while objective list theorist, by contrast, are objective. These philosophical traditions have influenced the psychological reflections, in fact in Positive Psychology we can find two different conceptions of well-being: "subjective well-being" (also called hedonic well-being) and "psychological well-being" (also called eudemonic well-being). The first refers to a person's subjective evaluation of his life satisfaction, while, psychological well-being links happiness with those acts aimed to achieve self-development.

2.1.2 Positive Technology paradigm

It is possible to combine the objectives of Positive Psychology with enhancements of Information and Communication Technologies (ICTs) toward the new paradigm of Positive Technology. The final aim of this paradigm is to use technology to manipulate and enhance the features of our personal experience with the goal of increasing wellness and generating strengths and resilience in individuals, organizations and society (Riva et al., 2012).

As stated by Riva (2012), it is possible to underline two faces of our experience: on one side, we can intentionally control the contents of our experience (subjective experience); on the other sides, its contents define our future emotions and intensions (personal experience). In other words, we both shape and are shaped by it. Moreover, not all the personal experiences are the same, in fact, for example, they are influenced by the meanings and values attributed and are connected and/or mediated by collective experience. These features suggest that it is possible to manipulate the quality of experience with the goal of increasing wellness and generating strengths and resilience in individuals, organizations and society. This is possible according to three different perspectives: Hedonic, Eudemonic and Social/Interpersonal.

Seligman in his book *Authentic Happiness* identified "three pillars" of the good life:

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

Similarly, Keyes and Lopez (2002), stated that positive functioning is a combination of three types of well-being: (a) high emotional well-being, (b) high psychological well-being and (c) high social well-being. This means that Positive Psychology identifies three characteristic of our personal experience - affective quality, engagement/actualization and connectedness - that help to promote personal well-being. Positive technologies can be so classified according to three different perspective, basing on their effects on the personal experience:

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

But how can technologies in practice, work on these three features of personal experience? Returning to the concept of subjective and personal experience, there is a critical difference between them, as stated by Riva (2012): if subjective experience is the experience of being a subject (experience as subject), personal experience is the experience affecting 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 outside. In other words, personal experience becomes the dependent variable that may be manipulated by external researchers. In particular, technology can be used to manipulate the features of an experience in three separate but related ways:

- *By structuring it* using a goal, rules, and a feedback system. (McGonical, 2011). The goal gives a sense of purpose, orienting the participation in the experience. The rules drive subject to see the experience in a different way. The feedback system helps to understand the distance to achieve the final goal and provides motivation to keep trying.
- *By augmenting it* to achieve multimodal and mixed experiences. Technology allows multi-sensory experiences in which content and its interaction are offered through more than one of the senses (Rosenblum, 2000).
- *By replacing it* with a synthetic one. Using Virtual Reality, it is possible to simulate physical presence in a synthetic world that reacts to the action of the subject as if he/she was really there (Slater et al., 2010).

In the next paragraphs we will focus more deeply on the three features of the personal experience (Hedonic, Eudemonic and Social/interpersonal) giving also some examples of how new technologies could be use to promote them.

2.2 THE THREE PERSPECTIVE: HEDONIC, EUDEMONIC AND SOCIAL/INTERPERSONAL

2.2.1 The Hedonic perspective: Fostering positive emotional states

The *pleasant life* and high emotional well-being have being investigated by the hedonic perspective. It owes it’s name to the ancient Greek vocabulary, where the word edonè means pleasure. This concept appeared several times in the psychological domain, as in the psychoanalytic model and in the behavioural approach (Peterson, Park, & Seligman, 2005), but only with the work of Kahneman et al. (2004), hedonic psychology was eventually conceptualized as the study of “what makes the experience pleasant or unpleasant” (Argenton, 2014). A large number of studies have focused on subjective well-being defined as “a person’s cognitive and affective evaluation of his or her life as a whole” (Diener, 2000; Diener, E., Diener, M., Diener, C, 1995). Thus, subjective well-being implies both emotional responses to life events and cognitive judgement of personal satisfaction. At the cognitive level, opinions and satisfaction of the life becomes fundamental. At the emotional level, subjective well-being, is related to the presence of positive emotional states and to the absence of negative moods. This point is particularly interesting for hedonic perspective: positive emotions can expand cognitive-behavioural repertoires and help to build resources that contribute to future success (Fredrickson, 1998; 2001). Key arguments for the usefulness of positive emotions in increasing well-being have been recently provided by Fredrikson (2001; 2004), in what she called the “broaden-and-build model” of positive emotions. According to her, positive emotions broaden, on the one hand, the organism with non-specific action tendencies that can lead to adaptive behaviours and mitigate the effect of negative stressors. The elicitation of positive emotions, for example, make people more likely to interact with others. Furthermore, on the other hand, by broadening an individual’s awareness and thought-action repertoire, positive emotions build over time, enduring physical, psychological and social resources. For example, lower levels of cortisol and an increase of immune function were found (Steptoe, Wardle, & Marmot, 2005), as well, the presence of positive emotions is an effective predictor of the level of happiness and longevity of individuals (Fredrickson & Joiner, 2002; Moskowitz, 2003).

2.2.2 Using technologies to foster positive emotional states

The hedonic side of Positive Technology framework concerns how technologies can be used to produce positive emotional states. As stated by Riva (2012) according to the model of emotions developed by Russell (Russel, 2003) 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” can be experienced as free-floating (mood) or attributed to some cause (and thereby begins an emotional episode). In this way, an emotional response is the attribution of a change in the core affect given to a specific object (affective quality). 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).

Recent researches showed that the core affect can be manipulated by Virtual Reality (VR). Riva and Colleagues tested the potentiality of VR in inducing specific emotional responses, including positive moods (Riva et al., 2007) and relaxing states (Villani, Lucchetta, Preziosa & Riva, 2009; Villani, Riva & Riva, 2007). Most recently, some studies explored the potentiality of emerging mobile devices to exploit the potential of positive emotions. For example, Grassi et al. (2009) showed that relaxing narratives supported by multimedia mobile phones were effective to enhance relaxation and reduce anxiety in a sample of commuters (Argenton et al., 2014). But the potentiality of VR and mobile technology will be explored after. Furthermore, in recent years there has been an intensified discussion toward the role of emotions in human-computer interaction, in fact trends as engineering aesthetics (Liu, 2003) and hedonic computing (Wakefield & Whitten, 2006), emerged, with the emphasis on the importance of understanding how interfaces should be designed to elicit positive emotional experiences from users.

2.2.3 The Eudemonic perspective: Promoting individual growth and fulfilment

The *engaged life* is based on the eudemonic definition of well-being. This perspective is associated with the possibility to fully realize human potential through the exercise of personal virtues in pursuit of goals that are meaningful to the individual and society (Serino, Cipresso, Gaggioli & Riva, 2009; Delle Fave, Massimini & Bassi, 2011). In the Greek tradition a daimon is in fact a divine spirit in charge of cherishing man and pushing him towards happiness. From a psychological point of view, in the work of authors as Maslow (1954), Allport (1961) and Rogers (1961), individuals, groups and organizations, are no longer perceived as passive receptors of external stimulations, but as proactive agents, fully engaged in their actualization and fulfilment. Thus, this approach focuses on the growth of individuals as a whole, rather than merely emphasizing the pursuit to pleasure and comfort (Argenton et al., 2014). In this case happiness no longer coincides with a subjective form of well-being, but with a psychological one and this is based on 6 elements (Ryff, 1989; Ryff & Singer, 1998; 2003):

- Self acceptance, characterized by awareness and a positive attitude towards personal qualities and multiple aspects of the self, including unpleasant ones;
- Positive relationship with others, determined by the ability to develop and maintain social stable relationship and to cultivate empathy, collaboration and mutual trust;
- Autonomy, reflected by the ability of seeking self-determination, personal authority, or independence against conformism;

- Environmental mastery, based on the ability to change the external environment and to adapt it to personal needs and goals;
- Purpose in life, marked by the presence of meaningful goals and aims in the light of which daily decisions are taken;
- Personal growth, achievable throughout a continuous pursuit of opportunities for personal development.

Another author that interpreted the complexity of eudemonic perspective is Csikszentmihalyi who formalized the concept of Flow (Csikszentmihalyi, 1975; 1990). Flow, or optimal experience, is a positive, complex and highly structured state of deep involvement, absorption and enjoyment. 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 and unambiguous feedback from the task at hand, loss of self-consciousness, control of one's actions and environment, positive affect and intrinsic motivation (Riva et al., 2012; Argenton et al., 2014).

2.2.4 Using technologies to promote individual growth and fulfilment

The eudemonic level of Positive Technology consists in how new technologies can be used to support individuals in reaching engaging and self-actualizing experiences. Scholars in the field of human-computer interaction are starting to recognize and address this challenge (Riva et al., 2012). For example, Rogers calls for a shift from "proactive computing" to "proactive people", where technologies are designed not to do things for people but to engage them more actively in what they currently do. Further, the theory of Flow, has been very used to study user experience with Information and Communication Technologies, for example with Internet (Chen, 2000), Virtual Reality (Gaggioli, Bassi, Delle Fave, 2003; Riva, Castelnuovo, & Mantovani, 2006), social networks (Mauri, Cipresso, Balgera, Villamira & Riva, 2011), video-games (Jegers, 2007; Sherry, 2004; Sweetser & Wyeth, 2005; Wang, L., Chen, 2010) and Serious Games (Bergeron, 2006). In fact, all these media are able to support the emergence of a flow state, as they offer an immediate opportunity for action and the possibility to create increasingly challenging tasks, with specific rules, as well as the opportunity to calibrate an appropriate and multimodal feedback.

Some researches have drawn parallels between the experience of flow in VR and the sense of presence, defined as the subjective perception of "being there" in a virtual environment (Riva, Waterworth & Waterworth, 2004; Riva, 2009). Both experiences have been described as absorbing states, characterized by a merging of action and awareness, loss of self-consciousness, a feeling of being transported into another reality, and an altered perception of time; further, both presence and optimal experience are associated with high involvement, focused attention and high concentration on the ongoing activity. Starting from these theoretical premises, Riva and colleagues (2009) have suggested the possibility of using VR for a new variety of applications in positive mental health, based on a strategy defined as "transformation of flow", defined as 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 (Riva et al., 2012). This strategy, which integrates the Fredrickson's "broaden and-build model" with "flow" theory, involves three main steps (Riva, Castelnuovo & Mantovani, 2006; Riva, Mantovani & Gaggioli, 2004). First, it is necessary to identify an information-rich environments that contains functional real-world demands; second, to use the technology to enhance the level of presence of the subject in the environment and to induce an optimal experience; third to allow cultivation, by linking this optimal experience to the actual experience of the subject.

2.2.5 The Social perspective: Enhancing integration and connectedness

Networking and participation are becoming the foundations of human performance in educational, organizational and recreational settings (Barabasi, 2002). New communities of practice (Wenger, 1999) are being established to promote an engagement economy that will be able to foster innovation and success by sustaining collective well-being and group flourishing (McGonigal, 2010; Richardson &West, 2012). However the enhancement of a human capital so dynamic and heterogeneous implies a deep involvement in nurturing a social form of well-being. In particular, social well-being indicates the extent to which individuals are functioning well in their social system and it is defined on five dimensions (Keyes , 1998):

- Social integration, conceptualized as the evaluation of the quality of personal relationship with a community or a society;
- Social contribution, evidenced by the perception of having something important to offer to society and world at large;
- Social coherence, determined by the meaning given to the quality, organization and operations that make up the social sphere;
- Social acceptance, based on the belief that people proactivity and agency can foster the development of societies and culture;
- Social actualization, determined by the evaluation of the potential and of trajectory of society (Argenton, 2014).

2.2.6 Using technologies to enhance integration and connectedness

The final level of Positive Technology, the social and interpersonal one, is concerned with the use of technologies to support and improve the connectedness between individuals, groups and organizations. As stated by Riva (2012) an open challenge is to understand how to use technology 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. Short et al. (Short, Williams & Christie, 1975) define "social presence" as the "degree of salience of other person in a mediated communication and the consequent salience of their interpersonal interactions". Conventional computer-mediated communicative tools, such as e-mail or text-based chat, are regarded as having lower social presence and social context cues when compared to face-to-face communication (Riva, 2012). However, some authors showed that it is possible to manipulate the technological experience to enhance social presence and in this way to improve different mediated activities (Park, 2010) such as online learning (Joyce , 2009), e-commerce (Swamynathan et al., 2008) and healthcare (Boulos & Wheeler , 2007).

Riva and colleagues (Gorini et al., 2010) recently argued that a subject is present within a virtual group if he is able to put his own intentions (presence) into practice and to understand the intentions of the other group members (social presence). This implies that to sustain social optimal experiences (networked flow), the technology has to provide the virtual group with the possibility of expressing itself and of understanding what each individual member is doing (Riva, 2004). Moreover, Gaggioli and colleagues (2011) suggested that optimal group state is achieved when the team develops a "we-intention", in which the actions of the individuals and of collective are merged, and the group acts as an autonomous, self-organizing entity. Networked flow occurs when high level of presence and social presence are matched with a state of "liminality" (Gaggioli, Riva, Milani & Mazzoni, 2013). In particular, three preconditions have to be satisfied:

- Group members share common goals and emotional experiences so that individual intentionality becomes a "we-intention" (Searle, 1983) able to inspire and guide the whole group;
- Group members experience a state liminality, a state of "being about" that breaks the homeostatic equilibrium previously defined;
- Group members identify in the ongoing activity the best affordances to overcame the situation of liminality (Argenton, 2014).

Western society is characterized by increasing levels of loneliness and lack of social integration, even if creating and maintaining social relationship is considered one of the main indicator of well-being and a protective factor for health (House, Landis & Umberson, 1988), The need of social integration is more important in specific social group, such as adolescents, disabled and 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 play a key role in improving these programs (Riva et al., 2012).

2.3 NEW TECHNOLOGIES: A LOOK TO THE MAIN TOOLS

Within the positive technology perspective, three main groups of advanced technologies emerged in a recent systematic review in relation to the management of psychological stress: virtual-interactive environments, mobile technologies and biofeedback (Serino et al., 2014). Each group offers 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 more suitable for multimedia presentation of content and are useful to provide to provide participants with real-time suggestions for how to deal with stress in their everyday lives. The potential for virtual reality (VR) to reduce anxiety and psychological stress has been exhibited in multiple studies (Choi et al., 2005; Goncalves, Pedrozo, Coutinho, Figueira, & Ventura, 2012; Gorini & Riva, 2008; Ling, Nefs, Morina, Heynderickx, & Brinkman, 2014; Parsons & Trost, 2014), and smartphones are a promising new tool to support related psychological health interventions. Other innovative emerging technologies include biosensors and the biofeedback interventions that they may offer. Current research is moving towards an integration of these three tools. In the next paragraphs, we will specifically focus on these three new positive technologies, as they have been used in the present empirical study, due to the possibilities that they may offer in the enhancement of stress management and emotion regulation abilities.

2.3.1 Virtual Reality and its application domains

As demonstrated by Serino et al. (2012), recent research has found that virtual reality (VR) could be an effective method to induce positive emotions. The potential advantages of using VR technology in inducing positive emotions include the following:

• Interactivity, so as to motivate participants, including video and auditory feedback;

• Manipulability, to allow the therapist and/or the researcher to tailor the sessions to focus on the specific needs of an individual as well as to increase task complexity as appropriate.

Riva et al. (2007) tested the potential of VR in inducing specific emotional responses, including positive moods. Their results suggest that VR is an affective medium for inducing relaxation through the use of relaxing virtual. Villani et al. (2007; 2009), compared the efficacy of structured experiences provided through different technologies (video, audio and VR) for inducing relaxation. Their results demonstrated a significant reduction of anxiety symptoms and a significant improvement in emotional states, assessed through psychological self-report and physiological parameters, but found no difference among the various media conditions (Serino et al., 2012).

An important feature of the virtual reality interface is that it gives the user the possibility to feel that he/she is inside a three-dimensional world and to navigate and interact within this environment in real time (Wiederhold & Wiederhold, 2005). Virtual Reality systems can be divided into two categories, depending on the technological components that are used: non immersive and immersive. In *non immersive systems,* the user interacts with the virtual environment through a monitor and through traditional tools such as a keyboard and a mouse. In *immersive systems,* the user wears a headband and is equipped with a tracking system that allows him/her to see changes in the environment in a dynamic way, corresponding to the participant's actual movements. Users interact via a joystick or with a glove, and the configuration can include haptic tools that provide feedback to the user in terms of touch, weight and intensity (Villani, Grassi & Riva, 2011).

Immersive VR systems are considered to be the most capable of supporting the emergence of flow experience (Riva, Castelnuovo & Mantovani, 2006; Riva et al., 2010). Research highlights two key characteristics of this technology as a source of flow: (a) opportunities for action (goals and rules) – due to its flexibility, immersive VR systems provides designers with the possibility of creating a wide range of increasingly challenging situations and tasks, and (b) feedback – immersive VR systems can offer multimodal feedback to individuals' actions and behaviour (Gaggioli, Bassi, & Delle Fave, 2003; Gaggioli, 2004). Furthermore, as previously explained, some researchers have drawn a parallel between the experience of flow in VR and the sense of presence, defined as the subjective perception of "being there" in a virtual environment (Riva, Waterworth, & Waterworth, 2004; Riva, 2009).

Currently, the most common forms of VR application domains in treatment capacities are in the treatment of the anxiety disorders, specifically for phobias (Emmelkamp, 2005; Riva et al., 2014; Wiederhold & Rizzo, 2005). Indeed, VR exposure therapy (VRE) has been proposed as a new medium for exposure therapy (Riva, 2005) that is safer, less embarrassing and less costly than reproducing real-world situations. The rationale is simple: in VR, the patient is intentionally confronted with the feared stimuli while allowing his/her anxiety to attenuate. Avoiding a dreaded situation reinforces a phobia, and each successive exposure to it reduces the anxiety through the processes of habituation and extinction. Exposure to feared stimuli or situations is therefore an

integral component of treatment for phobias, and VR can be described as an experiential form of imagery that is as effective as reality in inducing emotional responses (Vincelli, Molinari, & Riva, 2001). As stated by Baños, Botella, and Perpiña (1999), the VR experience can help the course of therapy through "its capability of reducing the distinction between the computer's reality and the conventional reality." The possibility of structuring a large amount of realistic or imaginary stimuli and, simultaneously, of monitoring the possible responses generated by the user of the technology offers a considerable increase in the likelihood of therapeutic effectiveness as compared to traditional procedures (Riva & Davide, 2001). Other areas in which VR has been successfully used include physical and neurological rehabilitation (Himelstein & Rizzo, 2004; Holden, 2005; Morganti, 2004; Rizzo & Buckwalter, 1997; Schultheis, 2005). as well as in education and general stress management. In virtual learning environments, students can interact with a set of complex information in an intuitive way, as opposed to a symbolic one. When it comes to stress management, the opportunity to experience circumstances through VR in which specific skills related to the management of emotions can be acquired, generates a sense of personal efficacy and prepares the participant to also be able to handle real-life situations (Villani, Grassi & Riva, 2011).
We will now focus on two emerging technological trends, biosensors and mobile technologies, which can serve to increase the opportunities offered by VR, enhancing its potential in the fields of stress management and emotion regulation.

2.3.2 Biosensors and their application domains

During the last several years, a number of researchers have begun to investigate 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 applications to collect, elaborate and transmit real-time information related to an individual's psycho-physiological state and to identify specific trends in each participant's data (e.g., increasing levels of psychological stress). This approach can also allow individuals to accurately monitor their psychological health and check their progress with encouraging and motivating feedback that can enhance their own self-efficacy (Bandura, 2005). Several portable technologies have been developed to recognize stress level, and the physiological signals that are typically measured include: blood pressure, heart rate, heart rate variability (HRV), skin conductance, cortisol and pupil diameter (Picard & Sano, 2013).

Although these devices don't directly measure an individual’s emotional state, they do capture the physiological changes that occur in accordance with said emotional states by providing objective information.
Biofeedback is one of the main physiological detection tools used in research related to stress. The main purpose of this tool is to enable people to achieve a state of awareness of their physiological responses to various stimuli, whether relaxing or stressful, and approach their feelings adaptively (Villani et al., 2011). Biofeedback is far from a mere measurement tool; it has become a technique aimed at teaching patients to become aware of physiological changes and to learn how to deal with these physiological responses in particular situations. Through receiving feedback from their environment, people can learn to tailor their behaviours when they come to understand the consequences of their responses (Villani et al., 2011).
In psychological research on stress, biofeedback is designed to monitor an individual’s physiological changes during relaxation sessions or during simulations of stressful situations, to make him/her aware, in real time, of how his/her body reacts to certain stimuli and trying to help him/her to manage these reactions. For example, in a biofeedback study that focused on relaxation, biosensors were connected to the computer, and heart rate and respiratory frequency were measured. On the computer, the user saw a relaxing forest with a bonfire. The biosensors recorded real-time physiological activity and allowed for changes to be made in the environment based on the physiological responses detected. The higher the heart and breathing rate, the higher the flame of the virtual bonfire was displayed, and vice versa, the slower and more controlled the physiological parameters were, the lower the virtual flame was displayed (Villani, Grassi & Riva, 2011). Stress detection technology could help people better understand and relieve stress by increasing their awareness of heightened levels of stress that would otherwise go undetected (Villani et al., 2011). In fact, sometimes people are aware of being under stress, for example, when they are occupied with deadlines for homework and projects; however, long-term situations with high stress can become chronic and people may be less likely to notice whether they are under high stress or may be generally less sensitive to stressors (Picard & Sano, 2013). In their analysis, Cohen et al. (2007), highlighted a serious association between psychological stress and several diseases, particularly mood disorders and cardiovascular disease (Antoni et al., 2006; Leserman et al., 2002; Rozanski, Blumenthal, & Kaplan, 1999).
The use of biofeedback has recently been associated with investigations of applied psychology in VR. Repetto, Gorini and Vigna e coll’s (2009) study included patients with generalized anxiety disorder (GAD), offering them an integrated treatment based on cognitive behavioural therapy (CBT), through the use of VR and biofeedback. The integrated use of the two tools in conjunction with CBT allowed the patient to become aware of his/her physiological changes through a direct

action in the virtual environment. Another recent study was carried out with patients with posttraumatic stress disorder (Riva, Raspelli, Algeri, & Pallavicini, 2010). In this study as well, through the presentation of stimuli that were related to PTSD symptoms, mediated by a VR interface, it was possible to support the patient in raising awareness of his/her personal physiological functioning and in the management of said functions, through a direct action in the virtual environment.

Neurofeedback is a complementary tool to biofeedback. Neurofeedback is designed to teach patients to learn and self-regulate their own central nervous system. This is done through information received from electroencephalogram, which is recorded by sensors connected to the computer. Neurofeedback is currently widely used in individual psychological therapies, particularly for attention deficit and hyperactivity disorder (Fuchs, Birbaumer & Lutzenberger, 2003; Leins, Goth, Hinterberger et al., 2007), anxiety (Hammond, 2005) and learning difficulties (Yucha & Gilbert, 2004).

2.3.3 Mobile technologies and their application domains

Recently, some studies have explored the potential of emerging mobile devices in inducing positive emotions and in improving physical and mental health. Mobile phone interventions, including text messages and smartphone applications, are part of the broader use of electronic tools to improve physical health (also called e-health or mHealth). mHealth is defined as "the use of mobile and wireless technologies to support the achievement of health objectives" (Kay, Santos, & Takane, 2011). There have been a large number of mHealth intervention studies that aim to improve physical health outcomes, as well as a number of published review articles and meta-analyses (Cole-Lewis & Kershaw, 2010; Fiordelli, Diviani, & Schulz, 2013; Fjeldsoe, Marshall, & Miller, 2009; Herbert, Owen, Pascarella, & Streisand, 2013; Krishna, Boren, & Balas, 2009; Liang et al., 2011; Militello, Kelly, & Melnyk, 2012; Park, Howie-Esquivel, & Dracup, 2014; Shaw & Bosworth, 2012; Whittaker et al., 2009). Moreover, building on the powerful potential that mobile technology has for reaching people in vivo, social scientists are developing innovative technology-based approaches to help individuals initiate and sustain behavioural change in psychological and social ("psychosocial") domains, which include mental health, personal well-being, and social relationships. Although there has been extensive research on the use of mobile technologies on physical health behaviours and outcomes, the use of these technologies to alter psychosocial outcomes is much more recent and far less common (Konrath, 2014). As Preziosa et al. (2009) point out the benefits that mobile technologies can give to the world are vast. For example, since mobile technologies are widely used, they may offer the possibility of treatment to different groups. In addition, the speed inherent in this medium allows for interactive feedback, which may increase participant's willingness to engage in treatment; moreover, there is potential for personalization, which may increase motivation to continue treatment programs (Konrath, 2014). Mobile phones also ensure the availability of content anytime, anywhere and this has been demonstrated to increase adherence to medication (Granholm, Ben-Zeev, Link, Bradshaw, & Holden, 2012), and the commonplace use of these technologies could promote mental health education. Furthermore, mobile interventions can help to build mentally and physically healthy habits because they can be repeated across time and specifically target high-risk time periods. They can also be individually tailored based on user characteristics; in addition, the fact that mobile interventions are applied within everyday contexts may help people to generalize these behaviours across a variety of real-life settings (e.g., work, school, home, leisure) (Konrath, 2014).

Currently research is moving towards the development of mobile devices that integrate the use of biosensors, giving the possibility to record and send psycho-physiological signals. Concurrently, research is moving towards the development of multimedia content developed in VR to be implemented on mobile technology readily at hand to be used directly in the context of the user (Villani, Grassi & Riva, 2011). For example, is a study conducted by Grassi et al. (2009) on a sample of commuters, relaxing narratives supported by multimedia mobile phones were demonstrated to be effective to enhance relaxation and to reduce anxiety. Villani et al. (2011) also demonstrated the efficacy of a stress management protocol supported by the use of mobile phones in reducing anxiety levels in a sample of oncology nurses. Another example of the integration of these three emerging technologies, is the Positive Technology App (PTA) developed by Riva (2013). In addition, the results of a current study will be introduced in chapter 4.

PART 2:
DESIGN AND DEVELOPMENT

CHAPTER 3: DESIGN AND DEVELOPMENT OF THE TECHNOLOGY ENHANCED PROTOCOL

Chapter Three focuses on the development of the technology-enhanced protocol, which preludes the second empirical study. The final aim, in this broader perspective, is to test and evaluate the efficacy of several sessions of the BEAR training technology-enhanced protocol (Pat-Horenczyk et al., 2012).

The development of the technology-enhanced protocol was carried out in 5 main sequential phases: the user need analysis; the adaptation of the BEAR to a technology enhanced protocol; the definition of functional requirements; the integration of the technological components; and then, the validation through an empirical study.

Beginning with a brief presentation of the actors involved, each one of these phases will be deeply analyzed, before introducing the second empirical study in chapter 5.

3.1 A USER CENTRED APPROACH

3.1.1 Actors involved

The development process involved three main universities in Italy, Israel and Portugal: the University of Milano-Bicocca (UNIMIB), the Hebrew University of Jerusalem (HUJI) and the Insituto Superior Tecnico of Lisbon-Technical University of Lisbon (IST-UTL).

The Hebrew university of Jerusalem is internationally ranked among 100 leading universities in the world and first among Israeli universities. Work with HUJI was conducted with Ruth Pat-Horenczyk and with Sarit Schramm. Prof Ruth Pat-Horenczyk is the main developer of the BEAR training protocol and is an Adjunct Associate Professor at the School of Social Work and Social Welfare at HUJI. She is also the Director of the “Child and Adolescent Clinical Unit” at the Israel Center for the Treatment of Psychotrauma (ICTP). The center has been active since 1989 as a project of the Herzog Hospital and today is a world-recognized innovator in the research and treatment of the widespread effects of trauma. Sarit Schramm is an educational psychologist and the coordinator of PANDA BEAR project at ICTP. She worked with Prof Pat-Horenczyk on the development and implementation of the original BEAR training.

The Instituo Superior Tecnico-Technical University of Lisbon (IST-UTL), since its founding in 1911, is the largest and most reputed school of Engineering, Science and Technology and Architecture in Portugal. This study was carried out in conjunction with GAIPS (Grupo de Agentes Inteligentes e Personagens Sintéticas), a research group on agents and synthetic characters at INESC-ID, the *Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento em Lisboa*, The INESC-ID is a R&D institute dedicated to advanced research and development in the fields of Information Technologies, Electronics, Communications, and Energy. Work with GAIPS was conducted with Ana Paiva, an Associate Professor in the Department of Computer Science and Engineering (Departamento de Engenharia Informática) of IST and the group leader of GAIPS, and with Joao Dias, an assistant professor at the Computer Science Department of IST-UTL, where he teaches courses on Introduction to Programming, Artificial Intelligence, Logic Programming, and Autonomous Agents and Multi-Agent Systems.

The three universities worked together to modify the BEAR training protocol so as to both create a technologically-enhanced protocol and in order to adapt it for work with different ages, through revisions of both each session and exercise. As previously stated, the development was carried out in 5 main sequential phases that will be introduced in the next paragraphs: the user need analysis; the adaptation of the BEAR to a technology-enhanced protocol; the definition of functional requirements; the integration of the technological components; and the validation of the revised protocol through an empirical study.

3.1.2 The methodological approach adopted: The user centred design

It is increasingly acknowledged that design must be centred on an individual, namely the *user*. A person-centred approach is developing in the field of technological design: the study of human-technology interactions has evolved from the application of theories regarding internal cognitive processes to approaches more focused on the contextually-situated activities of individuals (Kutti, 1995). User-Centred Design (UCD) is an approach to design and develop technologies that consider users' needs as the primary guides for technological implementation. UCD (Garrett, 2010; Lowdermilk, 2013; Miller, 2005) is considered by many to be the gold standard approach to achieve a satisfactory user experience. The goal of this type of design is to ensure that no aspects of the user experience take place in interactions outside of the designer's knowledge. The only way to achieve this is to actively involve the user in all the steps of the product design, as opposed to only in the evaluation phase, as seen in ergonomics/usability approaches that were popular in the last few decades. In this sense UCD is a broad term that refers to any design process where the end-users deeply influence how the design takes place (Abras, Maloney-Krichmar, & Preece, 2004). UCD of positive technologies is based on considerations of individuals' personal needs, concerns, and issues to orientate technology creation and application.

In order to develop a user centre product for the present study a UCD was followed, and both qualitative and quantitative methods were used. First, a user's need analysis was conducted through focus groups. Then, during the development phase, three different graphic design versions were directly evaluated by some high-school students in order to decide which one of these to use. Finally some usability tests were conducted to evaluate the total time required to complete the whole protocol and to see responses from the pre and post training questionnaires on the interface of the training, the animation of the avatars and to receive evaluations of the physiological measures. The development of the training evolved step by step in response to the main findings of the preliminary data and three different versions of the training were finally tested through an empirical study.

3.1.3 Methodological premises and tools used

Three main areas were analysed through focus groups of adolescents:

a) Stress experienced by adolescents in their day-to-day activities

b) Their physical awareness of stress effects and their coping abilities

c) Their expectations of the technological-enhanced protocol, both from the contents and based on the graphics used.

Four schools and two youth organisations were involved in the user needs analysis. Five focus groups were conducted by two psychologists with groups of students between the ages of 13 and 17. Each focus group lasted for about an hour and a half, and consisted of 8-10 students; in addition, each session was was audio-recorded. The focus groups were conducted in either school classrooms or in a designated room with a table and some chairs in the case of the youth organizations. Further, 4 of the 5 groups were made up of participants from different classes, so as to avoid working with a pre-existing group.

The following procedure was followed:

The psychologist made a brief introduction explaining who she was and explaining what the group was going to do. This was followed by a short ice breaker asking for each participant to introduce him/herself by sharing his/her name and choosing an image of an animal that each felt represented him/herself and explaining why.

Different aspects of the first area of interest (i.e., experiences of day-to-day stress) were then analysed. The topic was explored through some practical examples asking the students to describe a typical day while recognizing the common elements that constitute stressful experiences. Beginning with the examples given, the focus then moved on to the second topic, physical awareness and the participant's coping abilities, using an image of a cartoon body as a concrete tool on which to recognize and to indicate their own sensations. Then, the area of perceived social support was explored starting with practical examples given by the participants. Thereafter, the third topic, participant's expectations of the technological-enhanced protocol, was introduced. This was done through the provision of different images of videogames, social media games, and apps, exploring how many hours per week the participant's used these mediums and exploring their knowledge and competence about game/app content and graphic elements. To conclude the focus group, a link was created between the first two topics and the third by asking the students to imagine that they had the best developers on hand to create their own serious game focused on teaching them to learn how to better manage their own typical reactions to stressful situations, as well as the opportunity to tell the designers how they would like for them to develop the game (in terms of graphics, 2D / 3D characters, levels and devices to use such as a joystick, 3D glasses, Wii etc).

In reference to the three areas analysed, the main finding that emerged from the focus groups was that the most important stressful life domains for adolescents are *school, family and sport,* due to the difficulty in coping with the various requirements of these three domains. In particular, participants underlined that they felt a large amount of pressure from their daily commitments, such as home works and exams,. They also reported school-related stress with regards to relational aspects with their peers and conflicts with their parents, and among some participants even higher stress was reported with regards to time dedicated to sports, especially if practiced at a competetive level. A general feeling of depression was reported in response to not having achieved the many things that they would have liked to have achieved during the day. The participants felt that they needed time to both study and achieve good grades in addition to helping at home. Moreover, if they participated in an organized sport, they were even more busy, with these participants maintaining that high grades were still a significant priority.

As for their physical awareness, after an initial difficulty in identifying where they felt different emotions, participants succeeded in this task and were able to link their typical day-to-day situations and describing where they felt specific emotions in response to these events. As for the coping abilities, the most prevalent mechanism that seemed to be used was distraction through different kinds of activities such as listening to the music, going shopping and exercising; no specific cognitive ability to define situations in a different way emerged. As for perceived support, not every participant expressed having a good relationship with their parents and most of the students sought help from their peers, such as friends or siblings.

With regards to the third topic, students showed a good level of knowledge of different kind of games and were able to identify the main common game features such as levels, points, bonuses etc. In investigating how students imagined the technological-enhanced protocol and the future SG, the main finding that emerged was that most of the participants would like the game to be a simulation of real life, similar to The Sims, with realistic situations, 3D graphics, levels and points. They also expressed a desire to have the possibility to personalize their character and to use interactive technological supports such as Wii. From a graphics point of view, most of the participants suggested something similar to the game Call of Duty, a very high graphic level videogame. Furthermore, a number of male and female students expressed interest in the proposed game and appreciated the idea of a videogame to help them handle stress.

3.2 PROCESS OF THE TECHNOLOGY-ENHANCED PROTOCOL DEVELOPMENT

3.2.1 Adaptation of the BEAR training to a technology-enhanced protocol

The selection of the training protocol was made according to the main findings of the user needs analysis. The BEAR (Building Emotion and Affect Regulation) intervention, developed by Ruth Pat-Horenczyk and Sarit Schramm (2012), has a specific focus on enhancing emotion regulation. It incorporates the latest developments in the field including mindfulness techniques, cognitive behavioural strategies and narrative interventions, all of which are used in a creative and playful manner. Among the programs analysed, the BEAR was found to be the most suitable and comprehensive intervention to improve emotion regulation abilities in adolescents. For this reason it was selected to be adapted into a technology-enhanced version to be used in the empirical study.

The creation of the technology-enahnced BEAR protocol was conducted together with the Hebrew University of Jerusalem and the Instituto Superior Tecnico of Lisbon. Multiple meetings were held between the Italian psychologist and the Israeli psychologists during the protocol's development, in the year before work on the adaptated protocol commenced, and during the period that the Italian psychologist spent in Portugal. The aim was to establish, together with both research teams, how to best adapt the BEAR training for individual use and for a different age target. Each session and each exercise were analysed together, which was done in conjunction with a psychologist who conducted several BEAR groups in Israel and was able to give practical suggestions. The first meeting with the Portuguese engineering group was done via Skype. Subsequently, ten days of work were done by the IST team in Lisbon in order to establish all the next steps of the protocol development, the main aims of the adaptation and the people who would be involved. A period of some months then followed in which the Italian psychologist who attended the training course in Israel stayed in Portugal so as to work on the technology-enhanced protocol development together with the engineers and most importantly, to supervise the psychological part of the work. The work was thus divided step by step, from the translation and adaptation, to the integration of all of the tools, to a first validation of the adapted protocol in Italy.

For the initial evaluation one session, session 4, of the BEAR was specifically selected to assess the technological version for individual use and for teenagers between the ages of 12 and 18. Session 4, which focuses on physical regulation was chosen since it is the most suitable to test the efficacy of the wearable physiological sensors. The first session (becoming a group) was changed and improved so as to develop the technological version and adapt the session for individual use. This session became an introduction of the training to participants, explaining how the program works and the different functions and symbols that the user will work with. In addition, the user has the possibility to customize his/her space, choosing a background and his/her avatar. Then the training itself starts with the physical regulation exercises; session 4 was also adapted so as to obtain objective results about the efficacy the technological-enhanced protocol.

3.2.2 Description of Session 1: Group-traditional & individual-technological versions

In the group-traditional version of the BEAR the first session focuses on forming a group by having participants introduce themselves and actively work together to develop group rules and conventions, while in the individual-technological version there is no need to create the group. Therefore, in the latter, session 1 was adapted as showed in the following table (see Table 1). A short explanation is given for the technological additions:

Table 1. *Session 1, Group-traditional version vs. Individual-technological version*

Group-traditional version: **Becoming a group**	**Individual-technological version:** **Introduction**
1-Candle lighting Ceremony: Opening ritual	***1-Opening:*** Short general introduction of the game
2-Introducing Ourselves: Individual presentation and group creation	***2-Heart rate introduction*****:** Explanation of the heart rate symbol
3-A Minute for Myself – M&M*:* Stress level	***3-Points:*** Explanation of how to score points
4-Making a Contract: Rules of the group	***4-Instruction icon:*** Explanation of this icon
5-I-BOX 1**:** Introduction and general explanation	***5-My personal space:*** Possibility to choose a background, avatar and to give him/her a name
6-Closing of Session: M&M, summarizing sentence, blow out the	***6-I-BOX 1:*** Introduction of the I-BOX and possibility to

candle (closing ritual)	personalize it, colouring with a colour that represents anxiety

3.2.3 Description of Session 4: Group-traditional & individual-technological versions

The aim of the group-traditional version is to practice relaxation coping skills for physical regulation, in order to develop awareness of physical sensations and their connection to feelings and to become aware of the different experiences in one's body when one is tense or relaxed. In this case it was necessary to adapt the exercises to a technological version. The breathing exercise was added (session 4 - Physical Regulation - part 1) so as to make the work on physical aspects more complete. It was inserted after the Mindfulness exercise, before the active/shaking meditation.

The exercises of the session are summarized in the following table (see Table 2) and a short explanation is given for the technological version:

Table 2: Session 4: *Group-traditional version vs. Individual-technological version*

Group-traditional version: **Physical regulation**	**Individual-technological version:** **Physical regulation**
***1-Candle Lighting Ceremony*:** opening ritual	***1-Candle Lighting Ceremony*:** Opening ritual, the user has to light a virtual candle with a virtual match
***2-A Minute for Myself – M&M*:** Psycho-education and practice exercise	***2-A Minute for Myself – M&M:*** Psycho-education: the user is asked to select his/her level of tension from 1 to 10 on the virtual M&M by clicking on on the appropriate number.
3-Mindfulness – Facial Mindfulness	***3-Mindfulness – Facial Mindfulness:*** The user is asked to identify on his/her avatar's face where he/she feels tense and/or relaxed and to colour

	these parts in red or blue
4-Active/Shaking Meditation	***4-Breathing exercise:*** The user is asked to breath in a different way, focusing on his stomach and imagining that it's a ball. User avatars perform the same movements
***5-Progressive Muscle Relaxation*:** Psycho-education and practice exercise	***5-Active/Shaking Meditation:*** The user is initially asked to move in time to the music. This is followed by a relaxation exercise to calm down. User avatars dance as well.
6-How does my body feel	***6-Progressive Muscle Relaxation:*** Psycho-education is followed by 4 different experiential exercises with the PMR technique. The user has to do the exercise externally whilst observing his/her avatar doing the same; listening to the sounds/music required by each exercise.
***7-I-BOX 4*:** Internal Sensations	***7-How does my body feel:*** The user is asked to read a list of the main emotions then he/she is asked to pinpoint where in his/her body he/she feels each of these emotions in general, not in that moment. Then he/she needs to sign where he/she feels each emotion one on the body of his/her avatar
8-Closing of Session: Closing ritual with the candle	***8-I-BOX 4: Internal Sensations:*** The user is asked to colour his/her I-BOX with a colour that represents the sense of relaxation
	9-Closing of Session: A summary of the work done with each exercise is conducted followed by the closing ritual with the candle: the user has to blow out the candle clicking on it.

Following the adaptation of sessions 1 and 4 to technological-enhanced sessions, two different experimental versions were developed:

1- Written instructions and user's avatar doing the exercises

2- Instructions given by an avatar (speaking) and user's avatar doing the exercises

3.2.4 Description of the traditional adapted version

In order to test the two technology-enhanced versions comparing them with a control group, a new traditional adapted version was developed. It was necessary to adapt the original (non-technological) BEAR protocol so to be as similar as possible to the two experimental versions while concurrently changing the original protocol as little as possible.

Version 3 – The individual-traditional BEAR adaptation is organized in the following way:

Session one, as in the two technological-enhanced experimental versions, became a general introduction, which did not include the specific features of the technological versions (points, background etc.)

Session 4 then begins with participants doing every exercise exactly in the exact same way as in the technological-enhanced sessions, but with printed images, markers and a box. The researcher explains and shows the user how to do the exercises, in this way replacing the avatar, and does the exercises with the participant. At the same time the researcher clicks on the PC version doing the same thing that the user does so as to save information automatically.

To avoid any kind of influence due to individual changes, the same images were used in the PC versions. In addition, the researcher used the PC at the same time, and with the same sounds, in each session so as to increase internal validity. All physiological data was also collected in the same way as for each of experimental versions.

A summary of sessions 1 and 4 is given in the following table (see Table 3 and Table 4), comparing this version (3-Individual-traditional adapted BEAR) with the two technological versions (1-Written instructions and user's avatar doing the exercises; 2- Instructions given by an avatar (speaking) and user's avatar doing the exercises):

Table 3. Session 1: *Individual-technological version vs Individual- traditional adapted version*

Individual-technological version: Introduction	**Individual-traditional adapted version: Introduction**
1-Opening: Short general introduction of the game	***1-Opening:*** Short general introduction of the game
***2-Heart rate introduction*:** Explanation of the heart rate symbol	***2-Sensors introduction:*** Explanation of the wearable biosensors
3-Points: Explanation of the points logic	***3-My personal space:*** Possibility to choose his/her own character and to give him/her a name. The user is asked to choose the printed image of the male/female avatar
4-Instruction icon: Explanation of this icon	***4-I-BOX 1:*** Introduction on the I-BOX and possibility to personalize it, colouring it with a colour that represents anxiety. A real little box is given to the subject with printed papers of the colours palette
5-My personal space: Possibility to choose the background, the avatar and to give him/her a name	
6-I-BOX 1: Introduction of the I-BOX and possibility to personalize it, colouring with a colour that represents anxiety	

Table 4: Session 4: *Individual-technological version vs Individual-traditional adapted version*

Individual-technological version: **Physical regulation**	**Individual-traditional adapted version:** **Physical regulation**
***1-Candle Lighting Ceremony*:** Opening ritual, the user has to light a virtual candle with a virtual match	***1-Candle Lighting Ceremony:*** Opening ritual, the user has to light a printed candle taking a printed flame and sticking it on a sheet of paper
2-A Minute for Myself – M&M: Psycho-education: the user then is asked to point his/her level of tension from 1 to 10 on the virtual M&M, by clicking on the appropriate number.	***2-A Minute for Myself – M&M:*** Psycho-education: the the user is asked to point to select his/her level of tension from 1 to 10 on the printed M&M, colouring it in
3-Mindfulness – Facial Mindfulness: The user is asked to identify on his/her avatar's face where he/she feels tense and where relaxed and to colour the respective parts in red or blue	***3-Mindfulness – Facial Mindfulness:*** The user is asked to identify on his character/printed avatar's face where he/sje feels tense and where relaxed and to colour the respective parts in red or blue
4-Breathing exercise: The user is asked to breath in a different way, focusing on his/her stomach and imagining that it's a ball. User avatars does the same movements	***4-Breathing exercise:*** The user is asked to breath in a different way, focusing on his/her stomach and imagining that it's a ball. The trainer, in part, does the same movements
5-Active/Shaking Meditation: The user is first asked to move in time to the music then there is a relaxation exercise to calm down. User avatars dances too	***5-Active/Shaking Meditation:*** The user is first asked to move in time to the music then there is a relaxation exercise to calm down
6-Progressive Muscle Relaxation: Psycho-education is followed by 4 different	***6-Progressive Muscle Relaxation:*** Psycho-education is followed by 4 different

experiential exercises with the PMR technique. The user has to do the exercises externally while looking his avatar doing the same and listening to the sounds/music required by each exercise	experiential exercises with the PMR technique. The user has to do the exercises externally while looking the trainer doing in part the same and listening to the sounds/music required by each exercise
7-How does my body feel: The user is asked to read a list of primary emotions is then asked to assesses where in his/her body he/she feels each of these emotions in general, not in that specific moment. Then he/she needs to sign where he feels each one on the body of his/her avatar	***7-How does my body feel:*** The user is asked to read a list of primary emotions and is then asked to think where in his.her body he/she feels each of these emotions in general, not in that specific moment. Then he/she needs to sign where he feels each one on the body of his/her character/printed avatar, placing a small piece of paper to signify each emotion
8-I-BOX 4: Internal Sensations: The user is asked to colour his/her I-BOX with a colour that represents a sense of relaxation	***8-I-BOX 4: Internal Sensations:*** The user is asked to colour his/her I-BOX with a colour that represents a sense of relaxation. As before, a real small box is given to the subject with printed papers of the colours palette
9-Closing of Session: A summary of the work done with each exercise in conducted followed by the closing ritual with the candle: the user has to blow out the candle clicking on it	***9-Closing of Session:*** A summary of the work done with each exercise is conducted followed by the closing ritual with the candle: he has to blow out the candle, unpluging the printed flame

3.2.5 Definition of the storyboard for the two technology-enhanced versions

A masters student together with the Italian psychologist developed the storyboard, identifying the opening and closing exercises, which are identical for each session. The attention was focused on the specific exercises carried out during each of the eight sessions in order to re-work them.

The storyboard of the BEAR was thus created (See fig. 1 and fig. 2 for some examples).

Fig.1

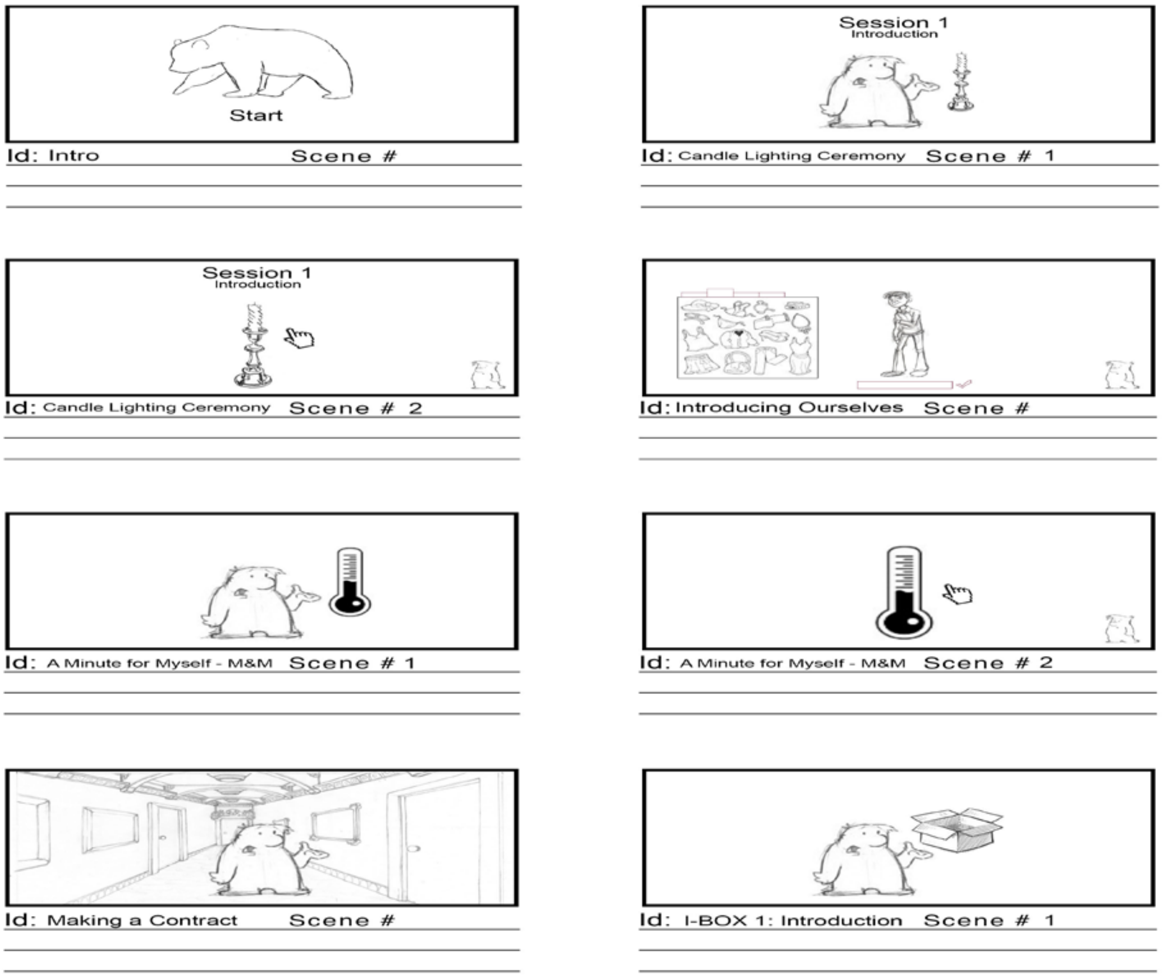
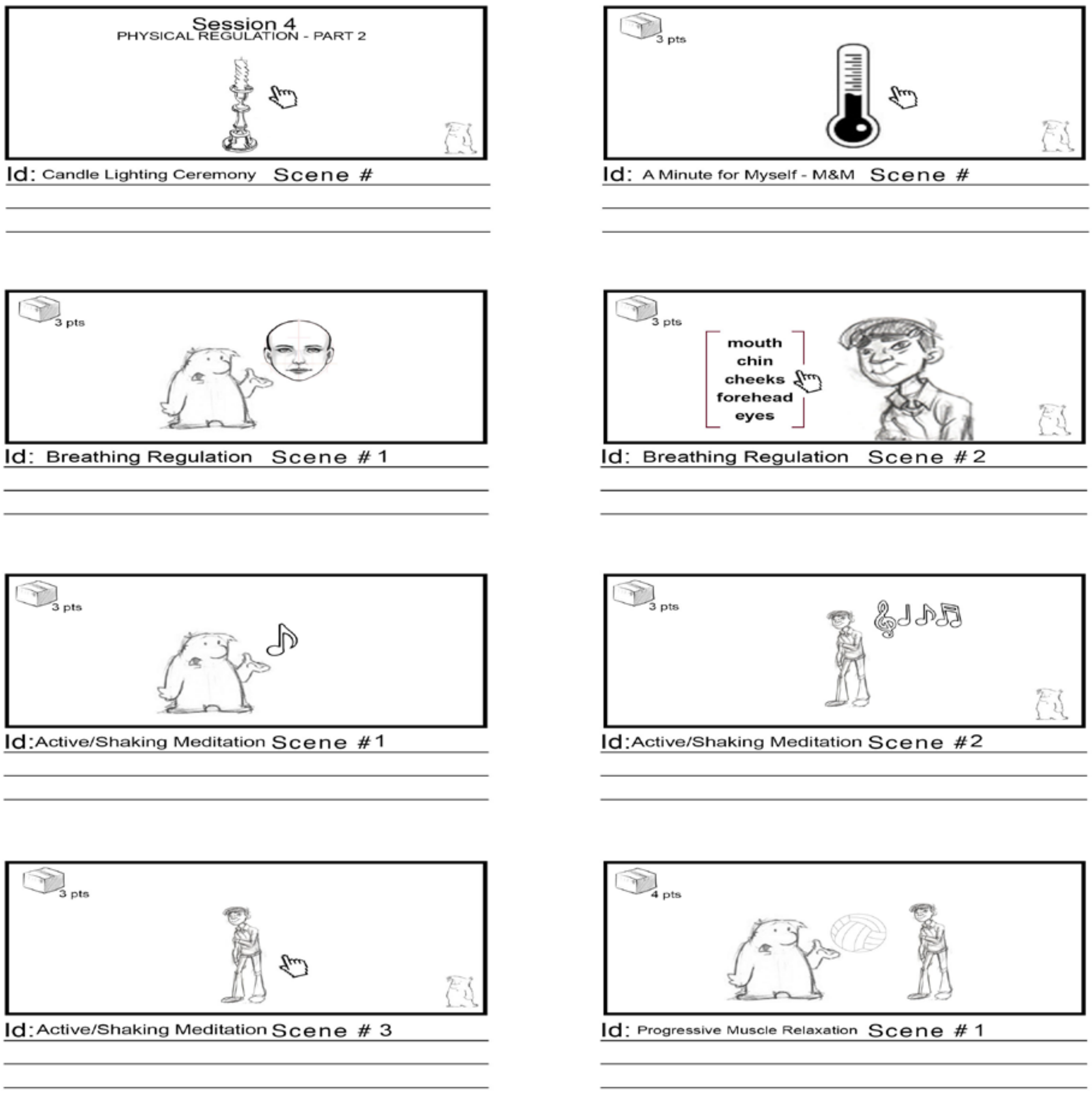


Fig.2



To start, the Italian psychologist wrote the text of each session in both English and in Italian; she added the introductory sections as if it was the traditional training and she then updated the text based on the changes made to each session. All the text was gone over by the authors Prof Ruthy Pat-Horenczyk and Sarit Schramm. The text was written in conjunction with the engineers who dealt with the technological development and it was divided screen by screen. Some notes with different colours were added by the psychologist in order to avoid misunderstanding (see Fig. 2), and every screen was gone over by both the engineers and the psychologist.

IMP NOTES for every session:

PAG X: not to write in the pc version, just for us

Screen 0: Title of the session. Must be "animated", like with ppt

Screen A, B, C... : Every letter means 1 screen; for every letter, the screen has to change. The exercise is not only on 1 screen/page

Text underlined like this: Means that either there is an image, a sound, or that the avatar should be inserted

Appears firstly ecc and underlined like this...: To tell you what comes first, the order to follow

Fig.2 Important notes for the development

Exactly the same division and features were retained for the version with the assistant (i.e., the individual-traditional adapted version).

In addition, in both of the technological versions it was decided to avoid any music or sound in the testing phases so as to be able to more clearly analyze which of the two versions involves the user more, without any other variable that could interfere with the results. The only music or sounds added were those necessary to the gamified experience itself or those required by the exercises.

3.3 DEFINITION OF FUNCTIONAL REQUIREMENTS

Basing on the main findings of the focus groups, the second step was the choice of functional requirements in order to develop a product as much near as possible to the user's needs and desires, to the final aim, and suitable to develop the storyboard as it was defined. During this phase were chosen the *software* for the design of the training, the *computational model* to integrate, the *avatars* to be used, the *motion capture* system, the *biosensors device* and the *gamification* aspects to be included.

3.3.1 The software selection

For the development of the BEAR training Unity 3D was used as the development environment since it was the most suitable one from the point of view of functionality in relation to the targets.

Unity is a cross-platform[1] game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites. Unity supports many state of the art graphical features[2] and it was chosen due to the existence of a large set of community-developed assets that can be used to extend Unity's functionalities, and due to the already existing integration of FAtiMA Agent Architecture with Unity 3D (using a different environment would require the additional effort of creating an additional communication layer between FatiMA and the environement).

3.3.2 The computational module selection and integration

The computational model adopted is FAtiMA, developed by Joao Dias and Ana Paiva.
FAtiMA (Fearnot AffecTIve Mind Architecture) is an Agent Architecture with planning capabilities designed to use emotions and personality to influence the agent's behaviour (Dias and Paiva, 2005). During the last years, the architecture was used in several scenarios (such as FearNot! (Paiva et al., 2005), ORIENT (Ruth et al., 2009), and a process Model of Empathy (Rodrigues et al., 2009) and by different research institutions, which led to the architecture being extended with several new features and functionalities.
The architecture is composed of a core algorithm and by a set of components that add particular functionality (either in terms of appraisal or behaviour) to the architecture. FAtiMA Modular is composed of a core layer (named FAtiMA Core) on which components are added in order to add functionality. FAtiMA Core is a template that generally defines how the Agent Architecture works. Added components can provide specific implementations for the generic functions defined in the Core. Figure 1 shows a diagram of FAtiMA Core with the basic functionalities for an emotional agent architecture. An agent is able to receive perceptions from the environment (events) which are used to update the agent's memory (or internal state) and to trigger the appraisal process. The result of the appraisal process is stored in the affective state 1, and later used to influence the action selection processes which will make the agent act upon the environment (Dias, Mascarenhas and Paiva, 2009).

[1] With an emphasis on portability, the engine targets the following APIs: Direct3D on Windows and Xbox 360; OpenGL on Mac and Windows; OpenGL ES on Android and iOS; and proprietary APIs on video game consoles.
[2] Unity allows specification of texture compression and resolution settings for each platform the game engine supports, and provides support for bump mapping, reflection mapping, parallax mapping, screen space ambient occlusion (SSAO), dynamic shadows using shadow maps, render-to-texture and full-screen post-processing effects

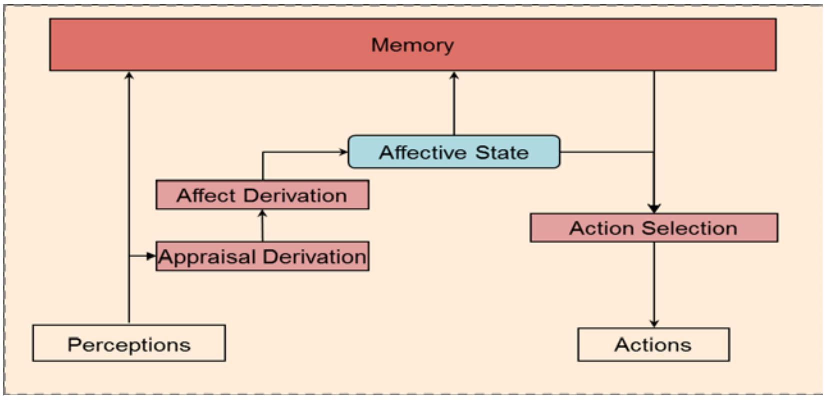


***Fig. 1**. FAtiMA Core Architecture*

It is important to point out that the Core architecture does not commit itself with the particular methods used. In fact a FAtiMA agent that only has a Core will not do anything. Behavior is included by adding components that implement the mentioned functionality. However, a component is not required to implement all functionality in the Core, it can implement just one of the processes. In order to differentiate components when adding them to the Core, they are categorized according to the implemented functionality. For instance, an Affect Derivation Component will have to implement an Affect Derivation process, and a Behaviour Component will have to implement the action selection function. All components are designed following two main properties:

they must be interchangeable - i.e, being able to be replaced, added or removed with a minimum effort; and they must be loosely coupled - dependencies between components should be avoided unless strictly needed.

FAtiMA Modular architecture is created by adding a set of components to the core (Dias, Mascarenhas and Paiva, 2009):

-Reactive Component - this component uses predefined emotional reaction rules to determine the value of Desirability, and Praiseworthiness appraisal variables and generates reactive behaviour based on action tendencies.

When an event is perceived, the reactive appraisal matches the event against a set of emotional rules. A rule may define a particular value for each of the appraisal variables and can then target a specific event (e.g. the agent finds it desirable whenever it receives a compliment from agent B) or it can be more general (e.g. the agent finds it undesirable whenever the action cry is performed).

-Deliberative Component - generates appraisal variables used for prospect-based emotions and handles goal-based behavior using planning.

While the reactive component handles the agent's reactive behaviour, the deliberative component implements the agent's goal based deliberative behaviour and an appraisal process based on the state of goals and plans. The first stage of the deliberative component, it's called deliberation and corresponds to the activation and selection of alternative goals. The deliberative component has a set of generic goals with a set of preconditions. A goal is considered active when all of its preconditions have been verified.

OCC Affect Derivation Component - generates emotions from the appraisal variables according to the OCC Theory of Emotions. For instance an event with a positive desirability value for the agent will generate a Joy emotion if it surpasses the agent's predefined threshold for Joy. On the other hand, if the event's desirability is negative, then a Distress emotion is generated instead.

-Motivational Component - component that models basic human drives, such as energy and integrity and uses them to help select between competing goals in the deliberative component. The more a certain need is low/high, the higher/lower the utility of a goal that contributes positively for that need is. Additionally it is also used to determine an event's desirability according to the effects it had on the agent's drives (e.g. an eat action lowers the energy need). When an event lowers/ raises the agent's needs, it is evaluated as desirable/undesirable for that agent.

-Theory of Mind Component - creates a model of the internal states of other agents.
This component determines the desirability of an event for others by simulating their own appraisal processes. Regarding its structure, the Theory of Mind component is composed by a list of Models of Others, which represent an estimation that the agent has about other's internal states.

-Social Relations Component - component that models social attraction relation between the agents and updates the relations based on the appraisal of events.
Initial relations can be predefined in the configuration, but if nothing is specified when the agent meets another agents for the first time, the component will establish an initial neutral relation. Since attraction is not reciprocal, i.e. an agent may like another that does not like him, it is necessary also to represent the attraction of others toward the agent. However, this is implemented by allowing this component to make part of the ToM. Secondly, this component is also responsible to updating the existing social relations according to emotions being generated.

-Emotional Intelligence Component - extends the planner in the deliberative component to handle planning about the emotional processes, and defines the goals and strategies used for interpersonal emotion regulation.

The Emotional Intelligence component adds a set of operators, social goals and generic relationship-focused regulation strategies to the Deliberative component, making it possible to reason about and plan about emotions, and perform interpersonal emotion regulation.

FAtiMA modular was adopted because in a future pilot version of the technology-enhanced training the avatars will become agents able to understand the emotions of the user and able to behave accordingly, for example, the trainer will encourage the user if necessary. The Emotional Intelligent Component will be especially used since this will give the possibility to make the virtual trainer as similar as possible to a human facilitator.

In the initial prototype version, we've only used part of FAtiMA's capabilities. The emotional reactive capabilities were used to make the agent/avatar to react emotionally to the user's progression in the application. However, given that we wanted the user's experience to be the same across different subjects, we fixed the appraisal process so that the emotions generated are always the same. This will be changed in the future to allow the agent to react differently according to the successful/unsuccessful progression of the user in the several exercises. FAtiMA's Deliberative Component was used to create interaction goals that will make the agent take the initiative to talk with the user (when necessary to provide instructions about a new exercise). Similar goals were also created to be triggered when the user presses the *Help button*

3.3.3 Integration of avatars

Avatars were required for the two technology-enhanced versions of the training so, after a deep analysis on the basis of the technical requirements, Daz 3D software was chosen. Daz Productions Inc., commonly known as Daz 3D is a 3D content and software company specializing in providing rigged 3D human models, associated accessory content and software to the prosumer market. DAZ 3D created their own 3D posing/animation package, DAZ Studio.

DAZ Studio is a software for 3D art and animation creation and as a rendering tool. This software uses a 'Genesis' platform with multi-file support and import and export capabilities, compatible with other design and 3D art and animation software solutions. It is available for free, but registration is required. First version was released in Fall 2005. For this development it was used the last version, Genesis 3 for the following reasons: The Genesis 3 technology combines the versatility and power of the revolutionary Genesis architecture with an extensive list of new features and enhancements. It provides superior control, articulation, movement, gender specific sculpting and HD Morphing technology and empowers creators with an unprecedented level of customization and detail. This platform allows to combine various body and extremity shapes, sizes, and muscularity in order to build your one-of-a-kind person or creature. It also gives the possibility to dress your characters in feminine and masculine design specific clothes. Also, with this version the levels of detail were improved on some of the most critical body parts including the face, mouth, teeth, hands, feet, chest and neck, also the levels of articulation are one of the most significant improvements. For example, Genesis 3 allows for individual movement of ears, toes, neck, chest, abdomen, etc., as well as reworked weight mapping, resulting in more realistic and advanced posing over previous generations.

Two cartoon style character were chosen: Jason and Jasmine, for avatar user male and female. Jasmine was also used for the assistant avatar modifying some physical characteristics and clothes, in fact utilizing the Genesis platform enables both figures to be mixed with any other Genesis figure and to combine them with any other Genesis figure to create a unique character. Moreover this was useful in order to use some of the animations already integrated with user avatars. Jason and Jasmine are carefully crafted cartoon characters, created in a typical 3D Universe style. Combining features from several of 3D Universe's other cartoon figures, these two bring the typical western cartoon guy style to the Genesis platform. Designed to compliment these figures perfectly, the included clothing items can be combined for various looks, from casual to formal. The clothes were chosen in order to be as more realistic as possible for teenager users and young-adult facilitator. Moreover a pilot version was shown to two students, a male and a female, to have an immediate feedback on how they are perceived by people of their age and what they would like to personalize if they will have the possibility to.

Avatars of the user - female and male

JASMINE

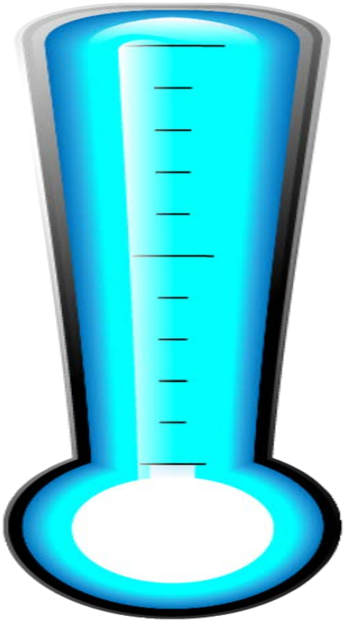
JASON

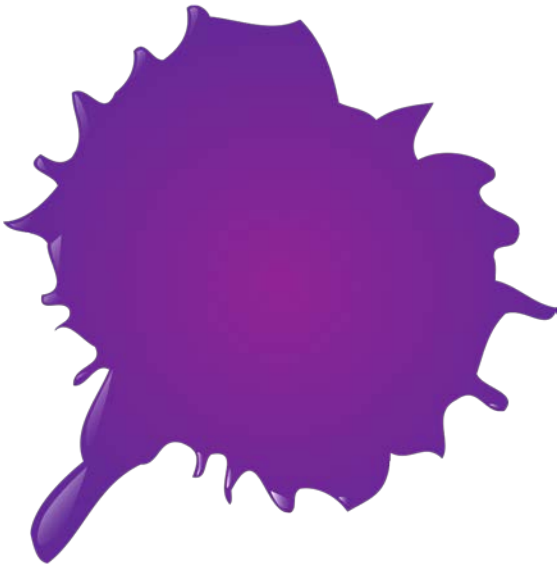
3.3.4 The graphic design for the two technology-enhanced versions

As for the two technology-enhanced training, for the design an university student was involved. She was asked to design some objects needed to perform the exercises instead of real ones. A meeting with her, the Italian psychologist and the engineers was organized in order to briefly explain her the sessions and the style required for the design in fact a cartoon style was refined so that it was suitable to the style of the avatars, but also adapt to teenager age.

The student designer made a first version, but she was asked to do a second one because the first one was considered too much realistic. She designed one more cartoon style and another one as a middle way. In order to develop a user centre product, 30 teenagers between 12-18 years old, 15 male and 15 female, were asked to vote the three options. The 3 versions were individually showed them and they were asked to choose which one they like more thinking that they will be used in a sort of videogame for their age. These were the result on the basis of which it was selected the second version, the more cartoon style: first version=4; second version= 18, third version= 8.

(See fig. 2 in the next page, for some examples: M&M, I-BOX, one colour pallet):





3.3.5 The biosensors choice

The step after was the choice of the biosensors, in fact the most recent theories highlight how emotions are multidimensional and multicomponent processes, claiming the urge for multi-modal assessment methods (Scherer, 2001). Today we have many wearable devices such as mobile phones and wearable sensors to measure physiological or behavioural data in our daily lives (Sano & Picard, 2013) and it is recognized that stress detection technology helps people better understand and relieve stress by increasing their awareness of heightened levels of stress that would otherwise go undetected (Vrijkotte, van Doornen, and de Geus, 2000; Dishman et al., 2000; Hernandez, Morris and Picard, 2011). Moreover with the focus groups it emerged a low body awareness for the adolescents. For all these reasons the training was integrated with specific biosensors: the user has the opportunity to use physiological monitoring devices that will measure his reactions and will allow to became aware of how he is performing the exercises. Thanks to a wearable device, non-invasive, able to connect in wireless, he measures his heart rate, his electro-dermal activity and his muscle's strength. In addition the physiological value of heart rate measured by the device is always displayed on the monitor. This gives an immediate feedback to the user and trains the user to gain control over his physiological activation related to the stress level. In this way he is able to take awareness and learn to manage his physiological reactions. This feedback gives the possibility to the user to see how his relaxation and stress level is changing both, while he is doing training exercises. Moreover the physiological measures are an objective data of the effectiveness of the technology enhanced training and also, in this way a multimodal assessment was conducted.
For each version of the training (techno and traditional) at the beginning and during the session, these physiological measures were recorded:
-Heart rate variability
-Muscle activity (Trapeze and biceps)
-Electro-dermal activity (EDA)
Psycho-physiological data were obtained using *Bioplux* sensors and *Opensignals* software.

Technical features:
The hub has analog Ports with 4 generic inputs, auxiliary ports with 1 digital I/O + 1 ground, resolution up to 16-bit (per channel), sampling rate up to 1000Hz (per channel), communication with Bluetooth Class II, a range: up to ~10m (extendable) and the size is 85x54x10mm.

The ECG sensor has a gain of 1000, a range of ±1.5mV (with VCC = 3V), bandwidth of 0.5-100Hz, input impedance >100GOhm and CMRR of 100dB, it has a triode configuration that enables fast application and unobtrusive data acquisition.
The EMG sensor has a gain of 1000, a range of ±1.5mV (with VCC = 3V), bandwidth of 25-500Hz, input impedance >100GOhm and CMRR of 100dB, it is especially designed for high performance surface EMG data acquisition even in the most extreme conditions.
The EDA sensor has a range of 0-13uS, bandwidth of 0-3Hz, Input Impedance of >1GOhm and CMRR of 100dB, it is capable of accurately measuring the skin activity with high sensitivity in a miniaturized form factor.

3.3.6 Inclusion of gamification aspects

Gamification is the application of game-design elements and game principles in non-game contexts (Huotari & Hamari, 2012; Deterding, Dixon, Khaled, and Nacke, 2011). Gamification commonly employs game design elements (Huotari, & Hamari, 2012; Deterding, Dixon, Khaled, and Nacke, 2011; Hamari et al., 2014) which are used in so called non-game contexts (Robson, Plangger, Kietzmann, McCarthy, and Pitt, 2015) in attempts to improve user engagement (Hamari & Juho, 2013), organizational productivity (Cunningham & Christopher, 2011), flow (Herzig, Strahringer, and Ameling, 2012), learning (Herger & Mario, 2014) employee recruitment and evaluation, ease of use and usefulness of systems (Hamari & Juho, 2013; Koivisto & Jonna, 2015), physical exercise (Hamari & Juho, 2013; Koivisto & Jonna, 2015), among others. A review of research on gamification shows that a majority of studies on gamification find positive effects from gamification (Hamari, et al., 2014).

During the last couple of years, gamification (Hamari & Koivisto, 2014; Hamari & Lehdonvirta, 2010; Huotari, and Hamari, 2012) has been a trending topic and a subject to much hype as a means of supporting user engagement and enhancing positive patterns in service use, such as increasing user activity, social interaction, or quality and productivity of actions (Hamari, 2013). These desired user patterns are considered to emerge as a result of positive, intrinsically motivating (Ryan & Deci, 2000), “gameful” experiences (Huotari & Hamari, 2012) brought about by game/motivational affordances implemented into a service (Hamari, Koivisto and Saarsa, 2014).

This technique has been integrated in this protocol in order to increase the user’s engagement, in fact, using the game elements in a non-playful contexts gives the possibility to improve the user experience and ensure its involvement (Pollak et al., 2010). Moreover basing on the fact that today's teenagers are the "digital natives” there is a strong potential to increase their involvement through the use of this elements. For example they earn points and bonus to strengthen their own avatar, or, only if they complete an exercise, they can pass to the next one; also, they can choose the background they want for their relaxing private space and they have to choose their own avatar giving him a name. Furthermore, in the two technological versions, most of the exercise are done directly at the computer sometimes with background music or sounds.

3.4 INTEGRATION OF THE TECHNOLOGICAL COMPONENTS

We will now provide an overview of the integration of the several components and systems that compose the EmoRegulators application. Figure 3 shows a diagram with the main components.

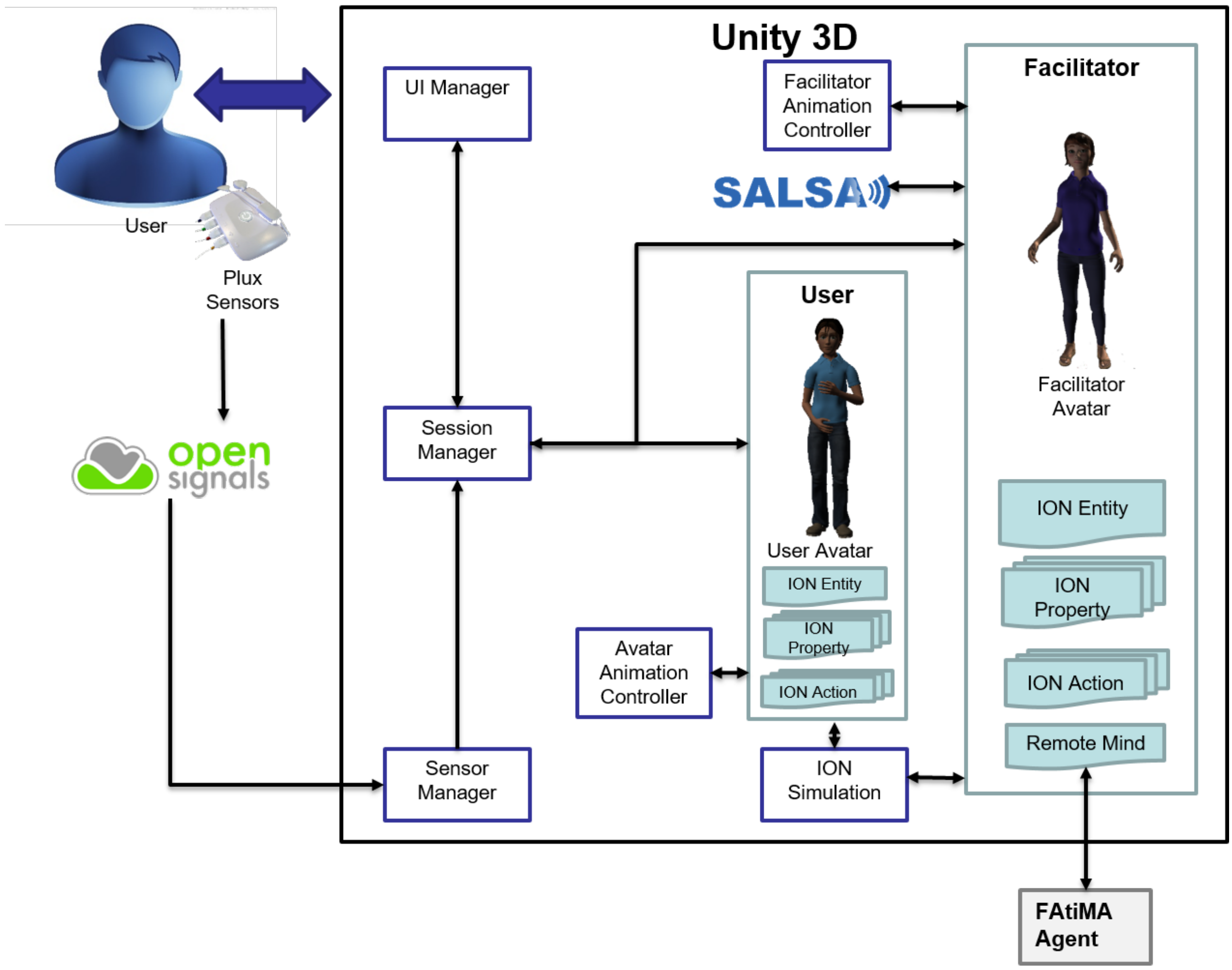


Fig. 3. EmoRegulators component diagram

3.4.1 Integration of the biosensor

The user, while interacting with the application has a set of sensors attached to its body, the sensors (measuring physiological signals such as heart rate, electro-dermal activity and muscle activation) are connected to a hub, which sends those signals via Bluetooth to the *OpenSignals* application.

In order to integrate the physiological signals into EmoRegulators, we started by extending the *OpenSignals* application[3], making it use a websocket to connect to the application in Unity. Additionally, the physiological data is processed in order to send only a summary of the relevant physiological information to the application. For instance, the raw heart rate signal is collected into a buffer that will contain 1 second of data. The buffer is then used to convert the signal into a measure of beats per minute (bpm), and the bpm information is then sent to Unity. Muscle activation data is also processed in order to determine if the last second of data corresponds to a muscle being active or relaxed.

The sensor manager component inside Unity receives the information from the *OpenSignals* application, stores and logs the processed physiological data. This data will be latter used by the session manager, to determine successful or unsuccessful realization of some exercises. As example, success in the Active Shaking Meditation exercise will be dependent on the bpm information. If the bpm during the dancing exercise is 50% higher than the user's baseline bpm (the baseline represents a state of no activation, then the user will get full points for the exercise. On another example, correct muscle activation and relaxation at the appropriate time will determine success in the Progressive Muscle Relaxation exercises.

3.4.2 Integration with FAtiMA

The integration between FAtiMA agents and the EmoRegulators application is achieved by using the ION framework (Vala et. al 2009). This framework acts as a bridge between those two systems and it's main purpose is to model and manage dynamic virtual environments. With the ION framework, there is a clear separation between the simulation environment and the virtual space, where without it, they would be tied up to the realisation engine. ION Framework is composed of three basic structures: Entities, Properties and Actions. Entities represent both objects and agents and populate the environment. Entities have properties that define them (e.g. such as score) and those can be changed through actions performed by any entity.

[3] *OpenSignals* was developed in the programming language *Python* by *Plux*.

As depicted in figure 3, the FAtiMA agent (running outside Unity 3D) is connected via sockets to a special Remote Mind process. When FAtiMA agent decides to perform an action (e.g. giving an instruction to a user, it will send a message to the Remote Mind, which will start the execution of the corresponding ION Action (in this case a Speak action). The ION simulation component will process the execution of the action, and will notify all entities when the action succeeds or fails. The user is also modeled as an ION Entity, thus when the user for instance presses a button or completes a particular exercise, the corresponding ION action will be considered successfull and the Remote Mind will send a message with such perception to FAtiMA.

3.4.3 Animation of avatars

There are two main aspects of the animations that are relevant to describe here. The first one is related to the process of designing and creating the animations, while the second corresponds to the display of the animations during the execution of the application.

The gestures for the user-avatars were decided according to each exercise on the basis of the different movements required. The aim was, on one side, to give the possibility to the user to identify himself with his own avatar, or, at least to use it as an example to follow, step by step. On the other side, every gesture necessary for the trainer (in the Assistant version) was analysed according to the speech and to the topic explained. In order to obtain movements as more realistic as possible for all the avatars, a motion capture system was used to record the movements of a person doing the movements. This was done in a motion capture laboratory from 112 Studios in Oeiras. Moreover a dance teacher of bodyweight was asked to record the movements. The list of the required movements was prepared by the Italian psychologist and then showed to the engineer before the recording so to be sure that everything was clear.

These are the recorded movements:

User-Avatar

<u>Breathing exercise:</u>

One hand on stomach, the other on chest

Fill the stomach with air (Breath in)

Hold on the air for some seconds

Take out the air (Breath out)

Breathing slowly (relaxing)

<u>Progressive muscle relaxation:</u>
Closing hands, squeezing a ball (Grabbing)
Open hands, drop the ball (relaxing)
Stretch the arms in front
Stretch up the arms (as if reaching the sun)
Put down the arms, drop down (relaxing)
Pull the shoulder up to the ears and push the head down into the shoulders. Hold it tight
Let go of the shoulders (relaxing)
Get the feet to the bottom, Push your feet as far down as possible, push down with the legs (as squish your toes deep into the sand)

<u>Active shaking meditation:</u>
Dancing (Every part of the body, rhythmic music, fast, as Gam Gam style)
Shaking (Every part of the body, rhythmic music, fast)

<u>Optional</u>
Walking
Running
Jumping
Resting

<u>Avatar-Assistant</u>
Talking gestures
Pointing (Various directions)
Clapping
Walking
Speaking

After the animations were captured, it was necessary to adjust and apply the animations to the avatar bodies. To do so, we used *Autodesk's MotionBuilder*[4] application. We started by importing the avatar, and then incorporating the motion capture data into a control rig defined by the avatar

[4] http://www.autodesk.com/products/motionbuilder/overview

body. Here we also add to adjust several animations, trimming them and selecting the most relevant parts of the animations. In some cases we had to manually correct the animations. For instance, in the Breathing exercise, the "hand in chest and stomach" animation had the hand of the avatar entering inside the body, so we had to adjust the hand and arm to move slightly away from the body. Individual animations were finally exported to *.fbx* file format so that the animations could to be imported into Unity 3D.

The display of animations during the application execution is controlled by the animation controller components, using Unity's Mecanim animation tool. As seen in figure 3, there is one animation controller for the avatar body, and another independent one for the facilitator. By using the animation controller we can easily configure existing animations and define transitions between them. Transitions between animations will be automatically created using interpolation between animation positions for each body joint. The animation of the facilitator required additional animation mechanisms. First, we manually created facial expressions for a couple of emotions (e.g. Joy, Distress). Then, two independent masks were created for the facilitator animation controller. The first one controls the face of the avatar, while the second one controls the remaining body parts. This makes it possible to display facial expressions independently of any body animation being currently displayed.

An additional requirement for the facilitator was the need to perform lip-sync animations. Given that the facilitator would talk using speech with the user, it would not look believable to have the facilitator talking without moving its lips. To solve this problem, we used an external Unity asset named Salsa[5] developed by Crazy Minnow Studio. Salsa dynamically analyses the sound file being played, and will automatically generate phoneme expressions synchronized with the sounds. The expressions are directly performed over the avatar face, merging with any other animation being performed by the animation controller. The results are not perfect, but are very reasonable. Moreover, we explored a second feature of Salsa, called random eyes. The random eyes feature allows Salsa to control the eyes of the avatar, making it blink and look to random places every now and then. This provide a more realistic behaviour than just staring at a fixed point during the whole interaction.

Finally, as for the Assistant version two pilot students tested it, before starting the experimental group and, on the basis of their suggestions, the gestures for the facilitator-assistant were modified manually; in fact they related that the original gestures made them feel stressed exactly the opposite that the training facilitator is supposed to do. Three other attempts have been analyzed by the

[5] https://www.assetstore.unity3d.com/en/#!/content/16944

psychologist and then the last one is actually used basing on a further test made on two other students. This aspect has been more deeply analyzed through specific questionnaires during the empirical study itself.

3.4.4 Integration of images and music, text and voice

As for the Assistant version, the same text of the written version was followed and the voice was recorded according to this, both in Italian and in English. The engineer pointed out exactly where to make a pause between each sentences in order to have the possibility to work on this after.
The recording was done in the demo room of GAIPS, at INESC-ID, using a Rode Videomic shotgun microphone (with Rycote Lyre mount on a tripod, and Rode Deadcat windshield) and a Zoom H4n recorder. The voice was then listened by a Master student at IST in order to try to understand how it would be perceived. Also, this was asked to the two students in Italy who made the test for the avatar movements. The same process was followed for the Written version: first a student at IST tested it, then 2 students in Italy. Basing on their suggestions some changes and improvements have been made in order to obtain as more as possible a user center product.

The whole technological development, with Portuguese engineers of the two versions to test lasted one year, preceded by the preparatory work done by the Italian psychologist with Israeli psychologists. Then, phase 4, the validation in Italy, followed. This phase will be deeply explained in chapter 5.

PART 3:
EMPIRICAL CONTRIBUTION

OVERVIEW OF EMPIRICAL STUDIES

The research question of the present empirical contribution concerns if and how new technologies can support adolescents in stress management and in enhancing their emotion regulation abilities, proposing an innovative technology-enhanced approach.

Starting from the main points emerged from the literature review advanced in the previous chapters, the efficacy of positive technologies was tested in a sample of young people aged 12-19.

Two empirical studies were carried out:

1- The aim of the first study was to test the efficacy of the Positive Technology App (PTA, Riva, 2013) in inducing relaxation.

In particular on the one hand, if the use of the app elicits a lower perceived stress and a lower trait anxiety. On the other hand if the integration of biofeedback in the app, allows to experience a greater sense of relaxation.

2-The aim of the second study was to test the efficacy and to evaluate selected sessions of the BEAR training protocol (Pat-Horenczyk et al., 2012) in the technology-enhanced version developed, comparing two technological versions with a traditional version, not supported by computer, That's to say: 1-Written instructions at computer & user's avatar doing the exercises vs 2-Instructions given by an avatar (speaking) & user's avatar doing the exercises vs 3- Individual-traditional adapted BEAR.

In particular the main aim was to explore, on the one hand, which one of the three versions is the more efficacy in term of lower state anxiety, lower perceived stress and less negative affect, as well as higher perceived calm and more positive affect, post training, and which one involves more. On the other hand, in which one of the three versions there is a significant change post training in HR and EDA, in the number of EDA peaks and in the level of muscle activation.

In the next two chapters these studies will be presented and the results will be discussed.

CHAPTER 4: THE POSITIVE TECHNOLOGY APP

4 INTRODUCTION

Every day individuals have to deal with several circumstances that may provoke anxiety and psychological discomfort. Cohen and colleagues suggested that psychological stress occurs when individuals perceive that these potential threats exceed their adaptive capacity (Cohen, Janicki-Deverts, & Miller, 2007). 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 especially on the individuals' ability to appraise and to cope with the stressful events (Serino et al., 2014). In recent years, as said in the previous chapter, there is a 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 (Serino et al., 2014).

Although research on mobile interventions is more established in physical health domains, research on psychosocial outcomes is only emerging. So far, the majority of studies have focused on mental health outcomes, with very few studies moving beyond specific mental health conditions and into psychological wellbeing and strengthening social relationships further, there are very few high quality randomized control trials. Thus, the full potential of mobile technologies in psychosocial domains is yet to be discovered (Konrath, 2014).

Based on these premises, Positive Technology app (PTA) 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 (Serino et al., 2014).

The Positive Technology App

The Positive Technology App (PTA, Riva, 2013) is an application for mobile phone and tablet composed of three parts to help the individual to learn several effective relaxing techniques 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 et al., 2013).

1- Guided Relaxation:

In the Guided Relaxation section, 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) (Serino et al., 2014).

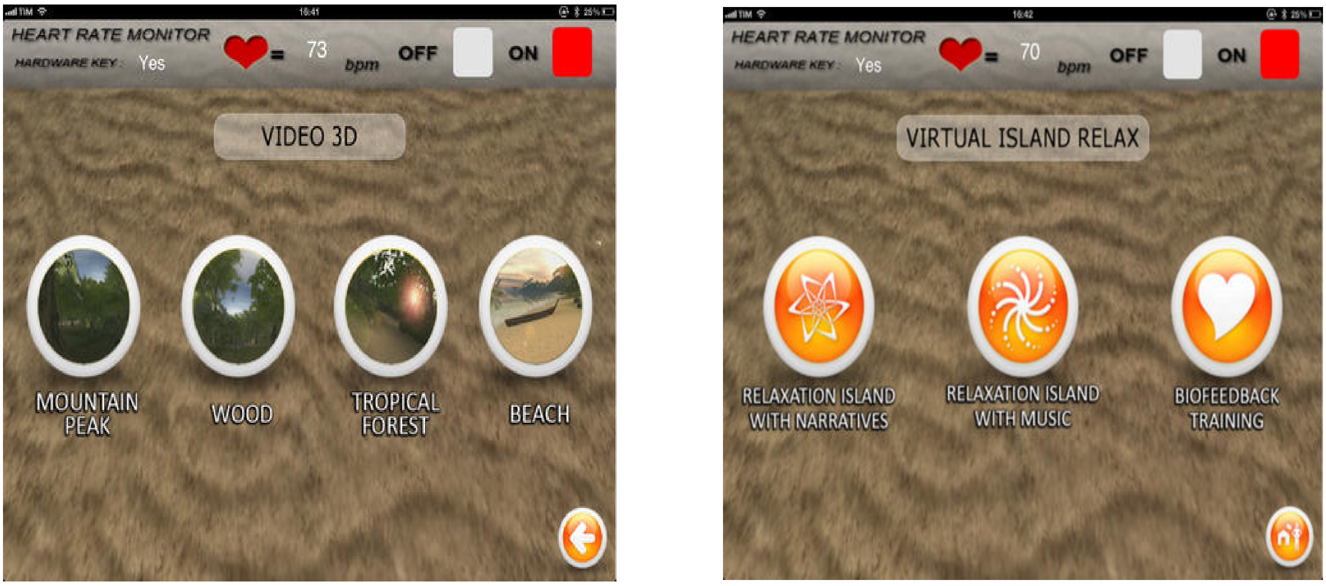


Figure 1. A screenshots of Video 3D menu and of Virtual Island menu

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 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) (Serino et al., 2014).

Figure 2. A screenshot of Biofeedback Training.

3- Stress self-tracking.

Users have two options to track their psycho-physiological 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).

Second, if the application is connected with a biosensors, it immediately captures the 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 levels variations by logging into the service website (Serino et al., 2014).

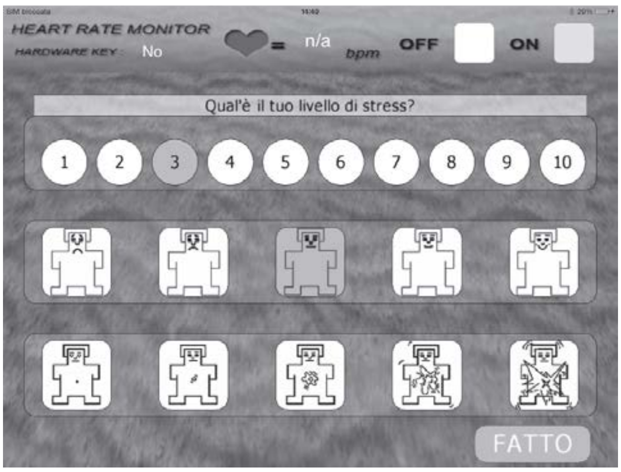


Figure 3. A screenshot of Stress Self-Tracking.

4.1 Aims and Hypothesis

The aim of this study is to test the efficacy of the Positive Technology App in inducing relaxation in a sample of youth between the age of 15 and 18.
In reference to this object and on the theoretical basis previously advanced (Serino et al., 2014; Gaggioli et al., 2013 Botella et al., 2012) the following hypothesis have been tested:

Hp.1- The use of the app elicits lower perceived stress and a lower trait anxiety

Hp.2- The integration of biofeedback in the app allows to the experimental group to experience a greater sense of relaxation, measured through a lower perceived stress and a lower trait anxiety

4.2 METHODS

4.2.1 Participants

113 volunteer students, aged between 15 and 18 (m=16,34; ds=0,97), were recruited at different school of Milan and surroundings.
All participants did not know, or use, Positive Technology App before and didn't have any experience with biofeedback before.
All the participants were asked for the informed consent of the parents, before participating, since they were minors.
The students were randomly assigned to one of the following groups:
(a) Experimental group (EG)=PTA with Biofeedback (PTAB);
(b) Control group (CG)=PTA without biofeedback (PTA);
(c) Waiting list group (WL)= No treatment.
Of the total students recruited, 79 subjects completed all the protocol and were included in statistical analyses.

4.2.2 Measures

The two groups that used the app, Experimental and Control groups (EG and CG) were assessed at the beginning and at the end of the protocol with the following questionnaires:

- State-Trait Anxiety Inventory Form (STAI, Spielberg et al.,1970). Consists of two scales containing 20 items each that measure anxiety in adults. It was used the STAY Y-2 that is the trait version and it addresses the general and long-standing quality of "trait anxiety", it measures the characteristic tendencies to be anxious.

- Psychological Stress Measure (PSM) (Lemyre et al., 1990; Di Nuovo et al., 2000). The questionnaire consists of 49 items based on the various individual perceptions of cognitive, physiological, and behavioural state of subjects. PSM provides a global score of stress and some partial sub-scores. The global score of the PSM is compared with ground truth scores, which give threshold cut off on the basis of the gender (103 for male and 110 for female subjects)

Moreover, before and after each relaxing exercise, these two groups had to mark:

- Level of perceived stress (1-10)
- Sam (Lang, 1980) 2 item: Arousal-Emotional valence

At the end of the protocol, they also compiled:

- The System Usability Scale (SUS) (Brooke, 1986). SUS provides a "quick and dirty", reliable tool for measuring the usability. It consists of a 10 item questionnaire with five response options for respondents; from Strongly agree to Strongly disagree. Originally created by John Brooke in 1986, it allows you to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications.

- Further, they compiled an evaluation questionnaire on the app with open questions on advantages, limits and suggestions on the app and some likert scales to evaluate each type of exercise.

.

As for the Waiting List group (WL), it was a control condition: they didn't receive any kind of relaxation training, but they compiled the same questionnaires pre and post training, at the beginning and at the end of the month to assess the level of anxiety and of perceived stress as the two other groups:

- State-Trait Anxiety Inventory Form Y-2 (STAI Y-2, Spielberger et al.,1970).
- Psychological Stress Measure (PSM) (Lemyre et al., 1990; Di Nuovo et al., 2000).

Hardware :

The hardware elements of the protocol for Experimental and Control groups (EG and CG) included:
56 3D glasses for the 3D relaxation environments, provided by the researcher
6 wireless (Bluetooth) sensors to measure the heart rate: Polar H7 BT, provided by the researcher
56 Iphone/Ipad/Ipod IOS, 4/5 version to use the app, of the participants themselves



To compare the efficacy of the different protocols, a 3 (Training conditions) between subjects x 2 within subjects (Time, pre and post) design was implemented.

4.2.3 PROCEDURE

Before starting the study, a meeting was organised for each class of each school to explain how the study would be carried out. . During this meeting the students involved the study provided their phone number so as to be personally contacted by the researcher later via WhatsApp in order to communicate them to which group they were randomly assigned to, and give them the link for questionnaire administration.

WhatsApp was also used to send written instructions related to the assigned protocol and memo for the compilation of post training questionnaires. .

Since only 6 sensors were available, different shifts were organized within each school. At task completion, students gave the Polar back to the professor or directly to the researcher who in turn gave it to the next student in the list.

(a) Participants in the Experimental group (EG-PTAB) followed this protocol:

1-They receive the link to fulfil the pre training questionnaires.

Each one had to put a code (the first 3 letters of name and the first 3 letters of surname).

2-They receive the name of the app with the icon and are asked to download it and to confirm

3-They use the app freely, for one month at least twice a week, choosing days and hour.

They were asked to use freely all the Guided relaxation options: audio, 2D /3D environments and Virtual Reality Island and to complete the Stress Self-Tracking before and after each session.

The PTAB group was asked to use also the Polar BT and the Biofeedback in the Virtual Reality Island.

4-After 1 month of use they receive a second memo for the post training questionnaires and the evaluation questionnaire.

5-They keep the 3D glasses and they receive credits by school and a certificate of participation.

The PTAB students give back the Polar BT to the professor or to the researcher in order to start the next turn.

(b) Participants in the Control group (CG-PTA) followed this protocol:

1-They receive the link to fulfil the pre training questionnaires.

Each one had to put a code (the first 3 letters of name and the first 3 letters of surname).

2-They receive the name of the app with the icon and are asked to download it and to confirm
3-They use the app freely, for one month at least twice a week, choosing days and hour.
They were asked to use freely 3 of the 4 Guided relaxation options: audio, 2D /3D environments, and to complete the Stress Self-Tracking before and after each session.
The PTA group wasn't asked to use the Virtual Reality Island since they weren't provided with the Polar BT and they weren't asked to do the Biofeedback.
4-After 1 month of use they receive a second memo for the post training questionnaires and the evaluation questionnaire.
5-They keep the 3D glasses and they receive credits by school and a certificate of participation.

(c) Participants in the Waiting List group (WL) followed this protocol:

It was a control condition in which students were included in a waiting list and did not receive any kind of relaxation training. They also completed the questionnaires: the pre training and then, after 1 month the post training.
1-They receive the link to fulfil the pre training questionnaires.
Each one had to put a code (the first 3 letters of name and the first 3 letters of surname).
2-After 1 month they receive a second memo for the post training questionnaires.
3-They receive credits by school and a certificate of participation.

4.3 RESULTS

4.3.1 Overview of statistical analyses

To test the hypotheses advanced, the following statistical analyses have been performed and several assumptions were met to use each one of these techniques:
To test Hp.1 and Hp2, if there are differences within and between three groups (EG; CG; WL) a repeated measures analysis of variance (ANOVA) was run to analyze the changes before and after the one month treatment. A two-sided P value of .05 or less was considered to be statistically significant. Experimental, Control and Waiting list groups were simultaneously taken into the analysis of variance model for repeated measures. Differential effects of the treatments were

determined using post-hoc analyses. In particular, to reduce the risk of type I errors, we used the Bonferroni post-hoc procedure.

Then a Paired Samples T Test was run to explore in which groups there were some differences, as emerged by the ANOVA.

4.3.2 Preliminary processing of data

Preliminary data processing included calculation of the total scores, of descriptive statistics for single items of the different scales, age, gender, and total score of each scale (See Table 1).

On the basis of this preliminary analyses we detected outliers using Z points and boxplot per each group and according to the results 20 participants were excluded from further analyses.

Also the reliability of the two questionnaires, both on pre and post scores, was analysed per each group with Cronbach's Alpha. All the scales showed a good reliability:

- STAI-pre: WL=0,86; CG=0,90; EG=0,86
- STAI-post: WL=0,88; CG=0,82; EG=0,88)
- MSP-pre: WL=0,90; PTA=0,90; PTAB=0,87
- MSP-post: WL=0,96; CG=0,90; EG=0,84.

Table 1. Descriptive statistics: Mean and standard deviation

Gruppo	**Genere**	**Età**	**MSP_Pre**	**MSP_Post**	**STAI_Pre**	**STAI_Post**
1- WL (n=17)	10m; 7f	16,29 (1.10)	94,29 (16.84)	97,82 (24.63)	42,65 (8.07)	45,88 (8.66)
2- CG (n=22)	12m; 10f	16,36 (1.09)	94,05 (15.87)	90,59 (15.63)	42,59 (9.00)	42,05 (7.40)
3- EG (n=20)	10m; 10f	16,35 (0.74)	88,40 (14.70)	80,60 (12.42)	43,30 (8.85)	38,55 (8.48)

4.3.3 Comparability at baseline

Before starting the analyses the comparability at the baseline between the three groups was assessed through One Way ANOVA, with Group as factor and Age, pre MSP total and pre STAI total as dependent variables.

No significant difference was found for Age ($F_{2,56}$=,025; P=,975), for MSP ($F_{2,56}$=,880; P=,420) and for STAI ($F_{2,56}$= ,041; P=,960). (See Table 2)

Also a Cross-tabulation was run for Gender highlighting that on the total sample, males are 54,2% and females are 45,8% (See table 3 for each group percentage).

Table 2. One Way ANOVA between the 3 groups on Age and Pre-Treatment Scores of Psychometric questionnaires

Variable	F	P
Age	.025	.975
MSP	.880	.420
STAI	.041	.960

Table 3. Cross-tabulation for Gender (1=Male; 2=Female)

Gender * Group Crosstabulation						
			1= WL; 2=CG; 3=EG			Total
			1	2	3	
Genere	1	Count	10	12	10	32
		Expected Count	9,2	11,9	10,8	32,0
		% within Genere	31,3%	37,5%	31,3%	100,0%
		% within Gruppo	58,8%	54,5%	50,0%	54,2%
		% of Total	16,9%	20,3%	16,9%	54,2%
	2	Count	7	10	10	27
		Expected Count	7,8	10,1	9,2	27,0
		% within Genere	25,9%	37,0%	37,0%	100,0%
		% within Gruppo	41,2%	45,5%	50,0%	45,8%
		% of Total	11,9%	16,9%	16,9%	45,8%

4.3.4 Self-report measures results

To explore if there are significant differences between and within the 3 groups in the post treatment scores in the perceived stress (MSP) and in the trait stress score (STAI Y2), *(Hp.1 and Hp.2)* a Repeated Measure ANOVA was run (See Table 4.a and 4.b).

The analysis on the perceived stress (MSP) revealed no significant difference in the effect of TIME or TIME x GROUP, but the results suggested to explore the between GROUP effect, even if no significant ($F_{1,56}$=3.09; p=.053; effect size=0.10).

The Pairwise comparisons indicate a mean difference between EG and WL of -11.559 (p=0.058) and the Post-hoc analysis indicates a P value for Bonferroni near to be significant (p=0.058).

A Paired Sample test was then run revealing a significant correlation in WL and in EG, then, with a 2-Tailed Sign, only in EG it was found a significant mean difference ($t_{(19)}$= -2.53; p<.05), while in WL and CG there is no significant difference even if the results showed that the mean of the post MSP in the WL increases, while in the CG decreases. Again, a 1-Tailed Sign showed that the only significant mean difference is in the EG with p<.01 (See Table 5.a. and 5.b.)

The same analysis were run for STAI Y2. The Repeated Measure ANOVA revealed a significant effect for TIME x GROUP ($F_{2,56}$= 5.19; p<.01; effect size = 0.15).

Then the Paired Sample test was run revealing a significant correlation in WL and in EG, then, with a 2-Tailed Sign, only in the EG a significant mean difference emerged ($t_{(19)}$ = -3,57; p<.01), while in WL and CG there is no significant difference even if the results showed that the mean of the post STAI in the WL increases, while in the CG decreases.

Running with a 1-Tailed Sign, a significant difference emerged also in the WL with p<.05 and with a p<.001 for EG, while for CG both with 2-Tailed and 1-Tailed there is no significant mean difference (See Table 5.a. and 5.b.).

The analyses show that although both treatment (PTA with biofeedback and PTA without biofeedback) were able to reduce perceived stress and trait anxiety, only participants of EG who also used the Biofeedback, reported a statistical significant reduction in both measures.

The results revealed also that the Waiting List group who didn't follow any treatment not only didn't decrease the perceived stress and trait anxiety, but also increased them in statistically significant way. According to our initial hypotheses, hp.1 it's only partially confirmed since the use of the app significantly elicits the expected emotional response only in the Experimental group while for the Control group was found a decrement of the variables measured, but not significant.

Hp.2 is confirmed demonstrating that integration of biofeedback in the app allows to experience a greater sense of relaxation, measured through a lower perceived stress and a lower trait anxiety in EG-PTAB.

Table 4.a. Repeated Measure ANOVA, Pre and Post session, TIME

Variable	F	P	Partial Eta Squared
MSP	1.360	n.s.	.024
STAI	.484	n.s.	.009

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 4.b.. Repeated Measure ANOVA, Pre and Post session, TIME x GROUP

Variable	F	P	Partial Eta Squared
MSP	2.092	n.s.	.070
STAI	5.190	**	.156

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 5.a. Paired Samples Correlations

Pair (Pre & Post)	WL	CG-PTA	EG-PTAB
MSP	r=,663 **	r=,340 n.s.	r=,496*
STAI	r=,636**	r=,415 n.s.	r=,766***

* Correlation is significant at .05 level; ** Correlation is significant at .01 level; *** Correlation is significant at .001 level

Table 5.b. Summary of Paired Samples test (2-tailed): Mean difference and Significance level.

Pair (Pre & Post)	WL	CG-PTA	EG-PTAB
MSP	3,529 n.s.	-3,455 n.s.	-7,800 *
STAI	3,235 n.s.	-0,545 n.s.	-4,750 **

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

4.3.5 Evaluation questionnaires

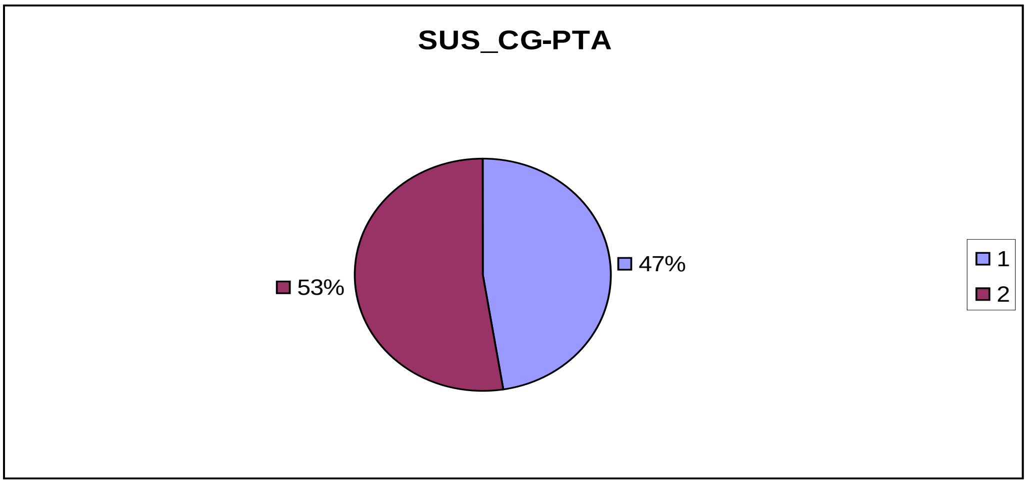
As for the qualitative questionnaire and the SUS (Brooke, 1986), administrated at the end of the month to the EG and to the CG, the main findings are: on a total of 44 valid subjects, 75% used the app twice a week, the minimum required, and 25% used it three times per week. The percentage per each group are reported in Table 6. showing a little difference between the two groups probably due to the more engaging biofeedback training.

Table 6. Weekly use of PTA, in each group

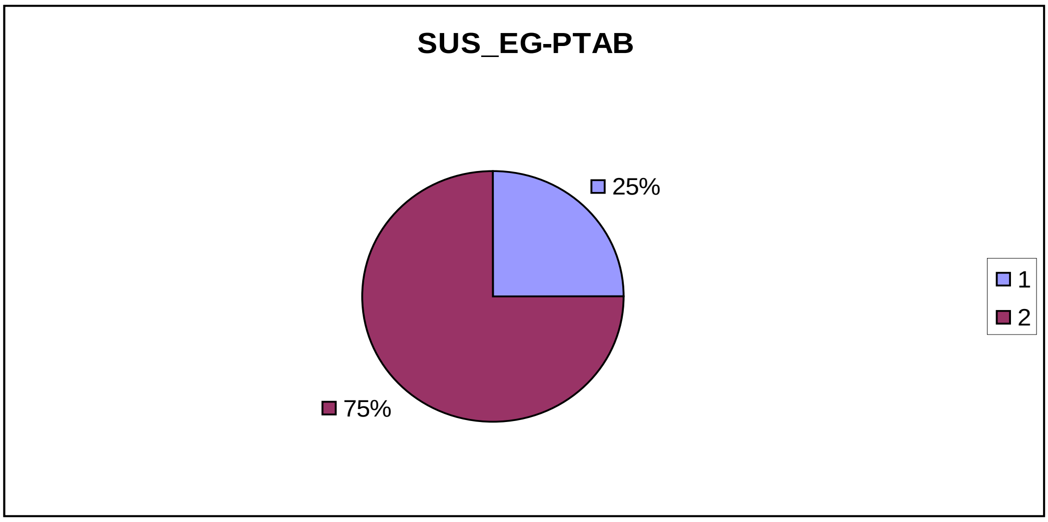
Weekly use	CG-PTA	EG-PTAB
2	77.7%	71.4%
3	22.7%	28.6%

As for the SUS questionnaire, on a total of 40 valid subjects, 65% obtained a value above the average (68), revealing an important difference between the two groups, as we can see in the following pie charts, where 2 is the percentage up the cut-off.

Pie chart. CG-PTA- SUS *1*= Below the cut off; 2= Up the cut off



Pie chart. EG-PTAB- SUS   1= Below the cut off; 2= Up the cut off



Also three open questions were included: (a) advantages, (b) limits and (c) suggestions.

As for the advantages of the app the most frequent answers are: "It calms, it relaxes, it helps to disconnect from the problems of everyday life, allows you to take time for yourself." "It can be used everywhere and every time". "A multimedia tool attracts new generations".

The limits that have been highlighted are: "An app is not personal, doesn't feel and doesn't transmit any emotions." "It's only a temporary distraction, then problems continue." "It works only for iPhone." "English isn't simple for everyone, it required to concentrate well." "Images aren't realistic, low quality video, not enough immersive, too mechanical and cold."

The users were asked to give also some suggestions: "To improve the graphics, 3D videos and the island functionality." "Lighten the weight of the app in GB with video on Youtube with active connection." "Put something more fun." "Use real images for the places." "Less bugs and functional errors" "To use an avatar that the user can choose." "Make it more interactive".

4.4 DISCUSSION

One of the main strength of the present study is the combination of different advanced technology: VR, mobile technology and biofeedback. Biofeedback training is regarded as a useful technique to reduce anxiety symptoms (Ratanasiripong, Ratanasiripong & Kathalae, 2012). As stated by Gaggioli et al. (2014) the most common limitation of biofeedback and relaxation training is that it requires time commitment and implementation effort on behalf of the patient who can rely only on very simple audio and visual cues provided by the system to learn about body responses to stress. In

VR-based biofeedback, elements of the virtual environment are directly modified by the patient's physiological parameters recorded in real time (eg, for the "Campfire" and the "Waterfall" scenario, physiological parameters control the fire/waterfall intensity, so that the reduction of the patient's physiological activation results in a reduction of the fire until it goes out or of the waterfall intesity). Thus, patients receives immediate feedback on their level of activation (as in the traditional biofeedback techniques), but with richer and more engaging 3D visual cues (Repetto et al., 2009).

Another strength of this study is to be a step forward a previous preliminary evaluation of the Positive Technology App (Serino et al., 2014) who tested the efficacy of PTA on 68 users who performed guided relaxation or biofeedback exercises for at least 120 seconds. 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 psycho-physiological data (heart rate data).

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, measured with 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). The main limits of this preliminary evaluation were that no standardized outcome measures were used and no controlled randomized trial was done, including a control group. With the present study both of these limits have been exceeded in order to further evaluate the efficacy of Positive Technology in reducing psychological stress.

However the present study has some limitations. First of all it didn't include any measure on coping abilities, while this variable can be positive influenced by this kind of treatment as demonstrated for example by Gaggioli et al. (2014) and by Pallavicini et al. (2009). Second it didn't include for now a follow-up research study to assess the participant samples again after some months and this could be interesting especially since trait anxiety was assess and changed significantly, not simply the state level. Also, it could be interesting to collect some data about pre-post each session considering also state anxiety and not only trait and the arousal-valence levels.

Moreover no statistically significant results were found for heart rate variability, but we can suppose that this wasn't due to the tool itself, but because the number of participants who used the Polar-BT and thus the biofeedback, wasn't enough, as it was found by Serino et al. (2014). The limited number of participants in EG was due to two main reasons: (a) the limited number of Polar-BT available and (b) to its incompatibility with IOS 9.1, the last updated version during the last two months of research. Also, for this reason many participants of the experimental group were lost, passing automatically to the control group. Another technical limitation was due to the compatibility of PTA (Riva, 2012) only with IOS system and not also with Android: many students who voluntary wanted to participate couldn't take part and in this way the number of participants was reduced.

According to our initial hypotheses, this study confirms the hp.2 demonstrating that integration of biofeedback in the app allows to experience a greater sense of relaxation, measured through a lower perceived stress and a lower trait anxiety, while hp.1 it's only partially confirmed since the use of the app elicits the expected emotional response significantly only in the Experimental group while for the Control group was found a decrement of the variables measured, but not significant.

The main findings of the present study are in line with a preliminary study on the Generalized Anxiety Disorder (GAD) (Pallavicini et al., 2009) who explored the efficacy of a biofeedback-enhanced virtual reality (VR)

System, comparing three groups: the VR and Mobile group (VRMB) including biofeedback; the VR and Mobile group (VRM) without biofeedback, and the waiting list (WL) group.

This study provided an initial evidence of the added value offered by the use of biofeedback. Only in the VRMB group was found a significant reduction in the GAD symptoms (GAD-7) and in the anxiety scores (STAI) from the beginning to the end of the treatment. Regarding the

patients' physiological responses was found a tendency indicating a decrease in HR and GSR between the pre and post-session measurements in the VRMB group, higher than in the VRM.

These results demonstrated that biofeedback used in combination with VR increases its effect helping patients to better control their physiological parameters and to gauge their success in a more efficient way (Pallavicini et al., 2009).

Regarding the results of the present study on PTA, for the perceived stress and the trait anxiety, similar findings were obtained in a previous study on the management of psychological stress (Gaggioli et al., 2014). The goal of that study was to evaluate the efficacy of a technological paradigm, Interreality, which combines different advanced technologies (virtual worlds, wearable biosensors, and smartphones), comparing three groups: (1) the Experimental Group (EG) which received a 5-week treatment based on the Interreality paradigm; (2) the Control Group (CG) which received a 5-week traditional stress management training based on cognitive behavioural therapy (CBT); and (3) the Wait-List (WL) group which was reassessed and compared with the two other groups 5 weeks after the initial evaluation. Although both treatments were able to reduce perceived stress better than WL, only EG participants reported a significant reduction (EG=12% vs CG=0.5%) in chronic "trait" anxiety.

As for the evaluative questionnaires, the important notes underlined by users are in line with the main findings of the focus groups and show us that despite the app in its complex was effective in terms of lower perceived stress and anxiety level, it can still be improved and made more suitable and accessible to teenagers users who, as digital natives, have on the one hand a good knowledge of the technical possibilities, on the other hand high demands in terms of graphics and usability.

Overall these data suggest that even only one moth of stress management exercise carried out on a mobile application might be useful in reducing psychological stress and trait anxiety.

Further, findings of the present study confirm what was already summarized by Preziosa and colleagues (2009): since smartphones and tablet are now widely integrated in both individual and social life, people have the opportunity to perform stress management exercises everywhere and every time. Second, as stated by Serino et al. (2014), 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 can be integrated with biosensors, as Polar-BT and Empatica for example, and these data can be used in combination with subjective self-reports to determine individuals' psycho-physiological 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).

Moreover, results highlight an important issue: since only the group who used also the biofeedback and not only the app, obtained a significant decrement of stress and anxiety, we can supposed that this is due to the fact that biofeedback increase the awareness of our physiological state, one of the main area explored in the present empirical contribution starting from the user needs analysis, and in which adolescents showed a particular difficulty. The biofeedback gives them the opportunity to enhance the physical awareness and to obtain better results. Not only, we can also suppose that the opportunity to use an innovative tool, that's to say, the POLAR-BT, make them feel more engaged and this variable influences the results.

Above all, the present study offers a preliminary evidence of the efficacy of positive technologies in reducing symptoms of psychological stress and in improving the relaxation abilities in adolescents.

It would be interesting, in the future, to increase the sample size and to analyze the engagement aspect, in specific for PTA and in general for positive technologies, as it was made with the second empirical study which will be illustrated in chapter 5.

CHAPTER 5: THE EMOREGULATOR STUDY

5 INTRODUCTION

'Games for Health' and 'Health eGames' are two terms that refer to health related computer games, or similar computer applications that use software tailored to computer game development. Currently there are over 300 Health eGames have been developed for both healthy and patient populations. The number and variety of these games according to the Gaming4Health game database are growing rapidly as more and more games are being identified from developers and sponsors in the United States and worldwide. A variety of health problems are tackled through Health eGames such as diabetes, Alzheimer, asthma, cancer, AIDS, obesity and pain. Other Health eGames promote best practices for a healthy lifestyle such as fitness and exercise, weight loss, nutrition and relaxation. At present, approximately 35 Health eGames target professionals in

health and medical professions. This new trend is not superficial: a growing body of research indicates that Health eGames provide measurable health benefits (Kalapanidas et al., 2009). Previous literature review studies suggest that computer games in general can serve as an alternative form of treatment, or an additional intervention, for disorders such as schizophrenia (Bellack et al., 2005); phobias (Robillard et al., 2003; Walshe et al., 2003); and asthma (Bussey-Smith & Rossen, 2007). Additional benefits have been observed for motor rehabilitation (Broeren et al., 2007; Cook et al., 2002; Merians et al., 2006) and as tool for for the promotion of psycho-education (Beale et al., 2007; Coyle et al., 2005; Rassin et al., 2004).

Psycho-education, in particular, emotion regulation enhancement, is the domain of the present empirical contribution, which specifically targeted at adolescents.

Adaptive emotion regulation (ER) strategies are especially important during adolescence, when deficits in this area might result in psychosocial and behavioral problems. Indeed, there is a great concern for the increase in psychological disorders as well as disruptive behaviors among adolescents and for the increase in school-age bullying. Therefore, the prevention of numerous emotional and behavioral problems through the early detection of dysfunctional ER strategies and training in adaptive ER strategies could be significant. Research has shown that students with well-developed social skills and emotional awareness have an easier time both socially and academically, are more motivated to engage in studies and to collaborate with peers, and are better able to manage stress. Recent studies point to the improvement of academic skills and, in particular, of cognitive processes important for school performance, such as attention and memory among adolescents with increased emotional awareness (Cherniss et al., 2006). Further, the transition from middle school to high school requires adolescents to develop new skills and to cope with new stiuations.

Today's students are have been described as “digital natives:” they have grown up with ever-evolving technologies and are in their natural habitat when using technological interfaces. Today’s adolescents do not need to adapt to new media (Ferri, 2011; Mantovani e Ferri, 2008). For them, the virtual and the real world are intrinsically connected. The youth of today’s western world have developed a powerful and versatile mind with the ability scan information very quickly (Carr, 2010).

Digital natives have achieved high competence in the digital and simulation field. They are able to quickly assess the complexity, the value of challenge and competition, the degree of cognitive engagement required and possible shortcuts (Egenfeldt-Nielsen, 2007). For the digital native, new technologies and Health eGames can be an attractive alternative to traditional treatment interventions.

The final aim of the present research is to create a technlogy-enhanced protocol for the development of ER abilities in adolescents, leveraging the fact that there is a strong potential to increase their involvement through the use of technology-enhanced tools, and that, based on the PT approach, technology can increase emotional, psychological and social well-being (Serino, et al., 2013).

The current research is of particular importance as one of the significant limitations in the research of ER to date has been that though there are many numerous ER training programs, none have been combined with new technologies such as VR, biosensors, or SGs (Brunwasser et al., 2010; Casel & Lss, 2003; Harlacher et al, 2010). These new tools allow for the promotion of situated and simulative learning as a form of participatory appropriation (Gee, 2003; Van Eck, 2007). Though there are some existing programs that employ innovative technologies to foster social and emotional learning in adolescents, they do not specifically focus on ER competencies. For example the Playmancer program (Ben Moussa, et al., 2009) deals with ER, but it aims to support patients in behavioral and mental disorder treatments and chronic pain rehabilitation; eCircus (Lim, 2011) focuses on antibullying education and the development of intercultural empathy; Gameteen (Rodriguez, et al., 2012) works on the assessment and development of ER strategies, but it doesn’t work with realistic environments and it also doesn’t provide a specific training program; with Interstress (Riva et al., 2010) an effective protocol has been developed, but it is targeted for work with adults and not with adolescents.

Another important feature in the field of ER is that most of the existing studies are based on a single measurement technique. The most recent theories on emotion highlight that it is a multidimensional and multicomponent processes. Currently, there is a wide range of assessment methods available in emotion-based research and researchers are moving towards multi-modal assessments (Scherer, 2001). Existing assessments, such as self-report measures, can be affected by distortions due to factors such as social desirability. In contrast, measurements with physiological instruments are less likely to be influenced by social desirability and other mitigating psychological factors: wearable sensors, particularly when assessed in conjunction with self-report measures, could be a method to receive more accurate data (Anolli, et al., 2010; Haag, 2004).

In the last decade the relationship between interactive media and stress has gained wide interest in the field mental health. Virtual reality (VR), in particular, has emerged as a potentially effective way to provide general and specialty healthcare services (Villani & Riva, 2011). But is VR always an effective emotional inductor? Riva et al. demonstrated that in case of treatment of anxiety disorders, without a high sense of presence the significant advantages of VR disappear (Gorini, 2010; Pallavicini, et al., 2013).

With all of the aforementioned in mind, a technology-enhanced protocol was developed combining the BEAR training (Pat-Horenczyk et al., 2014) with gamification aspects, virtual characters and wearable physiological sensors (See chapter 1). Three versions were developed each of which consisted of two sessions (1-Introduction and 4-Physical Regulation-part 1):

1- Written instructions & user's avatar doing the exercises (EG1-Written)

2- Instructions given by an avatar (speaking) & user's avatar doing the exercises (EG2-Assistant)

3- Individual-traditional adapted BEAR (CG-Traditional

For a complete explanation of the development process, see chapter 3. Here we report a summary of the exercises of the three versions (See Table A-B).

Table A. Session 1: *Individual-technological versions (1-2) vs Individual- traditional adapted version (3)*

Individual-technological version: **EG1-Written & EG2-Assistant** **Introduction**	**Individual-traditional adapted version:** **CG-Traditional** **Introduction**
1-Opening: Short general introduction of the game	***1-Opening:*** Short general introduction of the game
***2-Heart rate introduction*:** Explanation of the heart rate symbol	***2-Sensors introduction:*** Explanation of the wearable biosensors
3-Points:	***3-My personal space:***

Explanation of the points logic	Possibility to choose his/her own character and to give him/her a name. The user is asked to choose the printed image of male/female avatar
4-Instruction icon: Explanation of this icon	***4-I-BOX 1:*** Introduction on I-BOX and possibility to personalize it, colouring with a colour that represents anxiety. A real little box is given to the subject with printed papers of the colours palette
5-My personal space: Possibility to choose the background, the avatar and to give him/her a name	
6-I-BOX 1: Introduction on I-BOX and possibility to personalize it, colouring with a colour that represents anxiety	

Table B: Session 4: *Individual-technological versions (1-2) vs Individual- traditional adapted version (3)*

Individual-technological version: **EG1-Written & EG2 Assistant** **Physical regulation**	**Individual-traditional adapted version:** **CG-Traditional** **Physical regulation**
***1-Candle Lighting Ceremony*:** Opening ritual, the user has to light a virtual candle with a virtual match	***1-Candle Lighting Ceremony:*** Opening ritual, the user has to light a printed candle taking a printed flame and sticking it on the sheet
2-A Minute for Myself – M&M:	***2-A Minute for Myself – M&M:***

Psycho-education, then the user is asked to point on the virtual M&M his level of tension from 1 to 10, clicking on it	Psycho-education, then the user is asked to point on the printed M&M his level of tension from 1 to 10, colouring it
3-Mindfulness – Facial Mindfulness: The user is asked to identify on his avatar face where he feels tense and where relaxed and to colour the parts in red or blue	***3-Mindfulness – Facial Mindfulness:*** The user is asked to identify on his character/printed avatar face where he feels tense and where relaxed and to colour the parts in red or blue
4-Breathing exercise: The user is asked to breath in a different way, focusing on his stomach and imagining that it's a ball. User avatars does the same movements	***4-Breathing exercise:*** The user is asked to breath in a different way, focusing on his stomach and imagining that it's a ball. Trainer, in part, does the same movements
5-Active/Shaking Meditation: Before the user is asked to move according to the music then there is a relaxation exercise to calm down. User avatars dances too	***5-Active/Shaking Meditation:*** Before the user is asked to move according to the music then there is a relaxation exercise to calm down
6-Progressive Muscle Relaxation: Psycho-education, then 4 different experiential exercises with the PMR technique. User has to do the exercises externally while looking his avatar doing the same and listening to the sounds/music required by each exercise	***6-Progressive Muscle Relaxation:*** Psycho-education, then 4 different experiential exercises with the PMR technique. User has to do the exercises externally while looking the trainer doing in part the same and listening to the sounds/music required by each exercise
7-How does my body feel: User is asked to read a list of the main emotions then he is asked to think where in his body he feels each of these emotions in general, not in that moment. Then he need to sign where he feels each one on the body of his avatar	***7-How does my body feel:*** User is asked to read a list of the main emotions then he is asked to think where in his body he feels each of these emotions in general, not in that moment. Then he need to sign where he feels each one on the body of his character/ printed avatar, putting each emotion small paper on it

8-I-BOX 4: Internal Sensations: The user is asked to colour his I-BOX with a colour that represents the sense of relaxation	***8-I-BOX 4: Internal Sensations:*** The user is asked to colour his I-BOX with a colour that represents the sense of relaxation. As before, A real little box is given to the subject with printed papers of the colours palette
9-Closing of Session: Summary of the work done with each exercise then closing ritual with the candle: he has to blow out the candle clicking on it	***9-Closing of Session:*** Summary of the work done with each exercise then closing ritual with the candle: he has to blow out the candle, unplug the printed flame by it

5.1 Aims and Hypotheses

The aim of the present study is to test and to evaluate the efficacy of the selected sessions of the technology enhanced protocol of the BEAR training, comparing the three groups, in a sample of youth between the ages of 12 and 19:

1- Experimental Group 1 (EG1-Written)

2- Experimental Group 2 (EG2-Assistant)

3- Control Group (CG-Traditional)

On the basis of the theoretical premises previously discussed, the following hypotheses have been tested:

Hp.1-There will be significant differences between the three groups in post treatment outcomes as for state anxiety, calm and anxiety levels, positive and negative affect (Pat-Horenczyk et al., 2014; Gorini et al., 2010).

Hp.2-There will be significant differences between the three groups as for the level of engagement. In particolar we expect a higher level of engagement for the Experimental Group 2-Assistant, but no for Experimental Group-1 and for Control Group (Coyle et al., 2005; Beale et al., 2007; Rassin et al., 2004; Villani et al., 2012)

Hp.3- The level of engagement will predict the post treatment results in the three groups as for state anxiety, calm and anxiety levels, positive and negative affects (Villani et al., 2012; Gorini, 2010)

Hp.4- There will be a significant difference between the two experimental groups, version 1 and version 2 as for the level of usability. Moreover the level of usability will predict the post treatment results in the two groups as for state anxiety, calm and anxiety levels, positive and negative affects (Pallavicini et al., 2013).

Hp5.- How the Avatar-Assistant will be perceived by the user will predict the post treatment results in the experimental group - version 2, as for state anxiety, calm and anxiety level, positive and negative affects and there will be significant correlations with engament and usability (Villani, 2012; Paiva, 2010).

Hp.6- There will be significant correlations between the scales used in the experimental group-version 2, to measure how the Avatar-Assistant is perceived (Bartneck et al., 2009; Niewiadomski et al. 2010).

Hp.7- We expect a higher number of EDA peaks and a higher Muscle activation in EG-2 for the whole session and in particolar during Active Shaking Meditation and Progressive Muscle Relaxation exercises, but no in EG-1 and in CG (Villani et al., 2012).

Hp-8- We expect a significant decreament of Heart rate and EDA after the sessions in all the three groups, with a higher difference pre-post treatment in Experimental Group-2, but no in Experimental Group-1 and Control Group (Villani & Riva, 2011).

5.2 METHODS

5.2.1 Participants

100 volunteer students, aged between 12 and 19 (m=15,92; ds=1,15), were recruited at different school of Milan and surroundings.

All the participants had never heard about the BEAR training and weren't following, at the time, some other training with the same aim.

Also, they were asked for the informed consent of the parents, before participating, since they were minors.
After recruitment, the students were randomly assigned to one of the following groups:

(a) *Experimental group 1 (EG1)* = Technology-enhanced protocol – EG1-Written:

Written instructions at computer & user's avatar doing the exercises

(b) *Experimental group 2 (EG2)* = Technology-enhanced protocol – EG2-Assistant:

Instructions given by an avatar (speaking) & user's avatar doing the exercises

(c) *Control group (CG)* = Traditional protocol – CG-Traditional:

Individual-traditional adapted BEAR, instruction given by a human trainer

5.2.2 Measures

All the three groups *were assessed* ***at the beginning and at the end*** *of the sessions, with the following questionnaires:*

- STAI State (Anxiety) (Spielberger, Gorsuch & Lushene, 1970 ; italian version by Pedrabissi e Santinello, 1989)
- VAS (Anxiety and Calm) (Streiner DL, Norman GR., 1989)
- PANAS (pos e neg affect) (Watson et al., 1988; Italian version by Terracciano et al., 2003).

Specifically:
-the State Trait Anxiety Inventory (STAI) (Spielberger, Gorush, & Lushene, 1970) is a 40-item self-reported instrument. It is broken down into two sections: state (or current) and trait (or characteristic or chronic) anxiety, each one of 20 items. The current study considered the state version to measure the current level of anxiety before the training sessions and to verify the reduction of anxiety achieved at the end, after the training. The Italian versions of the STAI have been validated by Lazzari & Pancheri, 1980.

- the Visual Analog Scale (VAS Anxiety and Calm) (Streiner DL, Norman GR., 1989) is a 10 points line. On one line the subject has to mark the level of perceived stress and on another line the perceived calm.

-the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988; italian version Terracciano et al., 2003) consists of 10 items that relate to positive affect (e.g. interested, enthusiastic) and 10 items that relate to negative affect (e.g. upset, ashamed). Participants indicate to what extent they are experiencing the described emotion using a five-point Likert-scale ranging from 1 ‘‘very slightly or not at all,’’ to 5 ‘‘extremely’’.

Moreover, ***the 3 groups after the sessions****, were assesed also with this questionnaire:*

Flow State Scale (FSS) (Jackson & Marsh, 1996). It's a 36 items questionnaires and it measures the following scales: Challenge-skill balance, action-awareness merging, clear goals, unambiguous feedback, concentration on task, control, loss of self-consciousness, transformation of time, autotelic experience.

Moreover, ***the 2 experimental groups after the sessions****, were assessed also with this questionnaire:*

The System Usability Scale (SUS) (Brooke, 1986) provides a “quick and dirty”, reliable tool for measuring the usability. It consists of a 10 item questionnaire with five response options for respondents; from Strongly agree to Strongly disagree. Originally created by John Brooke in 1986, it allows you to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications.

In particular, to the ***Experimental Group 2 (EG2) after the sessions****, in order to investigate how the trainer-avatar was perceived, were administered also:*

-The Godspeed questionnaire (GQS) (Weiss & Bartneck, 2015). The GQS consists of five scales that are relevant to evaluate the perception of (social) Human-robot Interaction. The scales are Anthropomorphism, Animacy, Likeability, Perceived Intelligence, and Perceived Safety.
The scales consist of five-point semantic differentials such as “Fake — Natural”. The GQS was translated in italian and the scales were mixed, as suggested by the authors, and the positive-negative adjectives were alternated, in order not to have always first the negatives, and then the positives, as suggested by Bartneck et al. (2009).

-The Niewiadomski et al. (2010) 7 point-likert scale analyzes three dimensions: warmth, competence and believability.

Psychophysiological assessment

For every condition, at the beginning and during the session, these physiological measures were recorded in order to obtain objective measures of participant's emotional state (for the technical features see chapter 3, paragraph 3.3.5):

-Heart rate variability
-Muscle activity (Trapeze and biceps)
-Electro-dermal activity (EDA)

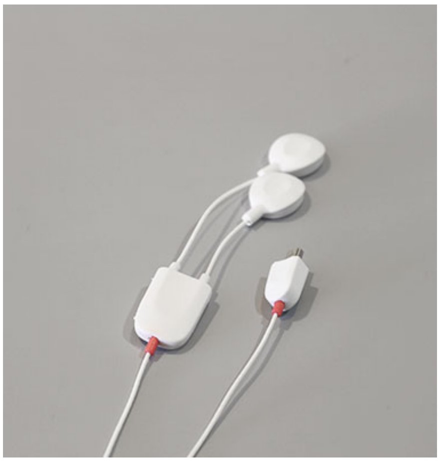
Psychophysiological data were obtained using Bioplux sensors and Opensignals software.

Hardware
The hardware elements for physiological measures include, for all three groups:

ECG

EDA

2 EMG



HUB

-BioPlux sensors: ECG, EDA, 2 EMG

Hub specifications:

- Analog Ports:4 generic inputs
- Auxiliary Ports:1 digital I/O + 1 ground
- Resolution: up to 16-bit (per channel)
- Sampling Rate: up to 1000Hz (per channel)
- Communication: Bluetooth Class II
- Range: up to ~10m (extendable)
- Internal Memory: (optional extra)
- Battery Life: ~10h streaming
- Size: 85x54x10mm

-Opensignals software: to record the physiological data

-portable computer: Hp 650; processore I3 2.2 GHZ; Ram 8Gb; HD 500 GB; Graphic card: intel HD; Graphics Sandi Bridge; Graphic accelerator: Intel media accelerator (GMA); Monitor 15.6"; Microsoft Windwos 8

This was used both to record the physiological data in the three groups and to run the technology-enhanced training for EG1 and EG2

To compare the different versions of the training in the three groups, a 3 (Training conditions) between subjects x 2 within subjects (Time, pre and post) design was implemented.

5.2.3 PROCEDURE

Before starting the study, a meeting was organized with each class, of each school, to give a general explanation about how the study would be carried out.

The setting of the session was a classroom, with good internet connection, comfortable temperature, not hot or cold, with the right lighting conditions for the PC monitor, and enough space for the student to move.

(a) Participants in experimental groups (EG1-Written and EG2-Assistant) followed this protocol:

1-The student arrives at the school room, sits on a chair at the table with the computer ready.

2-He/She receives a paper with a general explanation of what he/she will do during the next hour.

3-The link with the pre treatment questionnaires is opened. The student is asked to put a code (first 3 letters of his/her name and first 3 letters of surname) and he/she is asked to remember it, because it will be the same for the post treatment questionnaires and for the game, in order to collect all the data together.

4-The student fulfils the questionnaires.

5-The researcher explains that now he/she will wear the sensors, they will check if they works and then, the researcher will sit on a chair, next to the door, only at the beginning, to see that everything is working correctly, then she will go out and she will come back after some exercises. She will be outside, in case the student need any help.

In fact, always at the same point, before Active Shaking Meditation exercise in session 2, the researcher goes outside and come back after the Progressive Muscle Relaxation exercise.

6-The researcher asks to the students if he/she is left-handed, in order to know on which side to put the sensors.

7-The sensors are put on the student, explaining him/her what each of them will measure and that he will be able to see only the heart rate, even if all the data are recorded.

Also, the researcher explains that they are connected with the pc via Bluetooth, so he/she can't move too far from it and all the wi-fi connections and mobile phones need to be closet to avoid any interference.

8-The sensors are connected to the computer, opening Opensignal software. The researcher checks that they are working correctly.

9-The application is open and the student is asked to put again his/her code

10- The students click on “play” and starts the training. First he/she will watch the baseline video. Once the baseline video is finished, the training itself will start. The researcher moves back, and after she goes outside of the room.

11-The researcher comes back after PMR exercise, in order to check that everything is ok and then, to save the physiological data and to open the link for the post treatment questionnaires.

12-The sensors is turn off and the EDA, positioned on the hand, is removed in order not to disturb the student during the questionnaires.

13-The link is opened and the students fulfils the post treatment questionnaires.

14-The researcher removes all the sensors and she thanks the students for his/her contribution.

(b) Participants in the control group (CG-Traditional) followed this protocol:

1-The student arrives at the school room, sit on a chair at the table with the computer ready.

2-He/She receives a paper with a general explanation of what he/she will do during the next hour.

3-The link with the pre treatment questionnaires is opened. The student is asked to put a code (first 3 letters of his/her name and first 3 letters of surname) and he/she is asked to remember it, because it will be the same for the post treatment questionnaires, in order to collect all the data together.

4-The student fulfils the questionnaires

5-The researcher explains that now he/she will wear the sensors, they will check if they works and then, the researcher will go on the back for some minutes, while he/she will watch the video.

6-The researcher asks to the students if he/she is left-handed, in order to know on which side to put the sensors.

7-The sensors are put on the student.

Also, the researcher explains that they are connected with the pc via Bluetooth, so he/she can't move too far from it and all the wi-fi connections and mobile phones need to be closed to avoid any interference.

8-The sensors are connected to the computer, opening Opensignal software. The researcher checks that they are working correctly.

9-The application, written version with skip button, is opened and the student is asked to put again his/her code

10-The student clicks on “start” and starts to watch the baseline video. The researcher goes on the back.

11-Once the baseline video is finished, the students starts the traditional training with the researcher.

The researcher uses the computer, the written version, in order to respect exactly the same time as for the 2 other versions and in order to collect the physiological data exactly in the same way.

An introduction is done, following the session 1 of the technological version, avoiding the specific features of the technological versions (points, background etc.)

Instead of choosing his/her own avatar, the user is asked to choose the printed image of male/female avatar, to introduce himself/herself, giving also a name, as for the 2 other versions.

Then, the session two starts, doing every exercise exactly in the same way, but with printed images, markers and a box.

At the same time, the researcher click on the pc version, doing the same that the user does, in order to save automatically every info.

The researcher also, shows to the user how to do the exercises, doing them with him/her, replacing the role of the avatar.

As for the 2 experimental condition, the researcher goes outside the room during the Active Shacking Meditation, but in this case, she comes back immediately as this finishes, to continue the training with the subject.

11-At the end, the researcher saves the physiological data and open the link for the post treatment questionnaires.
12-The sensors is turn off and the EDA, positioned on the hand, is removed in order not to disturb the student during the questionnaires.
13-The link is opened and the students fulfils the post treatment questionnaires.
14-The researcher removes all the sensors and she thanks the students for his/her contribution.

5.3 Results

5.3.1 Overview of statistical analyses

To test the hypotheses advanced, the following statistical analyses have been performed and several assumptions were met to use each one of these techniques:

First of all, to test *Hp.1,* if there are differences between the three groups *(Hp.1)* (EG1-Written; EG2-Assistant; CG-Traditional) a repeated measures analysis of variance (ANOVA) was run to analyze the changes before and after the protocol. A two-sided P value of .05 or less was considered to be statistically significant. The two experimental groups and the control group were simultaneously taken into the analysis of variance model for repeated measures. Differential effects of the treatments were determined using post-hoc analyses. In particular, to reduce the risk of type I errors, we used the Bonferroni post-hoc procedure.
Then a Paired Samples T Test was run to better explore in which groups there were some differences, as emerged by the ANOVA.
To test the *Hp. 2,* if there is a significant difference between the 3 groups as for the level of engagement, a One Way Anova was run.
While to test *Hp.4,* if there is a significant difference between Experimental Group 1 (EG1) and Experimental Group 2 (EG2) as for the usability, an Indipendent T-Test was run.
To test *Hp.3,* if the level of engagement influences the post treatment scores in the three groups it were run a Hierarchical Regression for the total FSS and a Partial Correlation for the 9 single dimensions, in order to control the pre treatment scores as well as with the regression.
Also to test *Hp. 4,* if the level of usability predict the post treatment scores in EG1 and in EG2, a Hierarchical Regression was run.

To test *Hp. 5*, if the perception of the Avatar-assistant will influence the posttreatment results in EG2, it was run a Partial Correlation on the 5 dimensions of the GSQ (Weiss & Bartneck, 2015), in order to control the pre treatment scores as well as with the regression.

Also a Bivariate Correlation was run to explore if there are significant correlations between how the Avatar-assistant is perceived and the engagement (FSS) and the usability (SUS).

Finally to test *Hp. 6*, if there are significant correlations between the scales used for EG2 to measure how the Avatar-assistant is perceived (GSQ and The Niewiadomski scale) and between each dimensions, a Bivariate Correlation was run.

As for physiological measures, to test *Hp.7* if there is a higher number of EDA peaks and a higher Muscle activation in group 2 for the whole session and in particolar during Active Shaking Meditation and Progressive Muscle Relaxation exercises, a One Way ANOVA was run with all the three groups.

Then to test *Hp.8*, if there is a significant decreament of Heart rate and EDA after the sessions in all the three groups, with a higher difference pre-post treatment in group 2, a series of Repeated Measure Anova were run.

5.3.2 Preliminary processing of data

Preliminary data processing included calculation of the total scores, of descriptive statistics for single items of each scales, age, gender, and the total score of each scale (See Table 1. a,b,c,d,e). No problem of distribution emerged and the sample size for each group was big enough to run all of the desired analyses while respecting all the required assumption. To avoid any doubt, each analysis was also run using the Bootstrap method and the same results were obtained (For details see: Bollen & Stine, 1990; Lockwood & MacKinnon, 1998; MacKinnon et al., 2004; Preacher & Hayes, 2004, 2008; Shrout & Bolger, 2002)..

Table 1. a, b, c, d, e, f - Descriptive statistics: Mean and standard deviation

1.a

Group	Gender	Age
1 EG (n=29)	14m; 15f	15,83 (.805)
2 EG(n=39)	21m; 18f	16,10 (1.20)
3 CG (n=32)	15m; 17f	15,78 (1.33)

1.b

Group	STAI_Pre	STAI_Post	PANASpos_Pre	PANASpos_Post	PANASneg_PRE	PANASneg_POST
1 EG	39,86 (7.94)	32,69 (8.29)	30,55 (5.99)	32,41 (7.86)	16,41 (4.26)	12,97 (3.30)
2 EG	38,74 (8.69)	33,23 (7.64)	32,74 (7.02)	32,13 (7.92)	16,79 (5.28)	14,21 (4.87)
3 CG	37,78 (8.90)	31,97 (8.17)	31,69 (6.50)	31,22 (7.81)	15,38 (4.11)	13,53 (3.63)

1.c

Group	VASanxiety_Pre	VASanxiety_Post	VAScalm_Pre	VAScalm_Post	SUS	FSS tot
1 EG	43,10 (19.10	27,59 (16,61)	68,28 (17.74)	72,07 (23.35)	70,34 (11.56)	123,10 (20.73)
2 EG	40,51 (21.02)	25,90 (13.32)	65,38 (24.37)	79,23 (19.65)	73,40 (13.19)	122,79 (14.74)
3 CG	41,88 (20.85)	23,75 (16.99)	68,75 (21.06)	72,50 (28.62)	-	127,35 (17.18)

1.d

Group - FSS 9 dimensions	D1 Challenge skill Balance	D2 Action awareness merging	D3 Clear goals	D4 Unambiguous feedback	D5 Concentration on Task at Hand	D6 Sense of Control	D7 Loss of Self Consciousness	D8 Transformation Of Time	D9 Autotelic experience
1 EG	14,28 (2.82)	14,00 (3.21)	13,24 (4.14)	12,34 (3.69)	16,10 (3.14)	15,69 (2.84)	13,14 (3.31)	11,55 (3.43)	12,76 (3.30)
2 EG	15,05 (2.18)	14,38 (2.56)	12,15 (4.04)	12,21 (3.60)	14,62 (2.97)	15,49 (2.23)	14,10 (3.89)	12,08 (3.88)	12,72 (3.73)
3 CG	14,03 (2.70)	14,19 (3.40)	13,50 (3.94)	12,84 (3.23)	15,81 (3.14)	16,38 (2.81)	14,61 (4.07)	12,22 (3.82)	13,53 (3.99)

1.e

EG2 - GSQ 5 dimensions	D1 Antropophormism	D2 Animation	D3 Likeability	D4 PerceivedIntelligent	D5 PerceivedSafety
EG 2	14,95 (3.37)	18,36 (3.65)	17,64 (4.32)	20,62 (3.32)	12,77 (2.70)

1.f

EG2 - Niewiadomski et al. 3 scales	Competence	Warmth	Believability
EG 2	5,69 (1,055)	4,77 (1,441)	5,18 (1,485)

1.g. SUS- Cut Off- Experimental group 1 vs Experimental group 2

Valid Percent	EG 1	EG2
1 (<68)	39,3%	26,3%
2 (>68)	60,7%	73,7%

5.3.3 Comparability at baseline

Before starting the analyses the comparability at the baseline between the three groups was assessed through One Way ANOVA, with Group as factor and Age, pre VAS anxiety, pre VAS calm, pre STAI, pre PANAS pos and pre PANAS neg as dependent variables.
No significant difference was found for Age, STAI, VAS Anxiety, VAS Calm, PANAS positive and PANAS negative (See Table 2).
Also a Cross-tabulation was run for Gender highlighting that on the total sample, males are 50,0% and females are 50,0%. See table 3 for each group percentage.

Table 2. One Way ANOVA between the 3 groups on Age and Pre-Treatment Scores of Psychometric questionnaires

Variable	**F**	**P**
Age	.812	.447
STAI	.451	.639
VAS Anxiety	.135	.874
VAS Calm	.256	.775
PANAS pos	.928	.399
PANAS neg	.852	.430

Table 3. Cross-tabulation for Gender (1=Male; 2=Female)

Gender * Group Crosstabulation						
			1=EG1-Written 2=EG2-Assistant 3=CG-Traditional			Total
			1	2	3	
1=Male; 2=Female	1	Count	14	21	15	50
		% within 1=Male; 2=Female	28,0%	42,0%	30,0%	100,0%
		% within 1=Written; 2=Assistant; 3=Traditional	48,3%	53,8%	46,9%	50,0%
		% of Total	14,0%	21,0%	15,0%	50,0%
	2	Count	15	18	17	50
		% within 1=Male; 2=Female	30,0%	36,0%	34,0%	100,0%
		% within 1=Written; 2=Assistant; 3=Traditional	51,7%	46,2%	53,1%	50,0%
		% of Total	15,0%	18,0%	17,0%	50,0%

5.3.4 Self-report measures results

To explore if there are significant differences between the 3 groups in the post treatment scores as for state anxiety, calm and anxiety levels, positive and negative affects *(Hp.1)* a Repeated Measure ANOVA was run (See Table 4)

The analysis on the state level of anxiety (STAI) revealed a significant TIME effect ($F_{1,97}$= 70.76; p<.001; effect size = 0.42) , but no significant differences in TIME x GROUP effect.

The analysis on the calm level (VAS calm) revealed a significant TIME effect ($F_{1,97}$= 8.96; p<.01; effect size = 0.085), but no significant differences in TIME x GROUP effect. The same results were found for anxiety level (VAS anxiety) (TIME effect: $F_{1,97}$= 84.74; p<.001; effect size = 0.466).

As for positive affects (PANAS pos) no significant effect was found, while for negative affect (PANAS neg) a TIME effect was revealed ($F_{1,97}$= 38.95; p<.01; effect size = 0.287), but no significant effect of TIME x GROUP.

Since no significant difference was found between group, but it emerged a significant TIME effect, a Paired Samples T Test was run to better understand in which groups there were some differences.

Per each questionnaire a Paired Sample T-test was run revealing (See Table 5.a, 5.b): in EG1 a significant correlation for each one of the questionnaire between pre and post treatment score was revealed then, with a 2-Tailed Sign, it was found a significant mean difference for VAS anxiety ($t_{(28)}$ = -5,56; p<.001), for STAI ($t_{(28)}$ = -5,23; p<.001), and for PANAS negative ($t_{(28)}$ = -5,03; p<.001), while no significant mean differences was found for VAS calm and for PANAS positive.

In EG2 a significant correlation for each one of the questionnaire between pre and post treatment score was revealed, (See Table 4), then, with a 2-Tailed Sign, it was found a significant mean difference for VAS anxiety ($t_{(38)}$ = -5,94; p<.001), for STAI ($t_{(38)}$ = -4,92; p<.001), and for PANAS negative ($t_{(38)}$ = -4,06; p<.001), but in this group for VAS calm too ($t_{(38)}$ = -4,36; p<.001), while no significant mean differences was found for PANAS positive, as in EG1.

In the CG it was found a significant correlation between pre and post treatment score only for VAS anxiety, STAI and PANAS positive (See Table 4), then, with a 2-Tailed Sign, it was found a significant mean difference for VAS anxiety ($t_{(31)}$ = -4,84; p<.001), for STAI ($t_{(31)}$ = -4,37; p<.001), and for PANAS negative ($t_{(31)}$ = -2,17; p<.05), while no significant mean differences was found for VAS calm and for PANAS positive, as for EG1.

According to the initial hypothesis (Hp.1), a significant difference in self-report measures post training was found in all the three groups, even if no significant difference was found between the groups; in particular stait anxiety and anxiety perceived decrement are significant in all the three groups, negative affect decrement is significant only in EG1 and EG2, but not in CG, while positive affect isn't significant in any group and calm perceived is significant only in EG2.

These results partally confirm Hp.1, revealing that all the three groups were effective in anxiety decrement, but only EG2-Assistant allowed to perceive a significant calm difference post training, but no one has raised a positive higher affect (for a summary see Table 5.b).

Table 4. Repeated Measure ANOVA, Pre and Post session, TIME

Variable	F	P	Partial Eta Squared
VAS Anxiety	70.76	***	.42
VAS Calm	8.96	**	.081
STAI	84.74	***	.466
PANAS pos	-	-	-
PANAS neg	38.95	**	.287

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 5.A. Paired Samples Correlations

Pair (Pre & Post)	EG1-Written	EG2-Assistant	CG-Traditional
VAS Anxiety	r=,654 ***	r=,684 ***	r=,389*
VAS Calm	r=,543 **	r=,613 ***	n.s.
STAI	r=,588 **	r=,640 ***	r=,616***
PANAS pos	r=,668 ***	r=,882 ***	r=,671***
PANAS neg	r=,549 **	r=,696 ***	n.s.

* Correlation is significant at .05 level; ** Correlation is significant at .01 level; *** Correlation is significant at .001 level

Table 5.B. Summary of Paired Samples test: Mean difference and Significance level

Pair (Pre & Post)	EG1-Written	EG2-Assistant	CG-Traditional
VAS Anxiety	-15,517***	-14.615***	-18,125***
VAS Calm	n.s.	13,846***	n.s.
STAI	-7,172***	-5,513***	-5,813***
PANAS pos	n.s.	n.s.	n.s.
PANAS neg	-3,448***	-2,590***	n.s.

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

To test hypothesis 2, a One Way Anova was run, but no significant difference emerged between the 3 groups as for the level of engagement. Both the total score and each one of the 9 dimensions were considered (See table 6).

Hp.2 wasn't confirmed, also, looking at Table 1.c and 1.d (Pag.118) we can notice that all the three groups have similar value in each of the 9 dimensions and on the total score, but, even if not significantly different, CG has a little higher result, and we could assume that this may be due to the presence of a real-human trainer, but deeper exploration should be done.

Table 6. One Way Anova between the 3 groups on FSS total and 9 dimensions

Variable	F	P
FSS tot	,690	,504
D1 Challenge skill Balance	1,559	,216
D2 Action awareness merging	,134	,875
D3 Clear goals	1,119	,331
D4 Unambiguous feedback	,308	,736
D5 Concentration on Task at Hand	2,303	,105
D6 Sense of Control	1,078	,344
D7 Loss of Self Consciousness	1,167	,316
D8 Transformation Of Time	,268	,766
D9 Autotelic experience	,504	,606

Then it was explored if the level of engagement predict the post treatment results in the three groups as for state anxiety, calm and anxiety levels, positive and negative affects (Hp.3). For the total FSS score it was run a hierarchical regression per each questionnaire for each group, and the pre treatment score was inserted in model 2, while the total FSS was inserted in model 1, in order to see the influence of the engagement itself too. The results will be now presented divided per questionnaire, that's to say analyzing each group on the same questionnaire (See Table 7 a, b for a summary).

As for STAI:

In the EG1 the final model explains 60,6% of the variance of the post training stait anxiety (STAI) (Adjusted R^2= ,606) and at every step the increment of R^2 was statistically significant (See Table Model Summary-1A). Altogether, all predictors are statistically significant (see Table Coefficients-1A). In particular, the engagement in Model 1 negatively predicts the 64,9% of the post score, in Model 2, it negatively predicts the 66,4%, while the pre training score positively predicts the 60,7% of the post score of stait anxiety.

Table. Model Summary-1A. FSS-STAI, Experimental Group 1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	,649[a]	,421	,399	6,432	,421	19,604	1	27	,000
2	,796[b]	,634	,606	5,208	,214	15,181	1	26	,001

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOT_PRE_STAI

c. Dependent Variable: TOT_POST_STAI

Table. Coefficients-1A. FSS-STAI, Experimental Group 1-Written

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	64,651	7,317		8,836	,000	49,638	79,664					
	TOT_FSS	-,260	,059	-,649	-4,428	,000	-,380	-,139	-,649	-,649	-,649	1,000	1,000
2	(Constant)	40,045	8,659		4,625	,000	22,246	57,844					
	TOT_FSS	-,220	,049	-,549	-4,524	,000	-,320	-,120	-,649	-,664	-,537	,956	1,047
	TOT_PRE_STAI	,494	,127	,473	3,896	,001	,233	,755	,588	,607	,462	,956	1,047

a. Dependent Variable: TOT_POST_STAI

In the EG2 the final model explains 41,8% of the variance of the post training stait anxiety (STAI) (Adjusted R^2= ,418) and only Model 2 is statistically significant (See Table Model Summary-1B). In particular, the engagement doesn't predicts the post score, while the pre training score positively predicts the 63,6% of the post score of stait anxiety (see Table Coefficients-1B).

Table. Model Summary-1B. FSS-STAI, Experimental Group 2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,273[a]	,075	,050	7,456	,075	2,982	1	37	,093
2	,670[b]	,449	,418	5,835	,374	24,429	1	36	,000

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOT_PRE_STAI

c. Dependent Variable: TOT_POST_STAI

Table. Coefficients-1B. FSS-STAI, Experimental Group 2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	50,630	10,146		4,990	,000	30,072	71,188					
	TOT_FSS	-,142	,082	-,273	-1,727	,093	-,308	,025	-,273	-,273	-,273	1,000	1,000
2	(Constant)	24,886	9,495		2,621	,013	5,629	44,143					
	TOT_FSS	-,103	,065	-,199	-1,594	,120	-,234	,028	-,273	-,257	-,197	,985	1,015
	TOT_PRE_STAI	,542	,110	,616	4,943	,000	,320	,765	,640	,636	,612	,985	1,015

a. Dependent Variable: TOT_POST_STAI

In the CG the final model explains 48,2% of the variance of the post training stait anxiety (STAI) (Adjusted R2= ,482) and at every step the increment of R2 was statistically significant (See Table Model Summary-1C). Altogether, all predictors are statistically significant (see Table Coefficients-1C). In particular, the engagement in Model 1 negatively predicts the 57,4% of the post score, in Model 2, it negatively predicts the 37,1%, while the pre training score positively predicts the 52,8% of the post score of stait anxiety.

Table. Model Summary-1C. FSS-STAI, Control Group- Traditional

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,574[a]	,330	,307	6,810	,330	14,261	1	29	,001
2	,719[b]	,517	,482	5,885	,187	10,824	1	28	,003

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOT_PRE_STAI

c. Dependent Variable: TOT_POST_STAI

Table. Coefficients-1C. FSS-STAI, Control Group -Traditional

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	66,772	9,297		7,182	,000	47,758	85,786					
	TOT_FSS	-,273	,072	-,574	-3,776	,001	-,421	-,125	-,574	-,574	-,574	1,000	1,000
2	(Constant)	40,034	11,428		3,503	,002	16,623	63,444					
	TOT_FSS	-,190	,067	-,400	-2,823	,009	-,328	-,052	-,574	-,471	-,371	,860	1,162
	TOT_PRE_STAI	,428	,130	,466	3,290	,003	,162	,695	,616	,528	,432	,860	1,162

a. Dependent Variable: TOT_POST_STAI

As for VAS anxiety:

In the EG1 the final model explains 50,6% of the variance of the post training anxiety perceived (VAS anxiety) (Adjusted R^2= ,506) and only Model 2 is statistically significant (See Table Model Summary-2A). In particular, only in Model 2 the engagement negatively predicts the 44,5% of post score, while the pre training score positively predicts the 69,4% of the post score of anxiety perceived. (see Table Coefficients-2A).

Table. Model Summary-2A. FSS-VAS anxiety, Experimental Group1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	Change Statistics F Change	Change Statistics df1	Change Statistics df2	Change Statistics Sig. F Change
1	,338[a]	,114	,082	15,924	,114	3,489	1	27	,073
2	,736[b]	,542	,506	11,676	,427	24,222	1	26	,000

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, PREVAS_ANXIETY_RI

c. Dependent Variable: POSTVAS_ANXIETY_RI

Table. Coefficients-2A. FSS-VAS anxiety, Experimental Group 1-Written

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	60,967	18,113		3,366	,002	23,801	98,132					
	TOT_FSS	-,271	,145	-,338	-1,868	,073	-,569	,027	-,338	-,338	-,338	1,000	1,000
2	(Constant)	36,297	14,196		2,557	,017	7,117	65,476					
	TOT_FSS	-,270	,106	-,337	-2,535	,018	-,489	-,051	-,338	-,445	-,337	1,000	1,000
	PREVAS_ANXIETY_RI	,568	,115	,654	4,922	,000	,331	,806	,654	,694	,654	1,000	1,000

a. Dependent Variable: POSTVAS_ANXIETY_RI

In the EG2 the final model explains 47,3% of the variance of the post training anxiety perceived (VAS anxiety) (Adjusted R2= ,473) and only Model 2 is statistically significant (See Table Model Summary-2B). In particular, the engagement doesn't predicts the post score, while the pre training score positively predicts the 69,2% of the post score. (see Table Coefficients-2B).

Table. Model Summary-2B. FSS-VAS anxiety, Experimental Group 2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,204[a]	,042	,016	13,216	,042	1,608	1	37	,213
2	,708[b]	,501	,473	9,667	,460	33,163	1	36	,000

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, PREVAS_ANXIETY_RI

c. Dependent Variable: POSTVAS_ANXIETY_RI

Table. Coefficients-2B. FSS-VAS anxiety, Experimental Group 2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	48,540	17,983		2,699	,010	12,103	84,978					
	TOT_FSS	-,184	,145	-,204	-1,268	,213	-,479	,110	-,204	-,204	-,204	1,000	1,000
2	(Constant)	28,595	13,602		2,102	,043	1,010	56,181					
	TOT_FSS	-,164	,106	-,181	-1,539	,133	-,380	,052	-,204	-,248	-,181	,999	1,001
	PREVAS_ANXIETY_RI	,430	,075	,678	5,759	,000	,278	,581	,684	,692	,678	,999	1,001

a. Dependent Variable: POSTVAS_ANXIETY_RI

In the CG both the two models aren't statistically significant (See Table Model Summary-2C), revealing that probably only the pre training score predicts the result, as we can deduce by the significant mean difference in the pre-post score with the Paired Samples Test (See Table 5 pag.122) and as it was confirmed by a Standard Regression with only pre score as independent variable (*ß*= ,389; *t*(31)= 2,313; p < .05, Partial correlation=,389).

Table. Model Summary-2C. FSS-VAS anxiety, Control Group-Traditional

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,341[a]	,116	,086	16,247	,116	3,814	1	29	,061
2	,433[b]	,187	,129	15,856	,071	2,446	1	28	,129

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, PREVAS_ANXIETY_RI

c. Dependent Variable: POSTVAS_ANXIETY_RI

As for VAS calm:

In the EG1 the final model explains 26,6% of the variance of the post training calm perceived (VAS calm) (Adjusted R2= ,266) and only Model 2 is statistically significant (See Table Model Summary-3A). In particolar, the engagement doesn't predicts the post score, while the pre training score positively predicts the 53,4% of the post score. (see Table Coefficients-3A).

Table. Model Summary-3A. FSS-VAS calm, Experimental Group1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,213[a]	,046	,010	23,238	,046	1,289	1	27	,266
2	,564[b]	,318	,266	20,015	,273	10,397	1	26	,003

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, PREVAS_CALM_RI

c. Dependent Variable: POSTVAS_CALM_RI

Table. Coefficients-3A. FSS-VAS calm,Experimental Group1-Written

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	42,463	26,433		1,606	,120	-11,773	96,700					
	TOT_FSS	,240	,212	,213	1,135	,266	-,194	,675	,213	,213	,213	1,000	1,000
2	(Constant)	3,607	25,759		,140	,890	-49,342	56,556					
	TOT_FSS	,172	,184	,153	,938	,357	-,205	,550	,213	,181	,152	,987	1,013
	PREVAS_CALM_RI	,692	,215	,526	3,224	,003	,251	1,133	,543	,534	,522	,987	1,013

a. Dependent Variable: POSTVAS_CALM_RI

In the EG2 the final model explains 35,7% of the variance of the post training calm perceived (VAS calm) (Adjusted R2= ,357) and only Model 2 is statistically significant (See Table Model Summary-3B). In particolar, the engagement doesn't predicts the post score, while the pre training score positively predicts the 60,8% of the post score. (see Table Coefficients-3B).

Table. Model Summary-3B. FSS-VAS calm,Experimental Group2-Assistantl

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,146[a]	,021	-,005	19,704	,021	,802	1	37	,376
2	,625[b]	,391	,357	15,758	,370	21,853	1	36	,000

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, PREVAS_CALM_RI

c. Dependent Variable: POSTVAS_CALM_RI

Table. Coefficients-3B. FSS-VAS calm,Experimental Group2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	55,383	26,811		2,066	,046	1,058	109,708					
	TOT_FSS	,194	,217	,146	,896	,376	-,245	,634	,146	,146	,146	1,000	1,000
2	(Constant)	27,188	22,274		1,221	,230	-17,986	72,361					
	TOT_FSS	,163	,174	,122	,937	,355	-,189	,514	,146	,154	,122	,998	1,002
	PREVAS_CALM_RI	,491	,105	,609	4,675	,000	,278	,704	,613	,615	,608	,998	1,002

a. Dependent Variable: POSTVAS_CALM_RI

In the CG both the two models aren't statistically significant (See Table Model Summary-3C), in fact also no significant difference emerged in the pre-post score with the Paired Samples Test (See Table 5 pag.122).

Table. Model Summary-3C. FSS-VAS calm,Control Group-Traditional

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	,107[a]	,012	-,023	28,945	,012	,339	1	29	,565
2	,315[b]	,099	,035	28,121	,088	2,724	1	28	,110

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, PREVAS_CALM_RI

c. Dependent Variable: POSTVAS_CALM_RI

As for PANAS neg:

In the EG1 the final model explains 42,8% of the variance of the post training negative affect (PANAS neg) (Adjusted $R2$=,428) and at every step the increament of $R2$ was statistacally significant (See Table Model Summary-4A). Altogether, all predictors are statistically significant (see Table Coefficients-4A). In particolar, the engagement in Model 1 negatively predicts the 40,2% of the post score, in Model 2, it negatively predicts the 40,9%, while the pre training score positively predicts the 55,4% of the post score of negative affect.

Table. Model Summary-4A. FSS-PANAS neg ,Experimental Group1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	,402[a]	,162	,130	3,077	,162	5,201	1	27	,031
2	,685[b]	,469	,428	2,496	,307	15,039	1	26	,001

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOTPRE_PANAS_NEG

c. Dependent Variable: TOTPOST_PANAS_NEG

Table. Coefficients-4A. FSS-PANAS neg ,Experimental Group1-Written

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	20,842	3,501		5,954	,000	13,660	28,025					
	TOT_FSS	-,064	,028	-,402	-2,281	,031	-,122	-,006	-,402	-,402	-,402	1,000	1,000
2	(Constant)	13,934	3,352		4,157	,000	7,044	20,824					
	TOT_FSS	-,065	,023	-,409	-2,860	,008	-,112	-,018	-,402	-,489	-,409	1,000	1,000
	TOTPRE_PANAS_NEG	,429	,111	,554	3,878	,001	,202	,657	,549	,605	,554	1,000	1,000

a. Dependent Variable: TOTPOST_PANAS_NEG

In the EG2 the final model explains 51,6% of the variance of the post training negative affect (PANAS neg) (Adjusted R2= ,516) and only Model 2 is statistacally significant (See Table Model Summary-4B). In particolar, the engagement in Model 1 (see Table Coefficients-4B) doesn't predict the post score, while in Model 2, it negatively predicts the 33,1% and the pre training score ppositively predicts the 70,4% of the post score of negative affect.

Table. Model Summary-4B. FSS-PANAS neg ,Experimental Group2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	Change Statistics F Change	Change Statistics df1	Change Statistics df2	Change Statistics Sig. F Change
1	,302[a]	,091	,067	4,712	,091	3,723	1	37	,061
2	,736[b]	,541	,516	3,395	,450	35,309	1	36	,000

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOTPRE_PANAS_NEG

c. Dependent Variable: TOTPOST_PANAS_NEG

Table. Coefficients-4B. FSS-PANAS neg ,Experimental Group2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	26,492	6,412		4,132	,000	13,500	39,485					
	TOT_FSS	-,100	,052	-,302	-1,930	,061	-,205	,005	-,302	-,302	-,302	1,000	1,000
2	(Constant)	13,448	5,114		2,630	,012	3,077	23,820					
	TOT_FSS	-,079	,038	-,238	-2,102	,043	-,155	-,003	-,302	-,331	-,237	,991	1,009
	TOTPRE_PANAS_NEG	,622	,105	,674	5,942	,000	,409	,834	,696	,704	,671	,991	1,009

a. Dependent Variable: TOTPOST_PANAS_NEG

In the CG both the two models aren't statistically significant (See Table Model Summary-4C), in fact also no significant difference emerged in the pre-post score with the Paired Samples Test (See Table 5 pag.122).

Table. Model Summary-4C. FSS-PANAS neg,Control Group-Traditional

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,318[a]	,101	,070	3,507	,101	3,255	1	29	,082
2	,396[b]	,157	,096	3,457	,056	1,847	1	28	,185

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOTPRE_PANAS_NEG

c. Dependent Variable: TOTPOST_PANAS_NEG

As for PANAS pos:

In the EG1 the final model explains 56,0% of the variance of the post training positive affect (PANAS pos) (Adjusted R_2=,560) and at every step the increament of R_2 was statistacally significant (See Table Model Summary-5A). Altogether, all predictors are statistically significant (see Table Coefficients-5A). In particolar, the engagement in Model 1 positively predicts the 72,3% of the post score, in Model 2, it positively predicts the 51,3%, while the pre training score positively predicts the 37,8% of the post score of positive affect.

Table. Model Summary-5A. FSS-PANAS pos,Experimental Group1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,723[a]	,523	,506	5,531	,523	29,653	1	27	,000
2	,769[b]	,591	,560	5,218	,068	4,333	1	26	,047

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOTPRE_PANAS_POS

c. Dependent Variable: TOTPOST_PANAS_POS

Table. Coefficients-5A. FSS-PANAS pos,Experimental Group1-Written

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-1,386	6,291		-,220	,827	-14,295	11,523					
	TOT_FSS	,275	,050	,723	5,445	,000	,171	,378	,723	,723	,723	1,000	1,000
2	(Constant)	-4,752	6,152		-,772	,447	-17,397	7,894					
	TOT_FSS	,190	,062	,501	3,044	,005	,062	,319	,723	,513	,382	,579	1,726
	TOTPRE_PANAS_POS	,450	,216	,343	2,082	,047	,006	,895	,668	,378	,261	,579	1,726

a. Dependent Variable: TOTPOST_PANAS_POS

In the EG2 the final model explains 76,7% of the variance of the post training postive affect (PANAS pos) (Adjusted R2= ,767) and at every step the increament of R2 was statistacally significant (See Table Model Summary-5B). In particolar, the engagement in Model 1 (see Table Coefficients-5B) positevely predicts the 53,6% of the post score, while in Model 2, engagement isn't significant and the pre training score positively predicts the 83,0% of the post score of positive affect.

Table. Model Summary-5B. FSS-PANAS pos,Experimental Group2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,536[a]	,287	,268	6,776	,287	14,925	1	37	,000
2	,883[b]	,779	,767	3,827	,491	80,020	1	36	,000

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOTPRE_PANAS_POS

c. Dependent Variable: TOTPOST_PANAS_POS

Table. Coefficients-5B. FSS-PANAS pos,Experimental Group2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-3,246	9,221		-,352	,727	-21,929	15,437					
	TOT_FSS	,288	,075	,536	3,863	,000	,137	,439	,536	,536	,536	1,000	1,000
2	(Constant)	-2,633	5,208		-,506	,616	-13,195	7,928					
	TOT_FSS	,027	,051	,050	,520	,606	-,077	,131	,536	,086	,041	,675	1,482
	TOTPRE_PANAS_POS	,962	,108	,853	8,945	,000	,744	1,180	,882	,830	,701	,675	1,482

a. Dependent Variable: TOTPOST_PANAS_POS

In the CG the final model explains 42,9% of the variance of the post training positive affect (PANAS pos) (Adjusted R_2=,429) and at every step the increament of R_2 was statistacally significant (See Table Model Summary-5C). Altogether, all predictors are statistically significant (see Table Coefficients-5C). In particolar, the engagement in Model 1 positively predicts the 41,6% of the post score, while in Model 2, it positively predicts the 17,7%, while the pre training score positively predicts the 59,6% of the post score of positive affect.

Table. Model Summary-5C. FSS-PANAS pos,Control Group-Traditional

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,416[a]	,173	,144	7,234	,173	6,053	1	29	,020
2	,683[b]	,467	,429	5,909	,294	15,461	1	28	,001

a. Predictors: (Constant), TOT_FSS

b. Predictors: (Constant), TOT_FSS, TOTPRE_PANAS_POS

c. Dependent Variable: TOTPOST_PANAS_POS

Table. Coefficients-5C. FSS-PANAS pos,Control Group-Traditional

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	7,133	9,876		,722	,476	-13,066	27,332					
	TOT_FSS	,189	,077	,416	2,460	,020	,032	,346	,416	,416	,416	1,000	1,000
2	(Constant)	-,341	8,288		-,041	,967	-17,319	16,637					
	TOT_FSS	,067	,070	,146	,950	,350	-,077	,210	,416	,177	,131	,802	1,246
	TOTPRE_PANAS_POS	,728	,185	,606	3,932	,001	,349	1,108	,671	,596	,543	,802	1,246

a. Dependent Variable: TOTPOST_PANAS_POS

Table 7.a- Summary-Hierarchical Regression- MODEL 1_FSS-POST QUESTIONNAIRES, Partial Correlation %

Dependent variable	**EG1-Written**	% FSS	**EG2-Assistant**	% FSS	**CG-Traditional**	% FSS
STAI	***	-64,9	n.s.	-	***	-57,4
VAS anxiety	n.s.	-	n.s.	-	n.s.	-
VAS calm	n.s.	-	n.s.	-	n.s.	-
PANAS neg	*	-49,2	n.s.	-	n.s.	-
PANAS pos	***	72,3	***	53,6	***	41,6

*Signifiant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 7.b- Summary-Hierarchical Regression- MODEL 2_FSS+PRE SCORE--POST QUESTIONNAIRES, Partial Correlation %

Dependent variable	**EG1-Written**	% FSS	% PRE score	**EG2-Assistant**	% FSS	% PRE score	**CG-Traditional**	% FSS	% PRE Score
STAI	***	-53,7	63,6	***.	-25,7	63,6	**	-47,1	52,8
VAS anxiety	***	-44,5	65,4	***	n.s.	69,2	n.s.	-	-
VAS calm	**	n.s.	53,4	***	n.s.	61,5	n.s.	-	-
PANAS neg	***	-48,9	60,5	***	-33,1	70,4	n.s.	-	-
PANAS pos	*	51,3	37,8	***	n.s.	83,0	***	17,7	59,6

*Signifiant at .05 level; ** Significant at .01 level; *** Significant at .001 level

While to test each of the 9 dimensions of FSS a Partial Correlation was run, revealing that stait anxiety (STAI) and negative affect (PANAS neg) are significantly negative influenced by some dimensions in all the three groups, while positive affect (PANAS pos) is significantly positive influenced only in EG1 and in EG2, moreover perceived anxiety (VAS anxiety) is negative influenced only in EG1 and in CG, while perceived calm (VAS calm) is influenced only in EG2. Precise results are reported in table 7c, per each group, considering only the correlations with the pre treatment variable controlled.

Table 7.c. Partial Correaltion FSS 9 dimensions/Post treatment score, per each group, with Pre treatment score controlled

EG1 Written	**D1 Challenge skill Balance**	**D2 Action awareness merging**	**D3 Clear goals**	**D4 Unambiguous feedback**	**D5 Concentration on Task at Hand**	**D6 Sense of Control**	**D7 Loss of Self Consciousness**	**D8 Transformation Of Time**	**D9 Autotelic experience**
STAI	-	-,643 ***	-,512**	-,573***	-,483**	-,431*	-	-,441*	-,561**
VAS Anxiety	-	-,457*	-	-	-	-	-	-	-,485**
VAS Calm	-	-	-	-	-	-	-	-	-
Panas pos	-	-	,487**	-	,390*	,432*	-	-	-
Panas neg	-	-	-,498**	-,409*	-	-	-	-	-,508**

* Correlation is significant at .05 level; ** Correlation is significant at .01 level; *** Correlation is significant at .001 level

EG2 Assistant	**D1 Challenge skill Balance**	**D2 Action awareness merging**	**D3 Clear goals**	**D4 Unambiguous feedback**	**D5 Concentration on Task at Hand**	**D6 Sense of Control**	**D7 Loss of Self Consciousness**	**D8 Transformation Of Time**	**D9 Autotelic experience**
STAI	-	-	-,338*	-	-	-	-	-	-,471**
VAS Anxiety	-	-	-	-	-	-	-	-	-
VAS Calm	-	-	-	-	-	-	-	-	,344*
Panas pos	-	-	,322*	-	-	-	-	-	-
Panas neg					-,352*	-,331*			-,494**

CG Traditional	**D1 Challenge skill Balance**	**D2 Action awareness merging**	**D3 Clear goals**	**D4 Unambiguous feedback**	**D5 Concentration on Task at Hand**	**D6 Sense of Control**	**D7 Loss of Self Consciousness**	**D8 Transformation Of Time**	**D9 Autotelic experience**
STAI	-	-		-	-	-	-	-	-,702***
VAS Anxiety	-	-	-	-	-	-	-	-	-,383*
VAS Calm	-	-	-	-	-	-	-	-	-
Panas pos	-	-	-	-	-	-	-	-	-
Panas neg	-	-	-	-	-	-	-	-,409*	-,509**

Altogheter considered, these analyses partally confirm Hp.3, in fact the Hierarchical Regression revealed an influence of the total score around 50% in all the three groups, but not always on the same variable. Moreover if engagement was considered alone (Model 1) it amerged a very high influence on the positive affect in all the three groups. Also considering the influence of each one of the 9 dimensions, it emerged a significant influence of the engagement in the three groups.
These results show the efficacy of the training itself, but also the important percentage of influence of the engagement on the final outcome, further we can notice that EG1 is the group where the engagement predicts more variables, both considerating the total score and the 9 dimensions individually (See Table 7.a,b,c pag. 138).

To test if there is a significant difference between Experimental Group 1 (EG1) and Experimental Group 2 (EG2) as for the usability (Hp.4), an Indipendent T-Test was run. No significant difference between the two group was revealed ($F_{1,67}$=,987; p=,324).
Moreover it was explored if the level of usability predicts the post treatment results in the two groups as for state anxiety, calm and anxiety levels, positive and negative affects. A hiererchical regression was run per each questionnaire for each group, and the pre treatment score was inserted

in model 2, while the SUS score was inserted in model 1, in order to see also the influence of the usability itself.

Hp.4 wasn't confirm, in fact no significant difference emerged between EG1 and EG2, but we can notice that the average in EG2 is higher then EG1 (See Table 1.c, pag 118) and also that in EG2 the 73,3% of the sample had a score higher then 68 (considered upper then the average) while in EG1 the 60,7%. Further it was analyzed if usability predicts the post training results and it emerged in both the 2 groups a percentage of influence between 40-50 % (See Table 7.1.a and 7.1.b pag138). The results show the significant influence of the usability on the outcome, even if the efficacy of the training itself is higher. Altogether this findings highlight the attention that should be given to both these aspects to achieve greater effectiveness of the training itself in its technology-enhanced version.

The results will be now presented divided per questionnaire, that's to say analyzing each group (EG1 and EG2) on the same questionnaire (See Table 7.1.a,b for a summary)

As for STAI:

In the EG1 the final model explains 43,6% of the variance of the post training stait anxiety (STAI) (Adjusted R^2=,436) and at every step the increment of R^2 was statistically significant (See Table Model Summary-1A). Altogether, all predictors are statistically significant (see Table Coefficients-1A). In particular, the usability in Model 1 negatively predicts the 54,5% of the post score, while in Model 2, it negatively predicts the 44,7%, while the pre training score positively predicts the 50,6% of the post score of stait anxiety.

Table. Model Summary-1A.SUS-STAI, Experimental Group1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,545[a]	,297	,271	7,086	,297	11,398	1	27	,002
2	,690[b]	,477	,436	6,230	,180	8,936	1	26	,006

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, TOT_PRE_STAI

c. Dependent Variable: TOT_POST_STAI

Table. Coefficients-1A.SUS-STAI, Experimental Group1-Written

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	60,185	8,250		7,296	,000	43,258	77,112					
	TOT_SUS	-,391	,116	-,545	-3,376	,002	-,628	-,153	-,545	-,545	-,545	1,000	1,000
2	(Constant)	33,283	11,558		2,880	,008	9,526	57,041					
	TOT_SUS	-,277	,109	-,386	-2,545	,017	-,500	-,053	-,545	-,447	-,361	,877	1,141
	TOT_PRE_STAI	,473	,158	,453	2,989	,006	,148	,799	,588	,506	,424	,877	1,141

a. Dependent Variable: TOT_POST_STAI

In the EG2 the final model explains 51,8% of the variance of the post training stait anxiety (STAI) (Adjusted R2=,518) and at every step the increment of R2 was statistically significant (See Table Model Summary-1B). Altogether, all predictors are statistically significant (see Table Coefficients-1B). In particular, the usability in Model 1 negatively predicts the 46,7% of the post score, while in Model 2, it negatively predicts the 47,6%, while the pre training score positively predicts the 64,5% of the post score of stait anxiety.

Table. Model Summary-1B.SUS-STAI, Experimental Group2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,467[a]	,219	,197	6,852	,219	10,347	1	37	,003
2	,737[b]	,543	,518	5,309	,325	25,625	1	36	,000

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, TOT_PRE_STAI

c. Dependent Variable: TOT_POST_STAI

Table. Coefficients-1B.SUS-STAI, Experimental Group2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	53,115	6,278		8,460	,000	40,394	65,837					
	TOT_SUS	-,271	,084	-,467	-3,217	,003	-,442	-,100	-,467	-,467	-,467	1,000	1,000
2	(Constant)	29,296	6,768		4,328	,000	15,570	43,023					
	TOT_SUS	-,215	,066	-,371	-3,247	,003	-,349	-,081	-,467	-,476	-,366	,972	1,029
	TOT_PRE_STAI	,509	,100	,578	5,062	,000	,305	,713	,640	,645	,570	,972	1,029

a. Dependent Variable: TOT_POST_STAI

As for VAS anxiety:

In the EG1 the final model explains 49,8% of the variance of the post training anxiety perceived (VAS anxiety) (Adjusted R_2=,498) and at every step the increment of R_2 was statistically significant (See Table Model Summary-2A). Altogether, all predictors are statistically significant (see Table Coefficients-2A). In particular, the usability in Model 1 negatively predicts the 40,4% of the post score, while in Model 2, it negatively predicts the 42,9%, while the pre training score positively predicts the 66,5% of the post score of anxiety perceived.

Table. Model Summary-2A.SUS-VAS anxiety, Experimental Group1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	,404[a]	,163	,132	15,477	,163	5,276	1	27	,030
2	,730[b]	,533	,498	11,778	,370	20,617	1	26	,000

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, PREVAS_ANXIETY_RI

c. Dependent Variable: POSTVAS_ANXIETY_RI

Table. Coefficients-2A.SUS-VAS anxiety, Experimental Group1-Written

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	68,440	18,018		3,799	,001	31,471	105,409					
	TOT_SUS	-,581	,253	-,404	-2,297	,030	-1,100	-,062	-,404	-,404	-,404	1,000	1,000
2	(Constant)	37,633	15,299		2,460	,021	6,186	69,080					
	TOT_SUS	-,470	,194	-,327	-2,421	,023	-,868	-,071	-,404	-,429	-,324	,984	1,016
	PREVAS_ ANXIETY_RI	,533	,117	,613	4,541	,000	,292	,775	,654	,665	,608	,984	1,016

a. Dependent Variable: POSTVAS_ANXIETY_RI

In the EG2 the final model explains 47,1% of the variance of the post training anxiety perceived (VAS anxiety) (Adjusted R2= ,471) and only Model 2 is statistically significant (See Table Model Summary-2B). In particular, the usability in Model 1 (see Table Coefficients-2B) doesn't predict the post score, and in Model 2 only the pre training score positively predicts the 69,1% of the post anxiety level perceived.

Table. Model Summary-2B.SUS-VAS anxiety, Experimental Group2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
1	,203[a]	,041	,015	13,219	,041	1,591	1	37	,215
2	,706[b]	,499	,471	9,690	,458	32,864	1	36	,000

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, PREVAS_ANXIETY_RI

c. Dependent Variable: POSTVAS_ANXIETY_RI

Table. Coefficients-2B.SUS-VAS anxiety, Experimental Group2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	40,939	12,113		3,380	,002	16,397	65,482					
	TOT_SUS	-,205	,162	-,203	-1,261	,215	-,534	,124	-,203	-,203	-,203	1,000	1,000
2	(Constant)	21,449	9,507		2,256	,030	2,167	40,731					
	TOT_SUS	-,176	,119	-,175	-1,478	,148	-,418	,066	-,203	-,239	-,174	,998	1,002
	PREVAS_ANXIETY_RI	,429	,075	,677	5,733	,000	,277	,581	,684	,691	,676	,998	1,002

a. Dependent Variable: POSTVAS_ANXIETY_RI

As for VAS calm:

In EG1 the final model explains 25,1% of the variance of the post training calm perceived (VAS calm) (Adjusted R^2= ,251) and only Model 2 is statistacally significant (See Table Model Summary-3A). In particolar, the usability in Model 1 (see Table Coefficients-3A) doesn’t predict the post score, and in Model 2 only the pre training score positively predicts the 53,1% of the post calm level perceived.

Table. Model Summary-3A.SUS-VAS calm, Experimental Group1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
1	,176[a]	,031	-,005	23,416	,031	,860	1	27	,362
2	,551[b]	,304	,251	20,220	,273	10,208	1	26	,004

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, PREVAS_CALM_RI

c. Dependent Variable: POSTVAS_CALM_RI

Table. Coefficients-3A.SUS-VAS calm, Experimental Group1-Written

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	47,110	27,260		1,728	,095	-8,823	103,043					
	TOT_SUS	,355	,383	,176	,927	,362	-,430	1,140	,176	,176	,176	1,000	1,000
2	(Constant)	10,917	26,124		,418	,679	-42,781	64,615					
	TOT_SUS	,194	,334	,096	,580	,567	-,493	,881	,176	,113	,095	,977	1,023
	PREVAS_CALM_RI	,696	,218	,529	3,195	,004	,248	1,144	,543	,531	,523	,977	1,023

a. Dependent Variable: POSTVAS_CALM_RI

In EG2 the final model explains 34,8% of the variance of the post training calm perceived (VAS calm) (Adjusted R2= ,348) and only Model 2 is statistacally significant (See Table Model Summary-3B). In particolar, the usability in Model 1 (see Table Coefficients-3B) doesn’t predict the post score, and in Model 2 only the pre training score positively predicts the 59,1% of the post calm level perceived.

Table. Model Summary-3B.SUS-VAS calm, Experimental Group2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	Change Statistics F Change	Change Statistics df1	Change Statistics df2	Change Statistics Sig. F Change
1	,223[a]	,050	,024	19,413	,050	1,944	1	37	,172
2	,618[b]	,382	,348	15,875	,332	19,331	1	36	,000

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, PREVAS_CALM_RI

c. Dependent Variable: POSTVAS_CALM_RI

Table. Coefficients-3B.SUS-VAS calm, Experimental Group2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	54,812	17,788		3,081	,004	18,770	90,855					
	TOT_SUS	,333	,239	,223	1,394	,172	-,151	,816	,223	,223	,223	1,000	1,000
2	(Constant)	39,353	14,965		2,630	,012	9,003	69,704					
	TOT_SUS	,116	,201	,078	,579	,566	-,292	,525	,223	,096	,076	,940	1,064
	PREVAS_CALM_RI	,479	,109	,594	4,397	,000	,258	,700	,613	,591	,576	,940	1,064

a. Dependent Variable: POSTVAS_CALM_RI

As for PANAS neg:

In EG1 the final model explains 34,1% of the variance of the post training negative affect (PANAS neg) (Adjusted R2=,341) and at every step the increament of R2 was statistacally significant (See Table Model Summary-4A). Altogether, all predictors are statistically significant (see Table Coefficients-4A). In particolar, the usability in Model 1 negatively predicts the 42,8% of the post score, while in Model 2, it negatively predicts the 35,1%, while the pre training score positevely predicts the 50,1% of the post score of negative affect.

Table. Model Summary-4A.SUS-PANAS neg, Experimental Group 1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,428[a]	,183	,153	3,038	,183	6,044	1	27	,021
2	,623[b]	,388	,341	2,680	,205	8,695	1	26	,007

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, TOTPRE_PANAS_NEG

c. Dependent Variable: TOTPOST_PANAS_NEG

Table. Coefficients-4AB.SUS-PANAS neg, Experimental Group 1-Written

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	21,549	3,537		6,093	,000	14,292	28,806					
	TOT_SUS	-,122	,050	-,428	-2,458	,021	-,224	-,020	-,428	-,428	-,428	1,000	1,000
2	(Constant)	13,107	4,235		3,095	,005	4,402	21,811					
	TOT_SUS	-,087	,045	-,304	-1,911	,067	-,180	,007	-,428	-,351	-,293	,930	1,075
	TOTPRE_ PANAS_NEG	,363	,123	,469	2,949	,007	,110	,616	,549	,501	,453	,930	1,075

a. Dependent Variable: TOTPOST_PANAS_NEG

In EG2 the final model explains 55,9% of the variance of the post training negative affect (PANAS neg) (Adjusted R2=,559) and at every step the increament of R2 was statistacally significant (See Table Model Summary-4B). Altogether, all predictors are statistically significant (see Table Coefficients-4B). In particolar, the usability in Model 1 negatively predicts the 41,6% of the post score, while in Model 2, it negatively predicts the 43,4%, while the pre training score positively predicts the 70,4% of the post score of negative affect

Table. Model Summary-4B.SUS-PANAS neg, Experimental Group 2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	Change Statistics F Change	Change Statistics df1	Change Statistics df2	Change Statistics Sig. F Change
1	,416[a]	,173	,151	4,496	,173	7,732	1	37	,008
2	,763[b]	,582	,559	3,240	,409	35,275	1	36	,000

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, TOTPRE_PANAS_NEG

c. Dependent Variable: TOTPOST_PANAS_NEG

Table. Coefficients-4B.SUS-PANAS neg, Experimental Group 2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	25,485	4,120		6,186	,000	17,137	33,833					
	TOT_SUS	-,154	,055	-,416	-2,781	,008	-,266	-,042	-,416	-,416	-,416	1,000	1,000
2	(Constant)	12,731	3,664		3,475	,001	5,301	20,161					
	TOT_SUS	-,117	,040	-,316	-2,894	,006	-,198	-,035	-,416	-,434	-,312	,976	1,025
	TOTPRE_PANAS_NEG	,598	,101	,648	5,939	,000	,393	,802	,696	,704	,640	,976	1,025

a. Dependent Variable: TOTPOST_PANAS_NEG

As for PANAS pos:

In the EG1 the final model explains 54,0% of the variance of the post training positive affect (PANAS pos) (Adjusted R^2=,540) and at every step the increament of R^2 was statistacally significant (See Table Model Summary-5A). Altogether, all predictors are statistically significant (see Table Coefficients-5A). In particolar, the usability in Model 1 positively predicts the 51,8% of the post score, while in Model 2, it positevely predicts the 35,6%, while the pre training score positively predicts the 64,5% of the post score of positive affect.

Table. Model Summary-5A.SUS-PANAS pos, Experimental Group 1-Written

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,518[a]	,269	,242	6,851	,269	9,921	1	27	,004
2	,757[b]	,573	,540	5,336	,304	18,516	1	26	,000

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, TOTPRE_PANAS_POS

c. Dependent Variable: TOTPOST_PANAS_POS

Table. Coefficients-5A.SUS-PANAS pos, Experimental Group 1-Written

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	7,613	7,976		,955	,348	-8,752	23,979					
	TOT_SUS	,353	,112	,518	3,150	,004	,123	,582	,518	,518	,518	1,000	1,000
2	(Constant)	-8,166	7,213		-1,132	,268	-22,993	6,661					
	TOT_SUS	,251	,090	,369	2,780	,010	,065	,437	,518	,479	,356	,932	1,073
	TOTPRE_PANAS_POS	,750	,174	,571	4,303	,000	,392	1,109	,668	,645	,552	,932	1,073

a. Dependent Variable: TOTPOST_PANAS_POS

In the EG2 final model explains 80,1% of the variance of the post training calm perceived (VAS calm) (Adjusted R2= ,801) and only Model 2 is statistacally significant (See Table Model Summary-5B). In particolar, the usability in Model 1 (see Table Coefficients-5B) doesn’t predict the post score, while in Model 2 it negatively predicts the 39,4% and the pre training score positively predicts the 89,7% of the post calm level perceived.

Table. Model Summary-5B.SUS-PANAS pos, Experimental Group 2-Assistant

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,200[a]	,040	,014	7,865	,040	1,546	1	37	,222
2	,901[b]	,812	,801	3,530	,772	147,690	1	36	,000

a. Predictors: (Constant), TOT_SUS

b. Predictors: (Constant), TOT_SUS, TOTPRE_PANAS_POS

c. Dependent Variable: TOTPOST_PANAS_POS

Table. Coefficients-5B.SUS-PANAS pos, Experimental Group 2-Assistant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	23,306	7,207		3,234	,003	8,704	37,908					
	TOT_SUS	,120	,097	,200	1,243	,222	-,076	,316	,200	,200	,200	1,000	1,000
2	(Constant)	5,458	3,552		1,537	,133	-1,746	12,663					
	TOT_SUS	-,123	,048	-,205	-2,575	,014	-,220	-,026	,200	-,394	-,186	,825	1,213
	TOTPRE_ PANAS_POS	1,090	,090	,967	12,153	,000	,908	1,272	,882	,897	,879	,825	1,213

a. Dependent Variable: TOTPOST_PANAS_POS

Table 7.1.a- Summary-Hierarchical Regression- MODEL 1_SUS-POST QUESTIONNAIRES, Partial Correlation %

Dependent variable	**EG1-Written**	% SUS	**EG2-Assistant**	% SUS
STAI	**	-54,5	**	-46,7
VAS anxiety	*	-40,4	n.s.	-
VAS calm	n.s.	-	n.s.	-
PANAS neg	*	-42,8	**	-41,6
PANAS pos	**	51,8	n.s.	-

*Signifiant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 7.1.b- Summary-Hierarchical Regression- MODEL 2_SUS+PRE SCORE-POST QUESTIONNAIRES, Partial Correlation %

Dependent variable	**EG1- Written**	% SUS	% PRE score	**EG2- Assistant**	% SUS	% PRE score
STAI	**	-44,7	50,6	***.	-47,6	64,5
VAS anxiety	***	-42,9	66,5	***	n.s.	69,1
VAS calm	**	n.s.	53,1	***	n.s.	59,1
PANAS neg	**	n.s.	50,1	***	-43,4	70,4
PANAS pos	***	47,9	64,6	***	39,4	89,7

A Partial Correlation (1-tailed) was run also to explore if the perception of the Avatar-Assistant predict the post treatment results in the EG2, as for state anxiety, calm and anxiety level, positive and negative affects and engament (Hp.5, part 1). Both the 5 dimensions of the Godspeed questionnaire and the Niewiadomski scales were taken in consideration. Positive significant correlation were found for positive affect (PANAS pos) and for calm perceived (VAS calm), while negative significant correlation were found for stait anxiety (STAI) and perceived anxiety (VAS anxiety). Only negative effect (PANAS neg) revealed no significant correlation controlling the pre treatment score while there was a significant association with the zero order correlation (Believability: $r(37)=-,332$, $p<,05$), showing a weak correlation. The precise results, per each post-treatment score, are reported in table 8, considering only the correlations with the pre treatment variable controlled.

Table 8. Partial Correlation GSQ 9 dimensions and Niewiadomski scales / Post treatment scorses, with Pre treatment scorses controlled in EG2 2 (Assistant).

EG2 Assistant	**GSQ 1 Antropophormism**	**GSQ 2 Animation**	**GSQ 3 Likeability**	**GSQ 4 Perceived Intelligent**	**GSQ 5 Perceived Safety**	**Competence scale**	**Warmth scale**	**Believability scale**
STAI	-	-,421**	-,350*	-,291*	-,275*	-	-,311*	-,328*
VAS Anxiety	-	-,356*	-,278*	-	-	-	-,401**	
VAS Calm	-	-	-	-	,340*	-	,397**	-
Panas pos	-	-	-	-,345*	-	-	-	-
Panas neg	-	-	-	-	-	-	-	-

* Correlation is significant at .05 level; ** Correlation is significant at .01 level; *** Correlation is significant at .001 level

A Bivariate Correlation (1-tailed) was then run to explore also if there is a significant correlation between the perception of the Avatar-assistant and the engagement and the usability (Hp.5, part 2). The results revealed that engagement (total FSS) has positive significant correlations with Believability scale and with Animation, Likeability, Perceived Intelligent and Perceived Safety dimensions. Moreover, 6 of 9 dimensions of the engagement revealed significant correlations with how the Avatar is perceived, in particolar: D1-Challenge-skill balance with Warmth scale; D4-Unambiguous feedback with Perceived Intelligent dimension; D5-Concentration on task at hand with Competence scale; D6-Sense of control with Perceived safety; D7-Loss of self-consciousness with Believability scale and with Perceived Intelligent and Perceived Safety dimensions; D9-Autotelic experience with Competence and believability scales and with all the five GSQ dimensions (Antropophormism, Animation, Likeability, Perceived Intelligent, Perceived Safety); Only D2-Action-awareness merging, D3-Clear goals and D8-Transformation of time, revealed no significant correlations.

Usability showed positive significant correlation with Warmth and Believability scales and with Likeability, Perceived Intelligent and Perceived Safety dimensions. All the results are reported in tab 9.

Table 9. Bivariate Correlation (1-tailed) GSQ 5 dimensions and Niewiadomski 3 scales / FSS, 9 dimensiion FSS and SUS , in EG 2 (Assistant)

EG2 Assistant	**GSQ 1 Antropophormism**	**GSQ 2 Animation**	**GSQ 3 Likeability**	**GSQ 4 Perceived Intelligent**	**GSQ 5 Perceived Safety**	**Competence scale**	**Warmth scale**	**Believability scale**
FSS tot	-	,362*	,347**	,427**	,291*	-	-	,400**
D1 Challenge skill Balance	-	-	-	-	-	-	,388**	-
D2 Action awareness merging	-	-	-	-	-	-	-	-
D3 Clear goals	-	-	-	-	-	-	-	-
D4 Unambiguous feedback	-	-	-	,316*	-	-	-	-
D5 Concentration on Task at Hand	-	-	-	-	-	,313*	-	-
D6 Sense of Control	-	-	-	-	,326*	-	-	-
D7 Loss of Self Consciousness	-	-	-	,417**	,355*	-	-	,448**
D8 Transformation Of Time	-	-	-	-	-	-	-	-
D9 Autotelic experience	,306*	,482**	,407**	,372**	,419**	,391**	-	,365*
SUS	-	-	,301*	,316*	,320*	-	,278*	,368*

* Correlation is significant at .05 level; ** Correlation is significant at .01 level; *** Correlation is significant at .001 level

Altogheter considered, these results confirm Hp.5, in fact, on the one hand, all the 5 dimensions of the Godspeed questionaire and the 3 Niewiadomski scales revealed to be significant. In particular, the most influenced variable is the stait anxiety, further as we can see by the average (See Table 1.e and 1.f pag 119) Animation, Likeability and Perceived Intelligent obtained the higher scores, while Antropophormism and Perceived Safety are lower, as well, Competence and Believability scales have higher scores then Warmth. This emphasizes the need to improve these three aspects of the avatar.

On the other hand, it were found significant correlations also between avatar’s perception and engagement and usability (See Table 9, pag 154). In particular, the total level of engagement positively correlates with 4 of the 5 dimension of the Godspeed (besides Antropophormism) and with Believability scale; also the 9 FSS dimensions have positive correlations with the 5 GSQ dimensions and with 2 of the 3 Niewiadomski scales (besides Warmth) and we can notice that D9-Autotelic experience has significant correlation with all the 5 dimensions and 3 scales, besides Warmth.

Also for usability were found positive correlation with 3 of the 5 dimensions (Likeability, Perceived Intelligent and Perceived Safety) and with Believability scale, and in this case, also with Warmth.

These results confirm our hypothesis, highlighting the importance of avatar’s perception on engagement and usability, in particular the most influential aspect are competence and believability.

Finally it was explored if there are significant correlations between the scales used in the EG2 to measure how the Avatar-Assistant is perceived (Hp.6). It was both analyzed if there are correlations between the 3 Niewiadomski scales, in particular if Believability correlates with Warmth and Competence, and if there is a significant correlation between these three scales and the 5 Godspeed dimensions. The Bivariate Correlation (1-tailed) revealed a significant correlation between Believability and Competence but no with Warmth, as expected by the results obtained by Niewiadomski et al. (2010). Moreover it were found significant correlations between Competence scale and Likeability, Perceived Intelligent and Animation of the GSQ, also significant correlations were found between Believability scale and all the 5 GSQ dimensions, while no significant correlation was found for Warmth. The results are reported in tab 10.

This Hypothesis (Hp.6) has been partially confirmed and these results emphasises the main role of these dimensions in achieving a good level of believability for the avatar as well as with a human trainer.

Table 10. Bivariate Correaltion (1-Tailed) Niewiadomski 3 scales / GSQ 5 dimensions

EG2 Assistant	**Competence scale**	**Warmth scale**	**Believability scale**	**GSQ 1 Antropophormism**	**GSQ 2 Animation**	**GSQ 3 Likeability**	**GSQ 4 Perceived Intelligent**	**GSQ 5 Perceived Safety**
Competence scale		-	,507 **	-	,268*	,379**	,625**	-
Warmth scale	-	-	-	-	-	-	-	-
Believability scale	,507**	-		,270*	,337*	,539**	,760**	,372**

* Correlation is significant at .05 level; ** Correlation is significant at .01 level; *** Correlation is significant at .001 level

5.3.5 Physiological measures results

Of the total students recruited, 82 subjects were included in the physiological analysis, due to technical problems with biosensors, specifically: 27 in EG1 (Written), 27 in EG2 (Assistant) and 28 in CG (Traditional)

A One Way ANOVA was run to explore significant differences between the three groups at the baseline, during the session and at the end of the training (Hp.7), with Group as factor and EDA value, EDA total peaks, heart rate (HR) value and muscle activation (MA) as dependent variables. In particular for the MA it wasn't considered only the total value (for the whole session), but also in specific the value during the Active Shaking Meditation and the Progressive Muscle Relaxation, since both of them require lot of movements.

No significant difference emerged at the baseline between the three groups, beside the EDA peaks ($F_{2,81}$=5,973; P<.01), while some significant differences were found during the session and at the end of the training. Table 11. a, b, c and 12 a, b, c summarize the results.

Hp.7 was confirmed, in fact the results show a higher number of EDA peaks in EG2 for the whole session and a higher number of muscles activated both in Active Shaking Mediation and in Progressive Muscle Relaxation exercises. The data together suggest that the presence of the Avatar-Assistant induces an higher activation not only then written instruction (EG1), but also then a human trainer (CG). Further, as for EDA peaks we can notice that the difference between EG2 and CG, is lower then with EG1, while for Muscle Activation, EG2 achieved the best results, higher then EG1, but also of CG. We can also notice then at the end of the session there is a higher muscle relaxation then in CG (See Table 11.b and 11.c) Altogether these data suggest a very higher engagement in EG2 probably due to the presence of the Avatar-Assistant.

Table 11.a Media and ds at baseline of the 3 groups

BASELINE	**EG1-Written**	**EG2-Assistant**	**CG-Traditional**
EDA Peaks	37 (13,951)	50 (17,199)	43 (12,116)
EDA tot	189538 (88610,997)	155461 (87498,128)	203649 (78307,759)
HR tot	158341 (51083,822)	137878 (22771,136)	147168 (23453,588)
MA tot	2 (3,164)	1 (2,995)	2 (3,630)

Table 12.a One Way ANOVA at baseline, between the 3 groups

Variable	**F**	**P**	**Post-Hoc (Bonferroni)**
EDA Peaks	5,973	*	All 3 groups
EDA tot	2,331	n.s	-
HR tot	2,328	n.s	-
MA tot	,287	n.s	-

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 11.b Media and ds during the session, of the 3 groups

SESSION	**EG1-Written**	**EG2-Assistant**	**CG-Traditional**
EDA Peaks	297 (66,698)	522 (140,805)	418 (123,494)
EDA tot	2049551 (600119,321)	2215396 (1009191,657)	2400290 (824916,020)
HR tot	1209545 (216774,316)	1709195 (282987,922)	1578576 (274521,960)
MA tot	64 (27,51550)	82 (35,65748)	95 (32,12992)
Active Shaking MA	22 (10,613)	27 (10,388)	18 (7,648)
PMR MA	17 (8,050)	22 (9,573)	15 (6,489)

Table 12 b. One Way ANOVA, during the session, between the 3 groups

Variable	F	P	Post-Hoc (Bonferroni)
EDA Peaks	25,962	***	All 3 groups
EDA tot	1,234	n.s.	-
HR tot	26,875	***	EG1 vs EG2 + EG1 vs CG
MA tot	6,350	**	EG1 vs CG
Active Shaking MA	6,210	**	EG2 vs CG
PMR MA	5,555	**	EG2 vs CG

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 11.c Media and ds, end of the session, of the 3 groups

CLOSING	EG1-Written	EG2-Assistant	CG-Traditional
EDA Peaks	10 (5,326)	30 (8,352)	29 (19,836)
EDA tot	61588 (31590,354)	130786 (63974,500)	174436 (73121,625)
HR tot	36588 (14341,565)	89880 (15706,887)	104996 (41403,110)
MA	9 (7,454)	12 (10,438)	20 (10,050)

Table 12 c. One Way ANOVA, end of the session, between the 3 groups

Variable	F	P	Post-Hoc (Bonferroni)
EDA Peaks	22,489	***	EG1 vs EG2 + EG1 vs CG
EDA tot	25,343	***	All 3 groups
HR tot	47,974	***	EG1 vs EG2 + EG1 vs CG
MA	11,292	***	EG1 vs CG + EG2 vs CG

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Then a series of Repetead Measure ANOVA were run to explore if there is a significant difference between pre and post treatment scorses (Hp.8) of EDA (total), HR and MA; for EDA peaks it was run an ANCOVA due to the differences between groups at the baseline, but the same results were obtained with a Repeated Measure ANOVA.

The analysis on EDA peaks revealed significant TIME effect ($F_{1,79}$=164,040; p<.000; effect size=0,675) TIME x GROUP effect ($F_{2,79}$=5,128; p<.01; effect size=0,115). Pairwise Comparisons and Post hoc analysis in particolar revealed a signficant mean difference between EG1- EG2 and between EG1-CG.

Also for the total EDA value it were found TIME effect ($F_{1,79}$=75,864; p<.001; effect size=0,490) and TIME x GROUP effect ($F_{2,79}$=23,287; p<.001; effect size=0,371). Pairwise Comparisons and Post hoc analysis in particolar revealed a signficant mean difference between EG1-CG and EG2-CG.

As for HR also it were found TIME effect ($F_{1,79}$=325,503; p<.001; effect size=0,805) and TIME x GROUP effect (($F_{2,79}$=42,596; p<.001; effect size=0,519). Pairwise Comparisons and Post hoc analysis in particolar revealed a signficant mean difference between EG1-CG.

The same effect were found for MA, so TIME effect ($F_{1,79}$=150,359; p<.001; effect size=0,656) and TIME x GROUP effect ($F_{2,79}$=11,623; p<.001; effect size=0,227). Pairwise Comparisons and Post hoc analysis in particolar revealed a signficant mean difference between EG1-CG and EG2-CG.

Tables 13 a,b summarize the results.

Table 13.a. Repeated Measure ANOVA, Pre and Post session, TIME

Variable	F	P	Partial Eta Squared
EDA Peaks	164,040	***	.675
EDA	75,864	***	.490
HR	325,503	***	.805
MA	150,359	***	.656

Table 13.b. Repeated Measure ANOVA, Pre and Post session, TIME x GROUP

Variable	F	P	Partial Eta Squared	Post-Hoc (Bonferroni)
EDA Peaks	5,128	**	.115	EG1 vs EG2 + EG1 vs CG.
EDA	23,287	***	.371	EG1 vs CG + EG2 vs CG
HR	42,596	***	.519	EG1 vs CG
MA	11,623	***	.227	EG1 vs CG + EG2 vs CG

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

To explore the TIME effect, the significant decrease within each groups per each measures, a series of Paired Samples T Test were run revealing:

In EG1 a significant correlation only for Muscle Activation and a significant mean difference (2-Tailed) per each one of the measure: EDA Peaks (t (26) = 9,878; p<.001), EDA (t (26) = 7,921; p<.001), HR (t (26) = 12,166; p<.001), MA (t (26) = -6,173; p<.001).

In EG2 a significant correlation for every measure, beside MA and a significant mean difference (2-Tailed) per each one of the measure: EDA Peaks (t (26) = 9,003; p<.001), EDA (t (26) = 2,602; p<.05), HR (t (26) = 7,445; p<.001), MA (t (26) = -5,104; p<.001).

In CG a significant correlation for every measure and a significant mean difference (2-Tailed) per each one of the measure: EDA Peaks (t (26) = 4,408; p<.01), EDA (t (26) = 3,096; p<.01), HR (t (26) = 18,510; p<.001), MA (t (26) = -10,618; p<.001). (For a summary see Table 14 a,b)

Table 14.a. Paired Samples Correlations

Pair (Pre & Post)	EG1-Written	EG2-Assistant	CG-Traditional
EDA Peaks	r=,176 n.s.	r=,772 ***	r=,524**
EDA	r=,322 n.s.	r=,833 ***	r=,785***
HR	r=,076 n.s.	r=,816 ***	r=,703***
MA	r=, 623***	r= -,013 n.s.	r=,400*

* Correlation is significant at .05 level; ** Correlation is significant at .01 level; *** Correlation is significant at .001 level

Table 14.b. Summary of Paired Samples test: Mean difference and Significance level

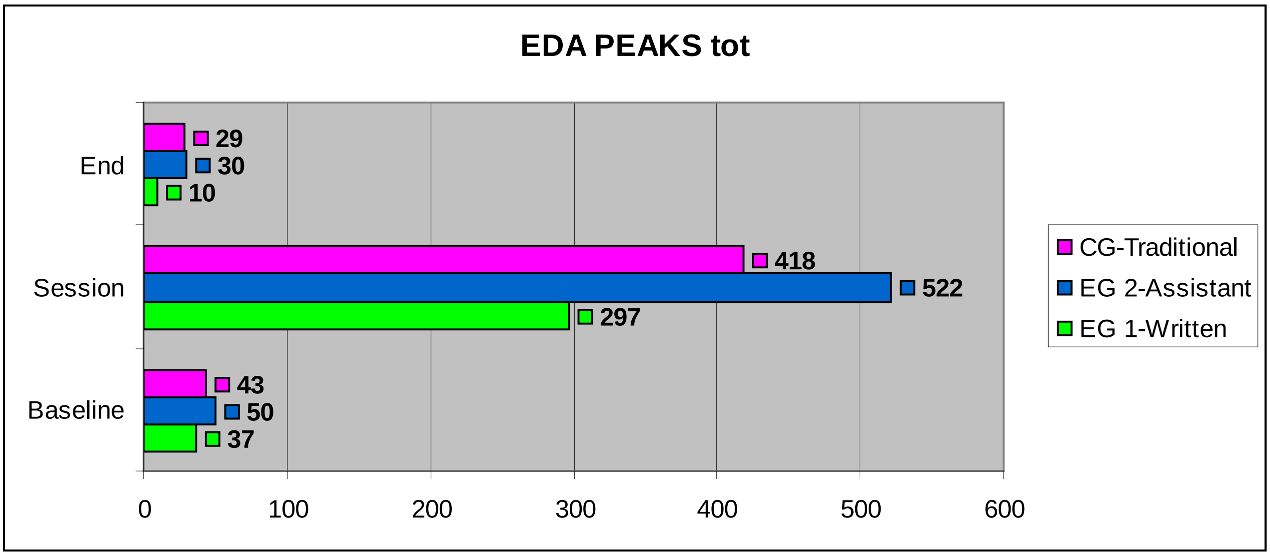
Pair (Pre & Post)	EG1-Written	EG2-Assistant	CG-Traditional
EDA Peaks	-27***	-21***	-14*
EDA	-127950***	-24674*	-29214**
HR	-121753***	-47998***	-42172***
MA	7***	11***	18***

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

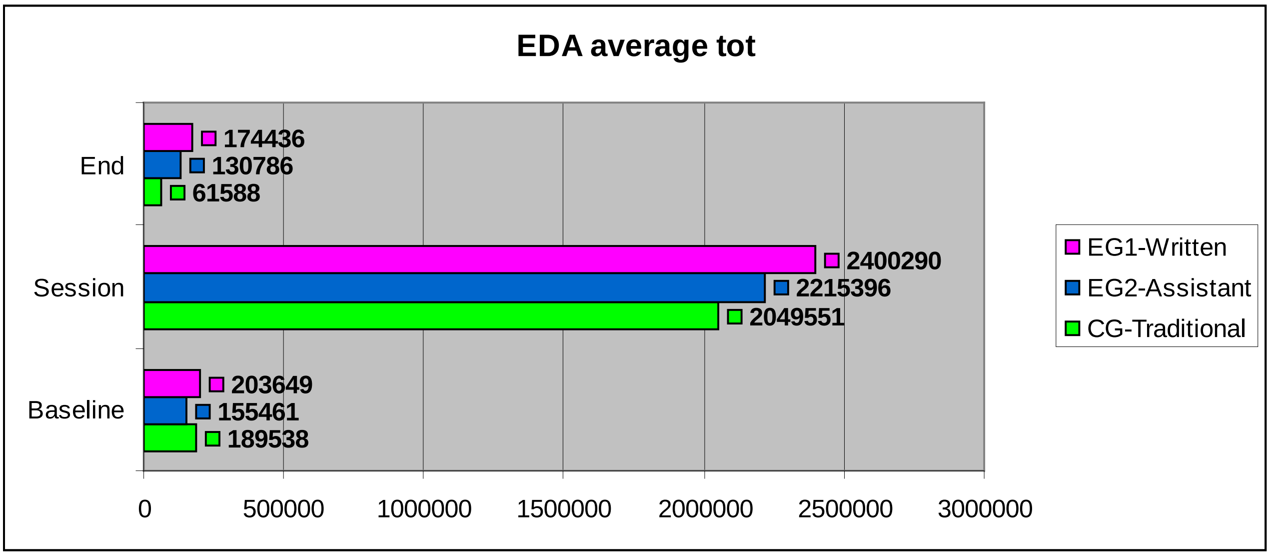
Hp.8 was only partially confirmed, in fact the results show a significant decrement post training in all the 3 groups for all the measures, but a higher decrement wasn't obtained by EG2 as supposed. This could be due to the fact that the aim of this session isn't to induce a complete physical relaxation, but it works specifically on achieving awareness of physiological reactions through a

continuous alternation of relaxation and activation of the body; since as we saw in EG2 emerged a higher muscle activation and number of peaks, we can suppose that also this overall result is due to a greater involvement that led to performing the activation exercises in a more complete way than the other two groups, as for example when it is asked to move every part of the body according to the rhythm and then to relax (Active Shaking Meditation).
A series of summary graphs will be now illustrated in the next pages.

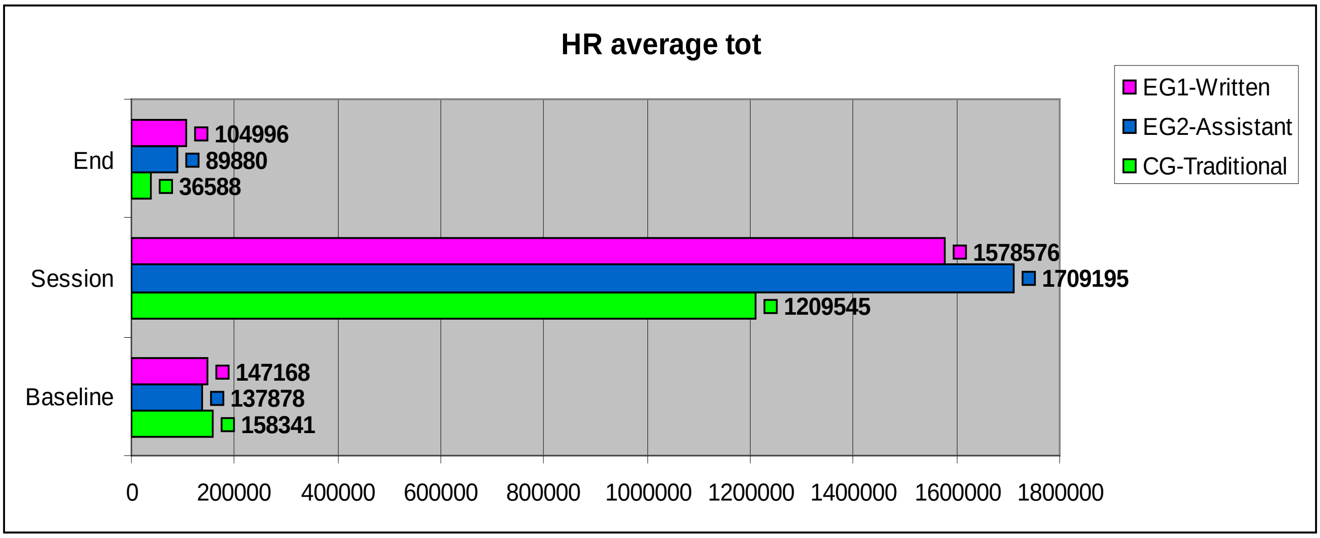
Eda peaks_ pre-session-post_3 groups



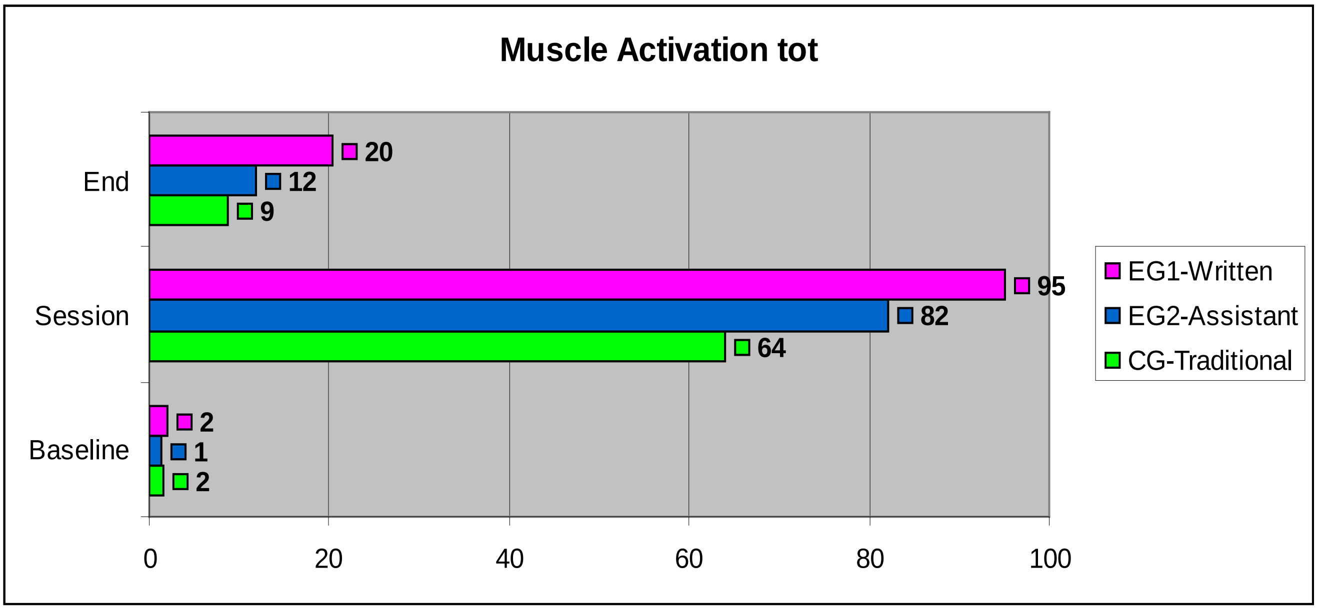
Eda average_ pre-session-post_3 groups



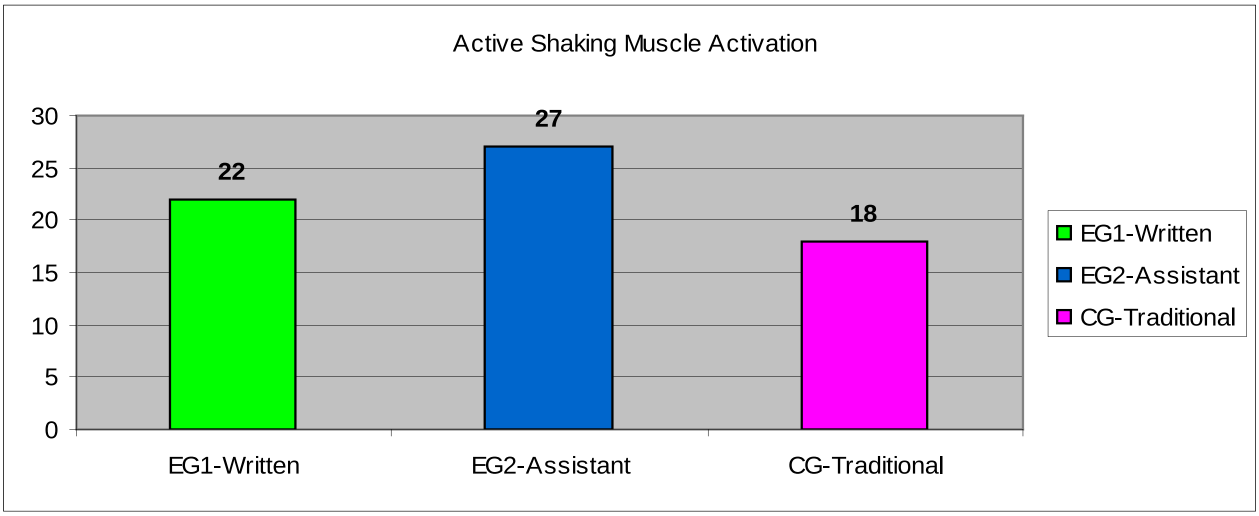
HR average_ pre-session-post_3 groups



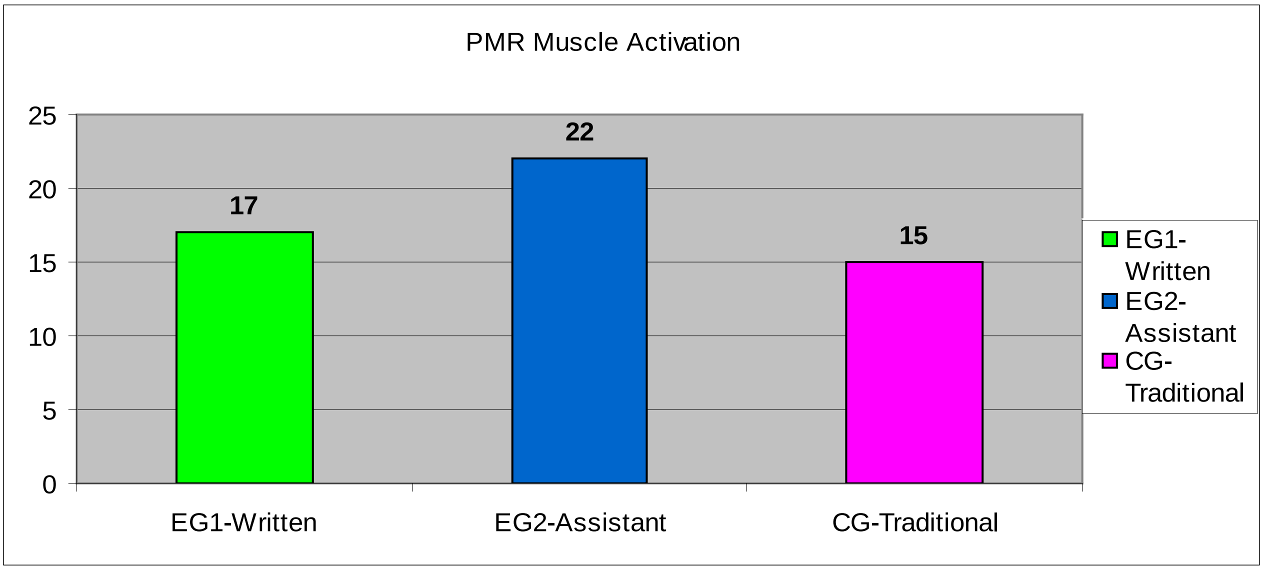
Muscle Activation_pre-session-post_3 groups



Muscle activation- During Active Shaking Meditation-3 groups



Muscle activation- During Progressive Muscle Relaxation-3 groups



Finally a series of Repeated Measure ANOVA were run for each exercise of the session to explore better the significant differences between the 3 groups and to have a more complete picture of the effectiveness of the session. For each exercise the test was run on the Min and the Max value of EDA and of HR. We will report only the exercises with significant data, in the same order of the session itself: Facial Mindfulness (FM); Breathing Relaxation (BR); Active Shaking Meditation (ASM); Progressive Muscle Relaxation (PMR); How does my body feel (HF); I-BOX2; Closing.
The Post-Hoc analysis will be directly reported in Tables 15-18 a,b that summarize the results. Then a series of summary graphs will be illustrated.

Facial Mindfulness: a significant TIME effect ($F_{1,79}$=23,946; p<.001; effect size=0,233) and TIME x GROUP effect ($F_{2,79}$=17,451; p<.001; effect size=0,306) were found for Max EDA and also for Max HR, TIME effect ($F_{1,79}$=7,773; p<.01; effect size=0,090) and TIME x GROUP effect ($F_{2,79}$=14,587; p<.001; effect size=0,270).

Breathing Relaxation: a significant TIME effect ($F_{1,79}$=48,467; p<.001; effect size=0,380) and TIME x GROUP effect ($F_{2,79}$=21,906; p<.001; effect size=0,357) were found for Max EDA and also for Max HR, TIME effect ($F_{1,79}$=69,506; p<.01; effect size=0,468) and TIME x GROUP effect ($F_{2,79}$=41,143; p<.001; effect size=0,510).

Active Shaking Meditation: a significant TIME effect ($F_{1,79}$=4,377; p<.05; effect size=0,052) was found for Min EDA, and a significant TIME effect ($F_{1,79}$=90,077; p<.001; effect size=0,533) and TIME x GROUP effect ($F_{2,79}$=34,655; p<.001; effect size=0,467) were found for Max EDA. Moreover: a significant TIME effect ($F_{1,79}$=6,142; p<.05; effect size=0,072) was found for Min HR and TIME effect ($F_{1,79}$=133,652; p<.001; effect size=0,629) and TIME x GROUP effect ($F_{2,79}$=22,189; p<.001; effect size=0,360) were found for Max HR.

Progressive Muscle Relaxation: a significant TIME effect ($F_{1,79}$=9,995; p<.01; effect size=0,112) was found for Max EDA. Moreover it were found a significant TIME effect ($F_{1,79}$=66,543; p<.001; effect size=0,457) for Min HR and for Max HR ($F_{1,79}$=5,519; p<.05; effect size=0,065).

How does my body feel: a significant TIME x GROUP effect ($F_{1,79}$=5,500; p<.01; effect size=0,122) was found for Min EDA and TIME effect ($F_{1,79}$=9,060; p<.01; effect size=0,103) and TIME x GROUP effect ($F_{2,79}$=7,743; p<.01; effect size=0,164) for Max EDA. Moreover it were found significant TIME x GROUP effect ($F_{2,79}$=10,768; p<.001; effect size=0,214) for Min HR and TIME effect ($F_{1,79}$=15,780; p<.001; effect size=0,166) for Max HR.

I-BOX2: a significant TIME x GROUP effect ($F_{2,79}$=9,565; p<.001; effect size=0,195) was found for Max EDA and for Max HR ($F_{2,79}$=4,988; p<.01; effect size=0,112).

Closing: a significant TIME effect ($F_{1,79}$=6,636; p<.05; effect size=0,077) and TIME x GROUP effect ($F_{2,79}$=5,394; p<.01; effect size=0,120) were found for Min HR and also for Max HR, TIME ($F_{1,79}$=26,801; p<.001; effect size=0,253) and TIME x GROUP (($F_{2,79}$=4,462; p<.05; effect size=0,101).

Table 15.a. Repeated Measure ANOVA, MIN EDA- Pre and Post exercise, TIME

EXERCISE	**F**	**P**	**Partial Eta Squared**
Facial Mindfulness			
Breathing Relaxation			
Active Shaking Meditation	4,377	*	.052
PMR			
How does my body feel			
I-BOX2			
Closing			

Table 15.b. Repeated Measure ANOVA, MIN EDA- Pre and Post exercise, TIME x GROUP

EXERCISE	**F**	**P**	**Partial Eta Squared**	**Post-Hoc (Bonferroni)**
Facial Mindfulness				
Breathing Relaxation				
Active Shaking Meditation				
PMR				
How does my body feel	5,500	**	.122	-
I-BOX2				
Closing				

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 16.a. Repeated Measure ANOVA, MAX EDA- Pre and Post exercise, TIME

EXERCISE	F	P	Partial Eta Squared
Facial Mindfulness	23,946	***	.233
Breathing Relaxation	48,467	***	.380
Active Shaking Meditation	90,077	***	.533
PMR	9,995	**	.112
How does my body feel	9,060	**	.103
I-BOX2			
Closing			

Table 16.b. Repeated Measure ANOVA, MAX EDA- Pre and Post exercise, TIME x GROUP

EXERCISE	F	P	Partial Eta Squared	Post-Hoc (Bonferroni)
Facial Mindfulness	17,451	***	.306	EG1 vs EG2 + EG2 vs CG
Breathing Relaxation	21,906	***	.357	EG1 vs EG2 + EG2 vs CG
Active Shaking Meditation	34,655	***	.467	EG1 vs CG
PMR				
How does my body feel	7,743	**	.164	EG1 vs EG2
I-BOX2	9,565	***	.195	EG2 vs CG
Closing				

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 17.a. Repeated Measure ANOVA, MIN HR- Pre and Post exercise, TIME

EXERCISE	F	P	Partial Eta Squared
Facial Mindfulness			
Breathing Relaxation			
Active Shaking Meditation	6,142	*	.072
PMR	66,543	***	.457
How does my body feel	10,768	***	.214
I-BOX2			
Closing	6,636	*	.077

Table 17.b. Repeated Measure ANOVA, MIN HR- Pre and Post exercise, TIME x GROUP

EXERCISE	F	P	Partial Eta Squared	Post-Hoc (Bonferroni)
Facial Mindfulness				
Breathing Relaxation				
Active Shaking Meditation				
PMR				
How does my body feel				
I-BOX2				
Closing	5,394	**	.120	EG1 vs EG2

* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

Table 18.a. Repeated Measure ANOVA within and between groups,MAX HR- Pre and Post exercise, TIME

EXERCISE	F	P	Partial Eta Squared
Facial Mindfulness	7,773	**	.090
Breathing Relaxation	69,506	**	.468
Active Shaking Meditation	133,652	***	.629
PMR	5,519	*	.065
How does my body feel	15,780	***	.166
I-BOX2	4,988	**	.112
Closing	26,801	***	253

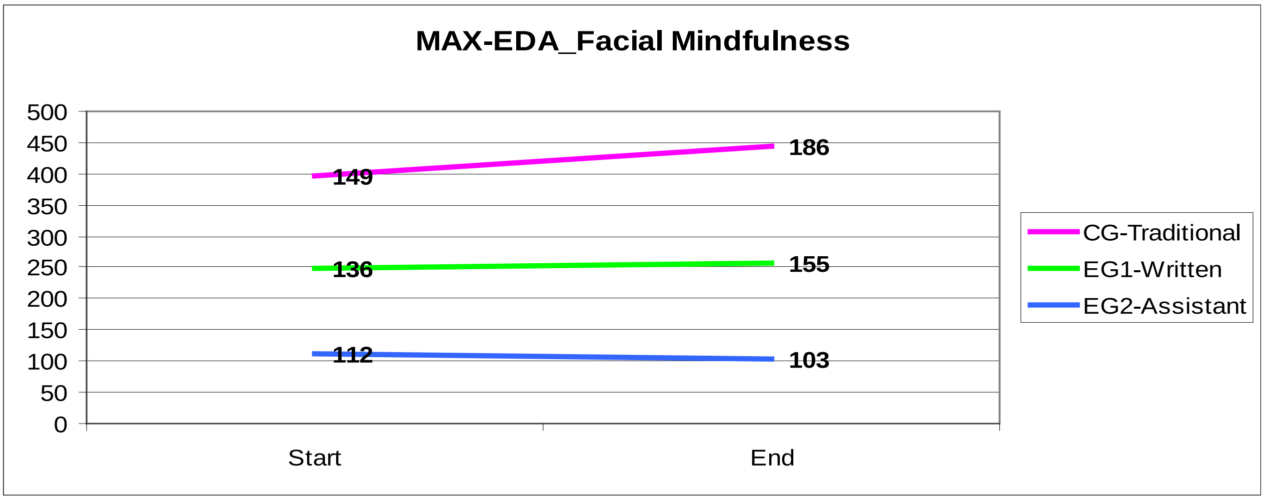
Table 18.b. Repeated Measure ANOVA within and between groups, MAX HR- Pre and Post exercise, TIME x GROUP

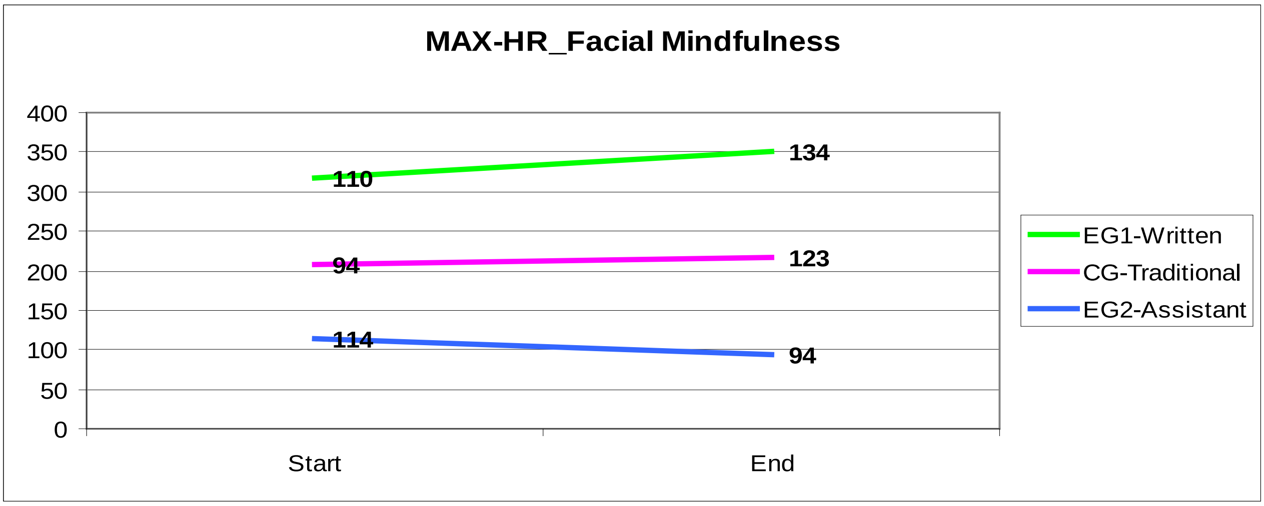
EXERCISE	F	P	Partial Eta Squared	Post-Hoc (Bonferroni/Tukey)
Facial Mindfulness	14,587	***	.270	. EG2 vs CG
Breathing Relaxation	41,143	***	.510	EG1 vs EG2 + EG2 vs CG
Active Shaking Meditation	22,189	***	.360	EG1 vs EG2 + EG2 vs CG
PMR				
How does my body feel				
I-BOX2				
Closing	4,462	*	.101	EG1 vs CG

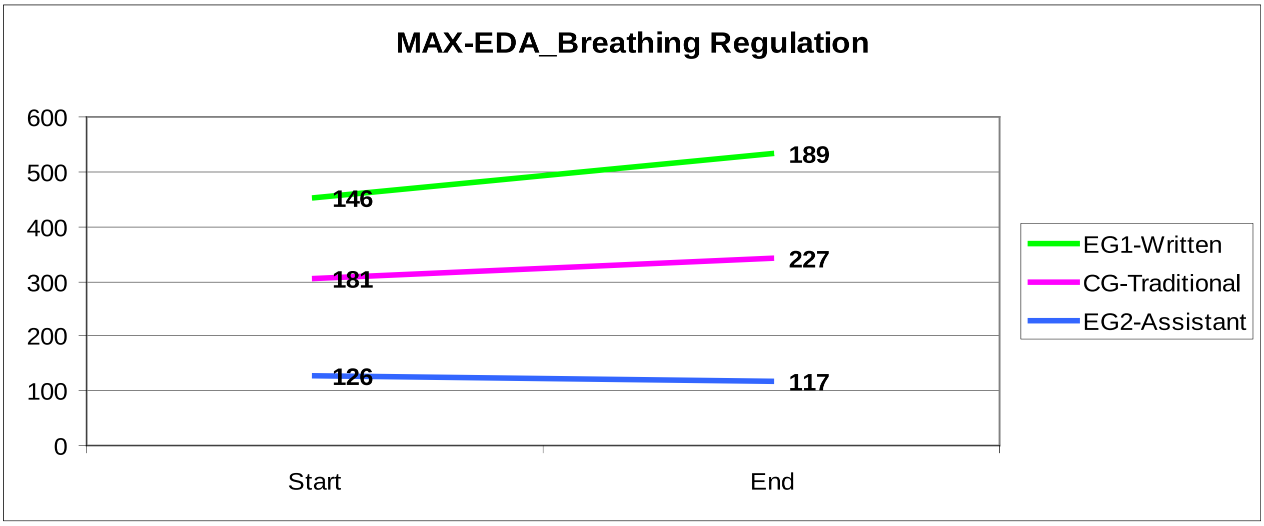
* Significant at .05 level; ** Significant at .01 level; *** Significant at .001 level

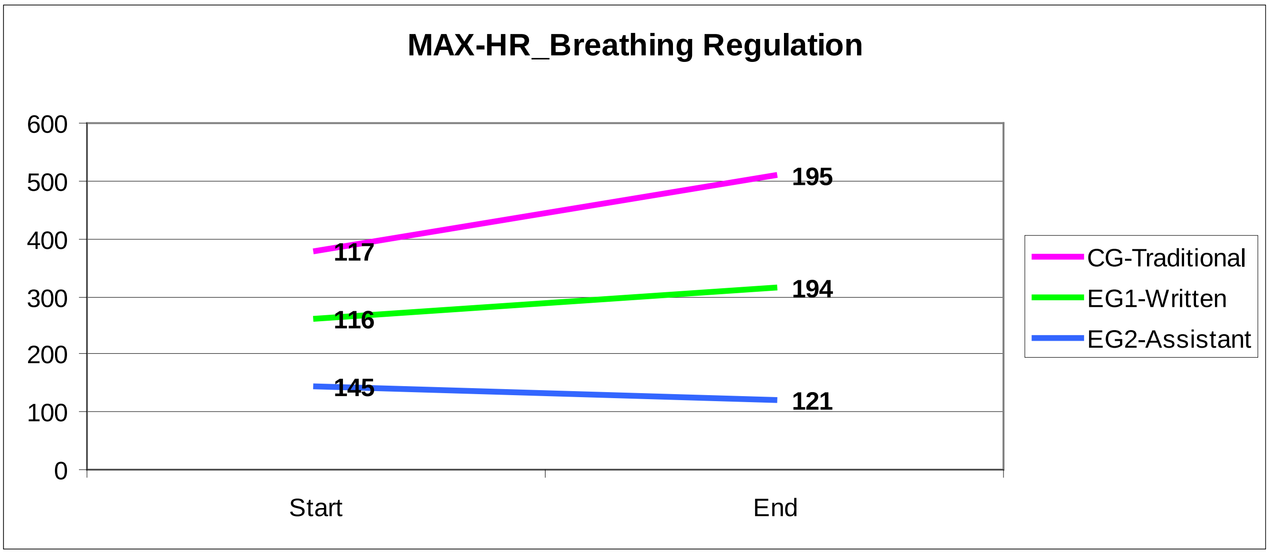
The main results will be now illustrated with a series of graphs, per each exercise.

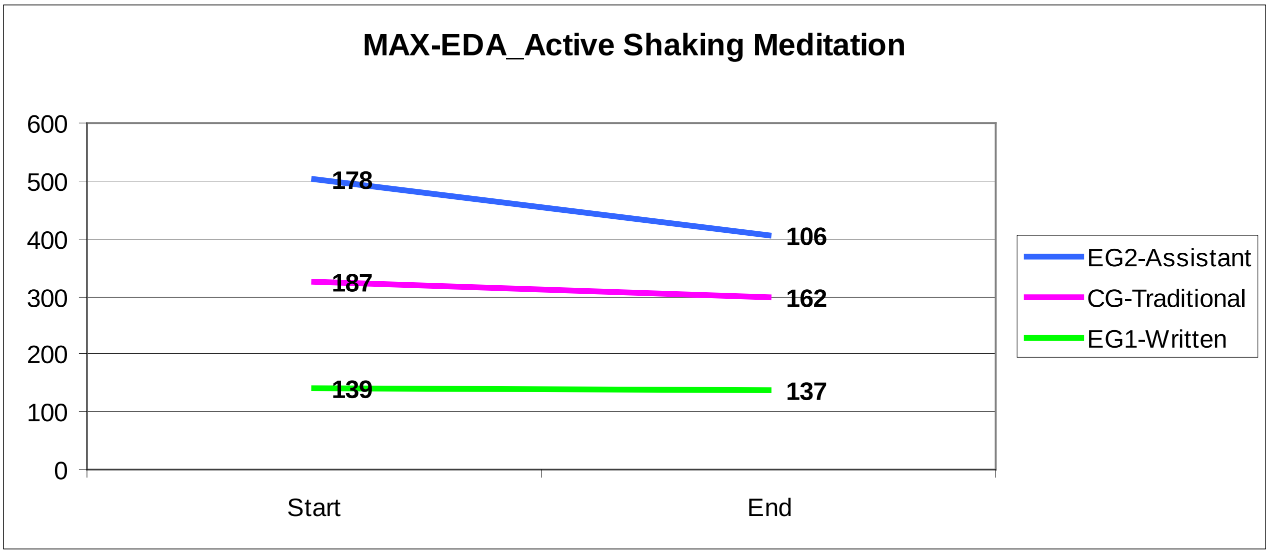
We can notice that in each exercise, EG2-Assistant has the higher difference pre-post both for EDA and for HR. Further, for those exercises where it was required to think and to gain self-awareness, for example, “Facial mindfulness” and “How does my body feel”, both in EG1-Written and CG-Traditional, EDA and HR values, didn’t diminished but on the contrary they have increased. This could be due to the fact that in EG2-Assistant, the participant is alone, he/she ‘interact’ only with the Avatar-Assistant, while in CG-Traditional the human trainer is next to him and this could be embarrassing, especially for an adolescent, while in EG1-Written it could be that the participant is less involved because he has only written instructions.

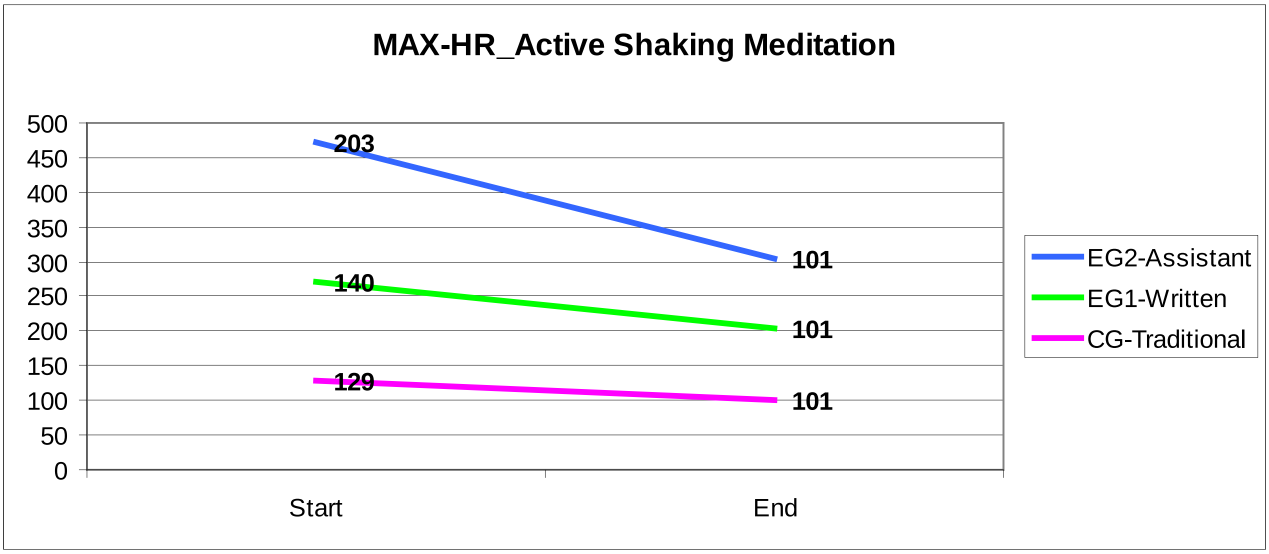

MAX-EDA_Facial Mindfulness
500
450
400
350
300
250
200
150
100
50
0
149
186
136
155
112
103
Start
End
CG-Traditional
EG1-Written
EG2-Assistant

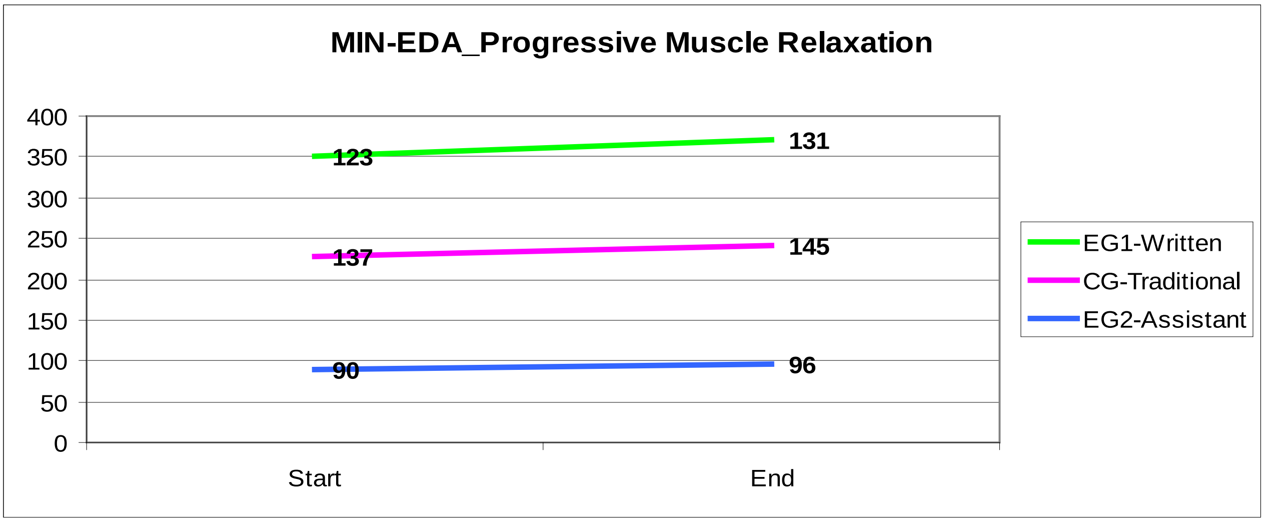

MAX-HR_Facial Mindfulness
400
350
300
250
200
150
100
50
0
110
134
94
123
114
94
Start
End
EG1-Written
CG-Traditional
EG2-Assistant

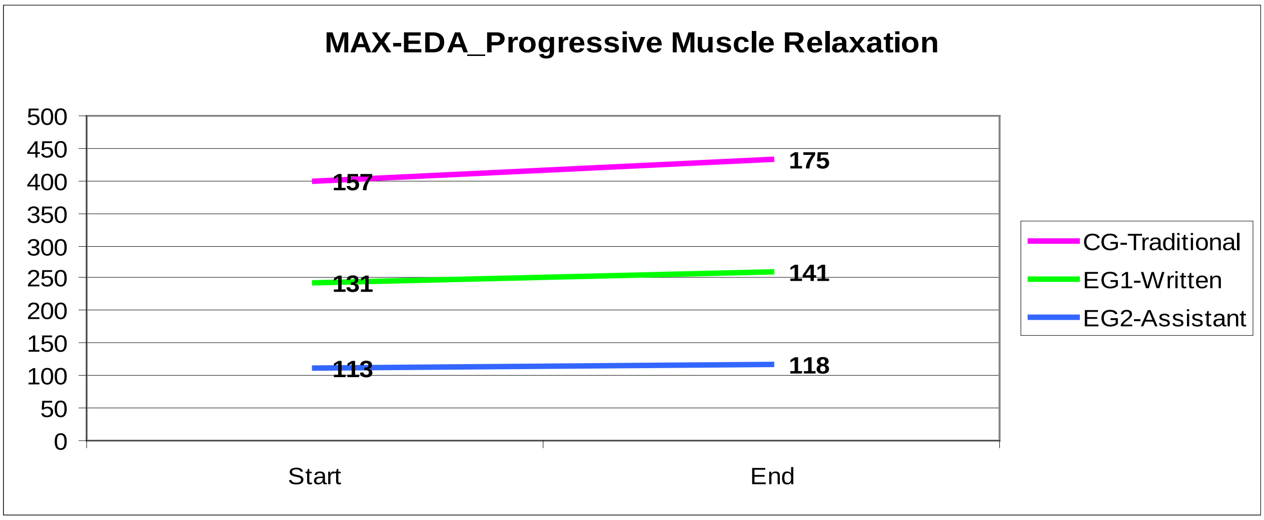

MAX-EDA_Breathing Regulation
600
500
400
300
200
100
0
146
189
181
227
126
117
Start
End
EG1-Written
CG-Traditional
EG2-Assistant

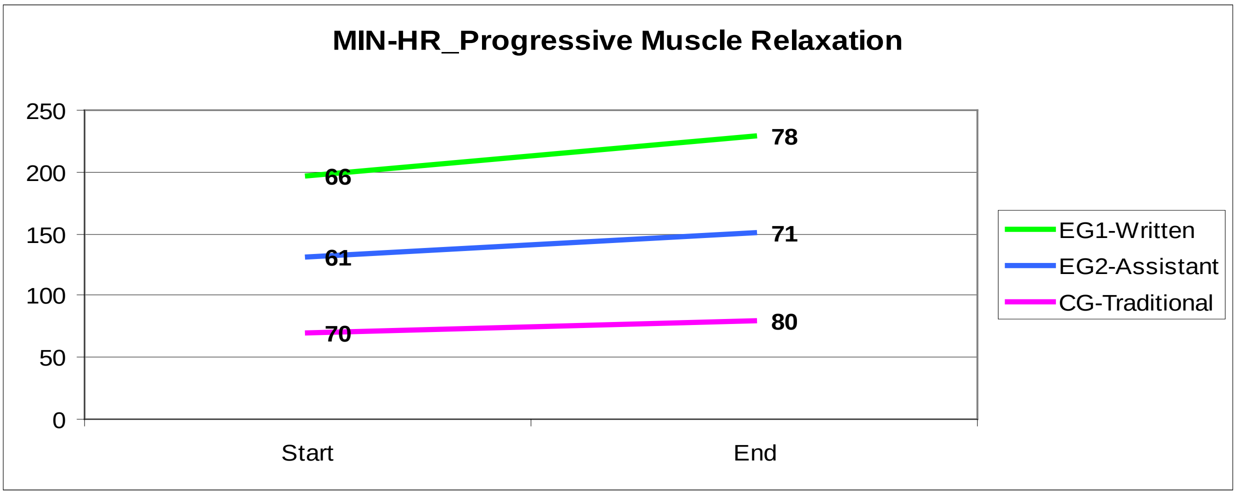

MAX-HR_Breathing Regulation
600
500
400
300
200
100
0
117
195
116
194
145
121
Start
End
CG-Traditional
EG1-Written
EG2-Assistant

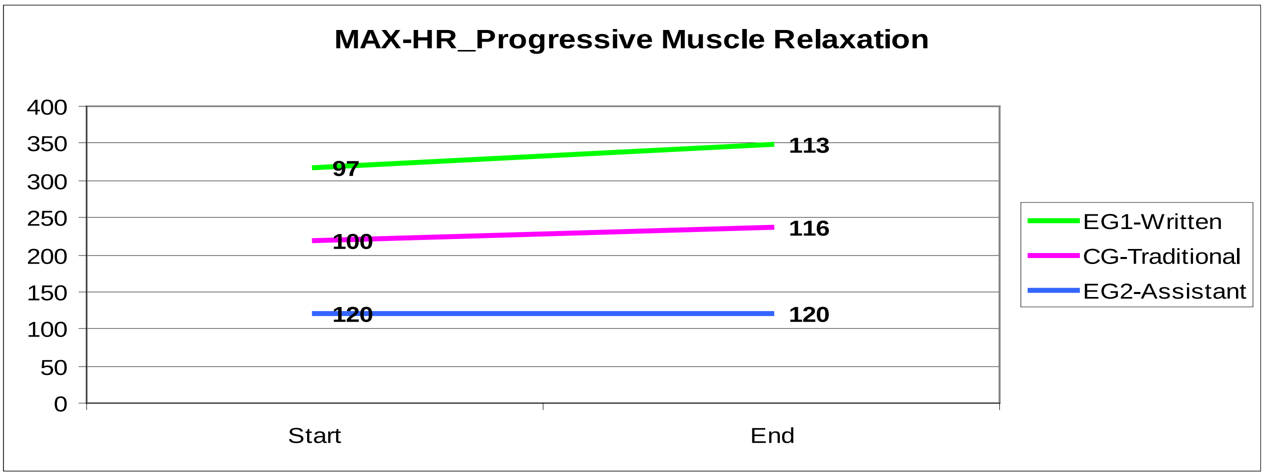

MAX-EDA_Active Shaking Meditation
600
500
400
300
200
100
0
178
106
187
162
139
137
Start
End
EG2-Assistant
CG-Traditional
EG1-Written

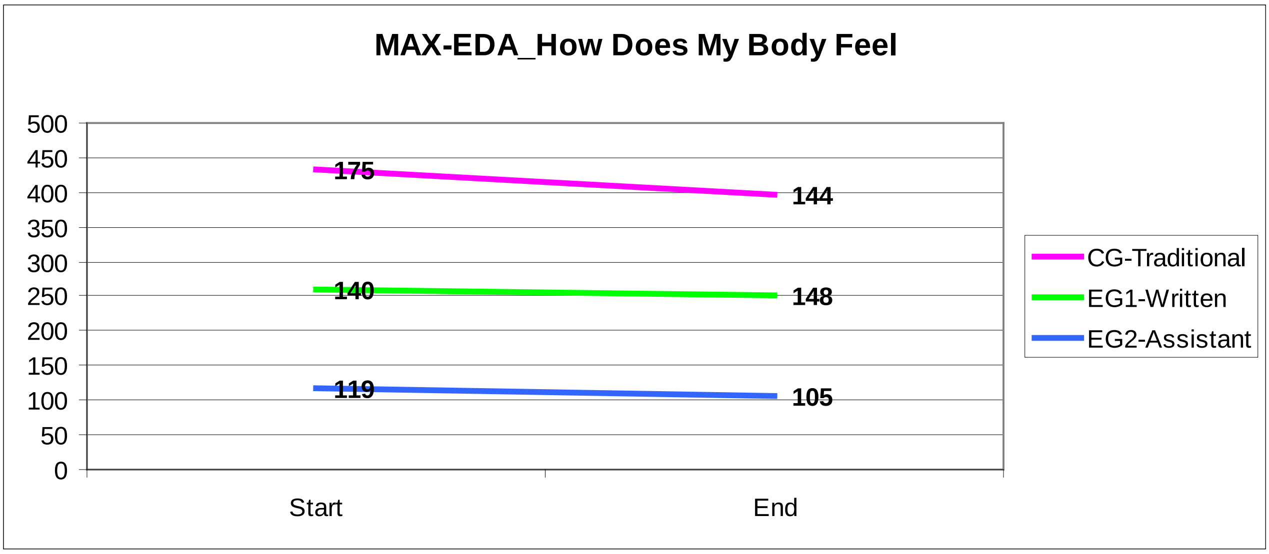

MAX-HR_Active Shaking Meditation
500
450
400
350
300
250
200
150
100
50
0
203
101
140
101
129
101
Start
End
EG2-Assistant
EG1-Written
CG-Traditional

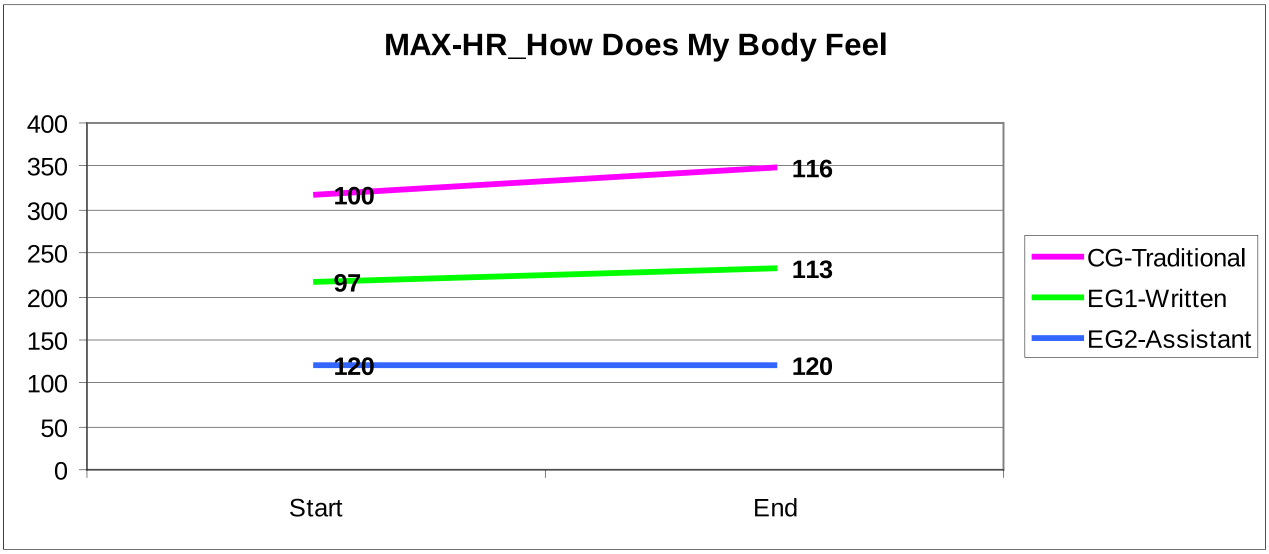

MIN-EDA_Progressive Muscle Relaxation
400
350
300
250
200
150
100
50
0
123
131
137
145
90
96
Start
End
EG1-Written
CG-Traditional
EG2-Assistant

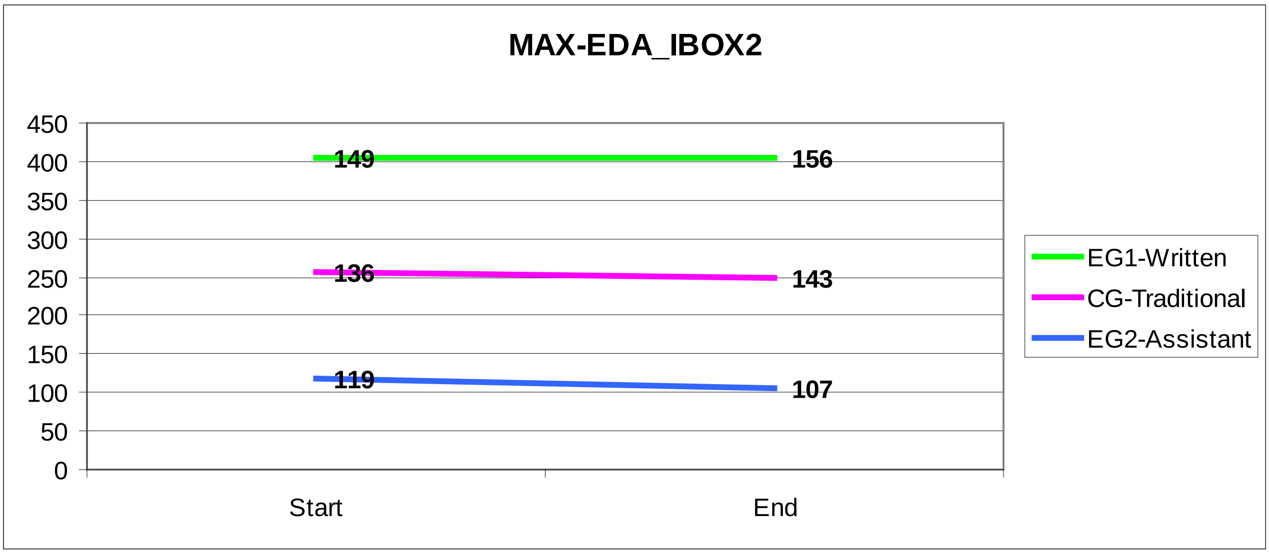

MAX-EDA_Progressive Muscle Relaxation
500
450
400
350
300
250
200
150
100
50
0
157
175
131
141
113
118
Start
End
CG-Traditional
EG1-Written
EG2-Assistant

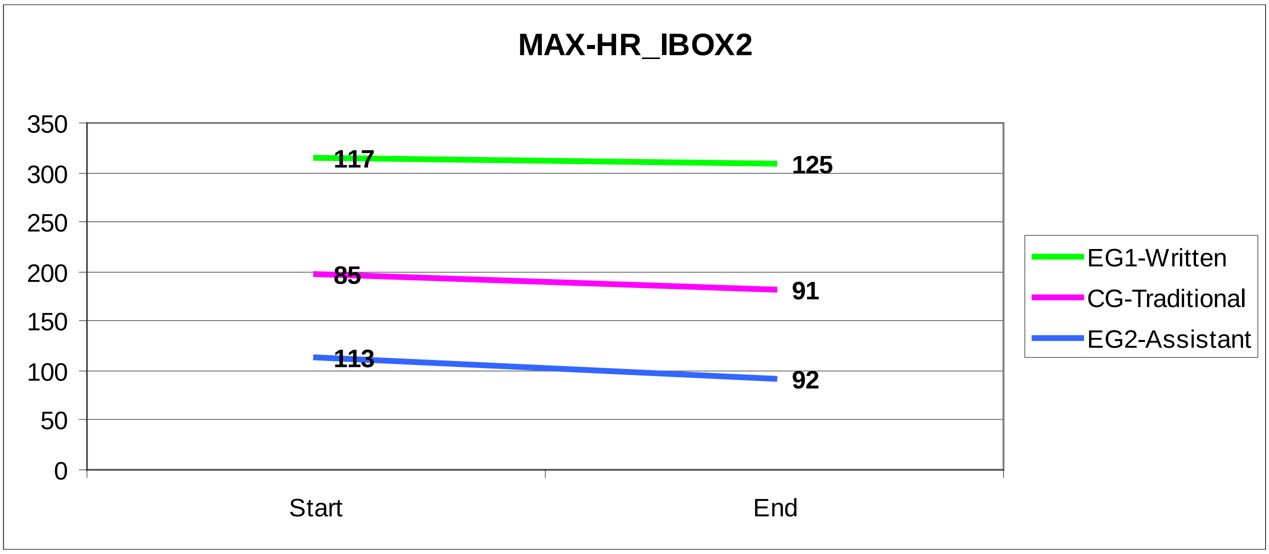

MIN-HR_Progressive Muscle Relaxation
250
200
150
100
50
0
78
66
71
61
80
70
Start
End
EG1-Written
EG2-Assistant
CG-Traditional


MAX-HR_Progressive Muscle Relaxation
400
350
300
250
200
150
100
50
0
113
97
116
100
120
120
Start
End
EG1-Written
CG-Traditional
EG2-Assistant

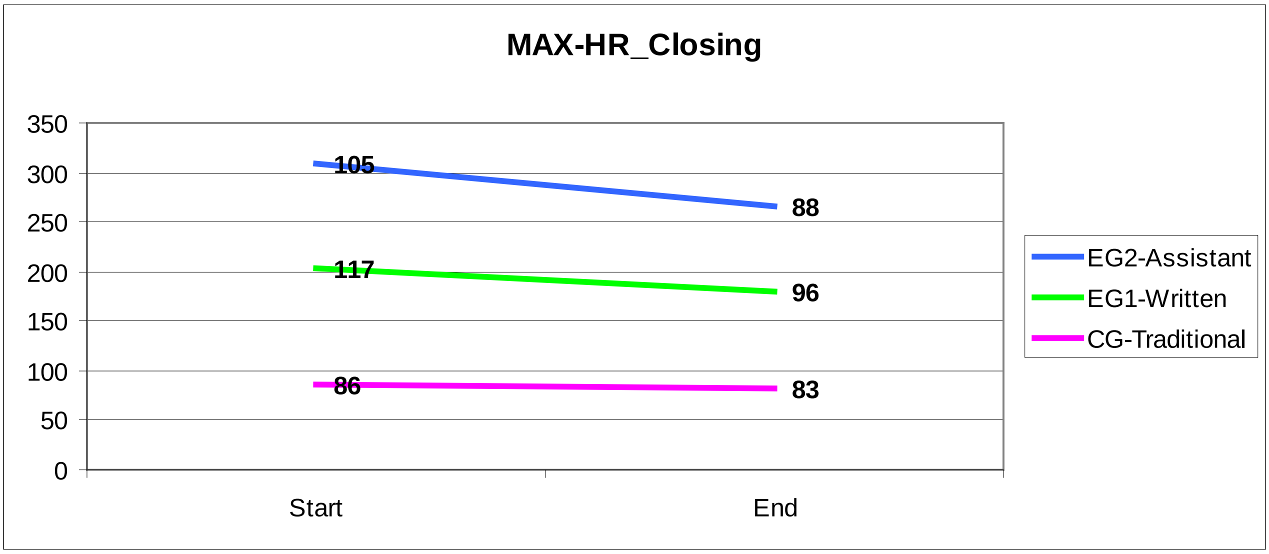

MAX-EDA_How Does My Body Feel
500
450
400
350
300
250
200
150
100
50
0
175
144
140
148
119
105
Start
End
CG-Traditional
EG1-Written
EG2-Assistant


MAX-HR_How Does My Body Feel
400
350
300
250
200
150
100
50
0
100
116
97
113
120
120
Start
End
CG-Traditional
EG1-Written
EG2-Assistant


MAX-EDA_IBOX2
450
400
350
300
250
200
150
100
50
0
149
156
136
143
119
107
Start
End
EG1-Written
CG-Traditional
EG2-Assistant

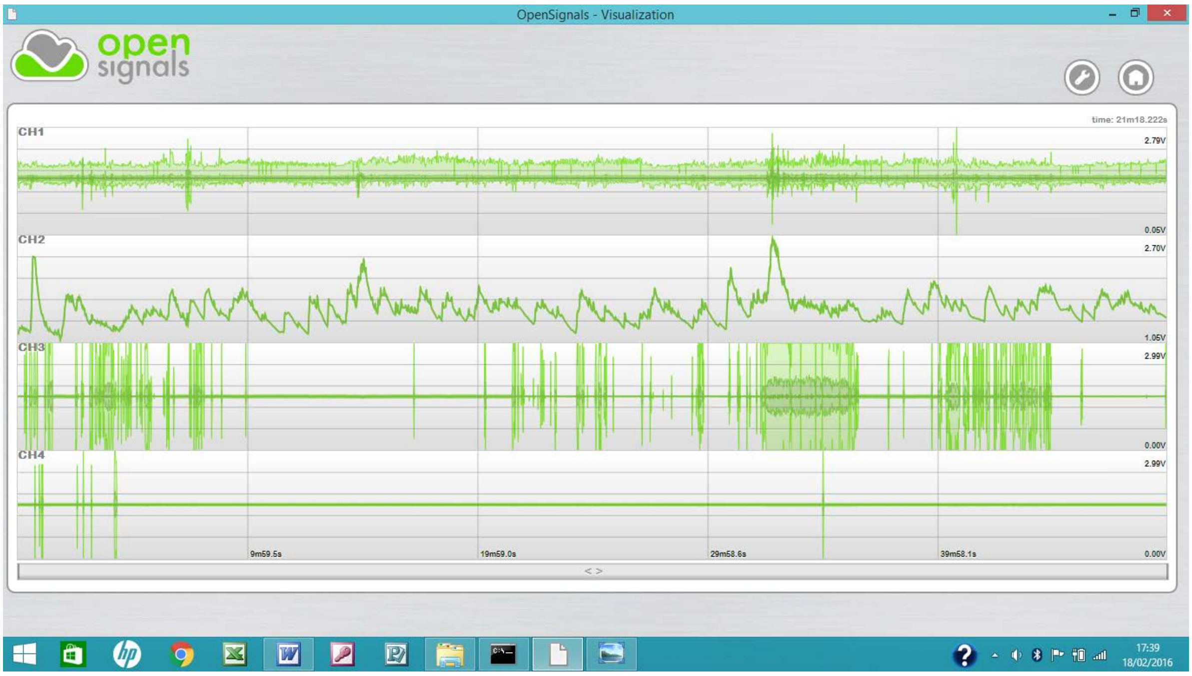

MAX-HR_IBOX2
350
300
250
200
150
100
50
0
117
125
85
91
113
92
Start
End
EG1-Written
CG-Traditional
EG2-Assistant


MAX-EDA_Closing
450
400
350
300
250
200
150
100
50
0
154
156
135
145
115
114
Start
End
EG1-Written
CG-Traditional
EG2-Assistant


MAX-HR_Closing
350
300
250
200
150
100
50
0
105
88
117
96
86
83
Start
End
EG2-Assistant
EG1-Written
CG-Traditional

An example of EG2-Asssitant session:

ch1= HR; ch2= EDA; ch3= Muscle activity biceps; ch4=Muscle activity trapez



5.3.6 Evaluation questionnaires

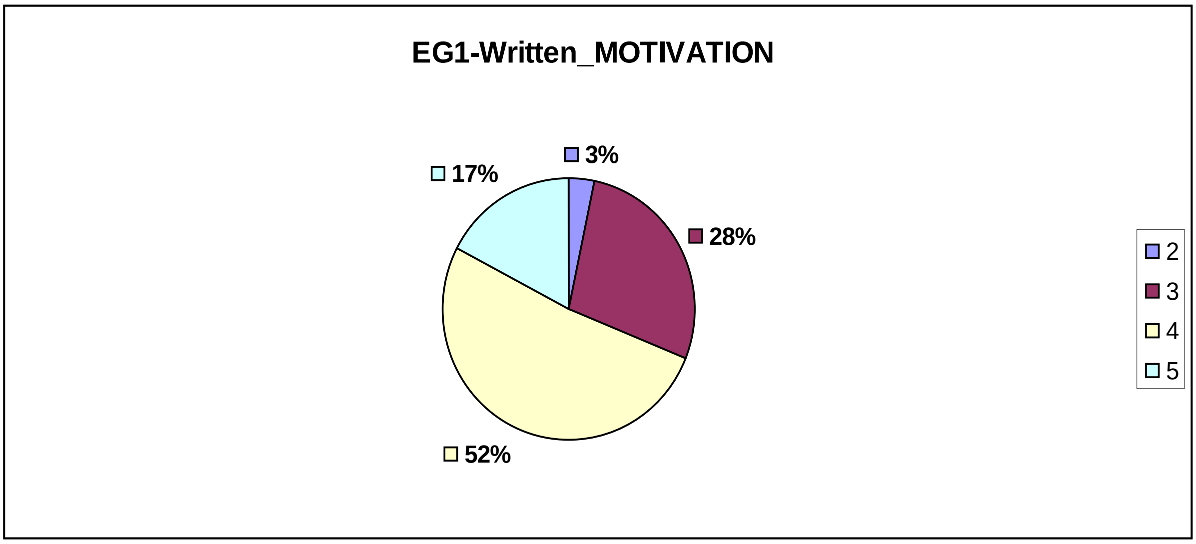
Besides the psychological and physiological measures, also some evaluative questions were asked to participants.

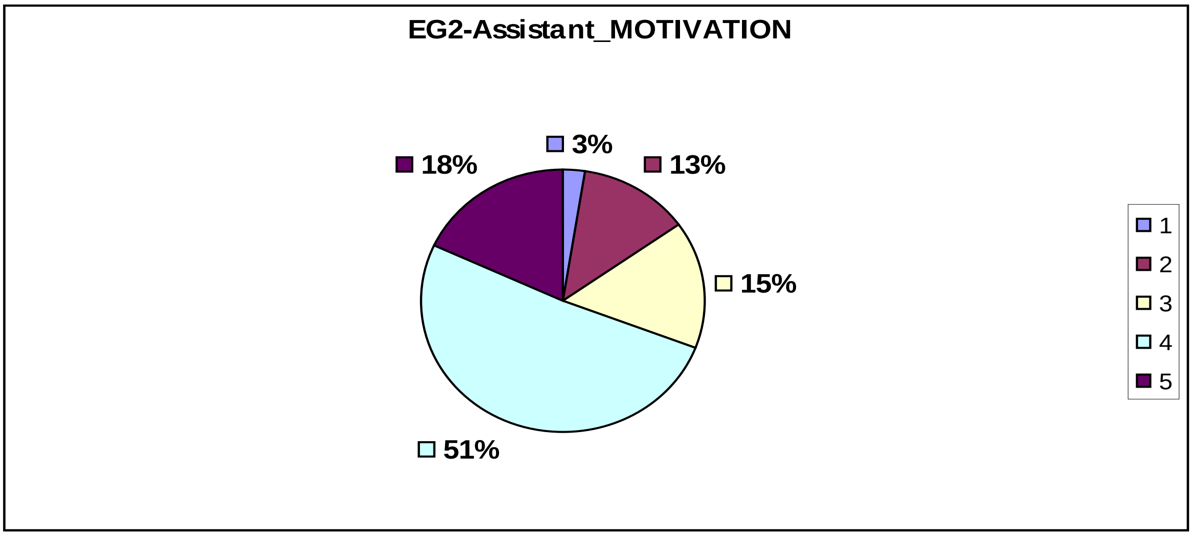
To all three groups it was asked to evaluate on a 5-likert scale: Motivation and Fun.

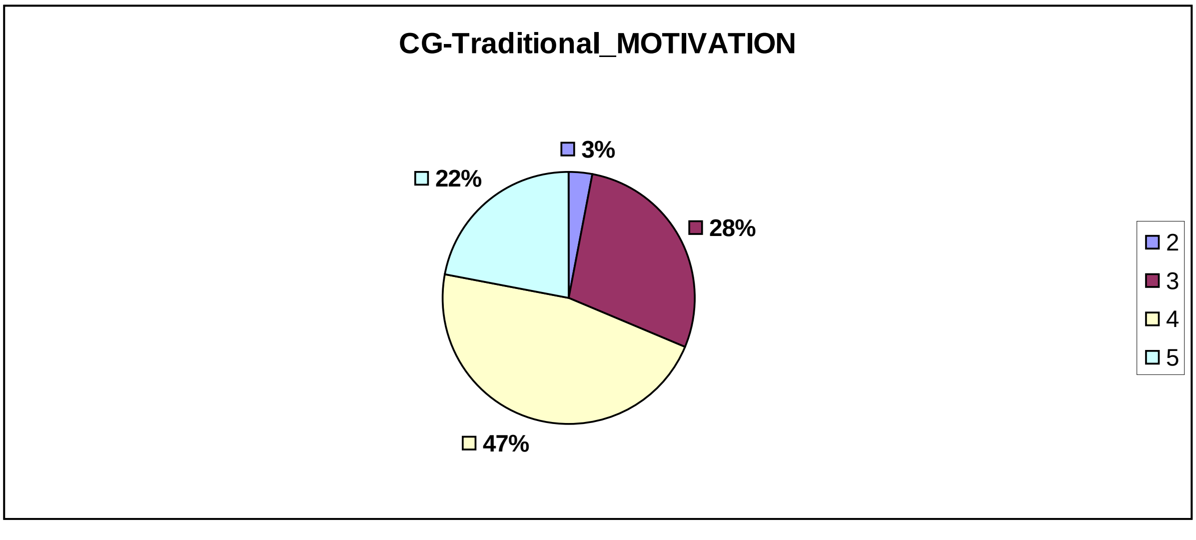
To EG1-Written and to EG2-Assistant it was asked to evaluate also: Graphics, Identification (with their own avatar) and Score, while to CG-Traditional it was asked to evaluate also: Tools (the printed images etc used for the training).

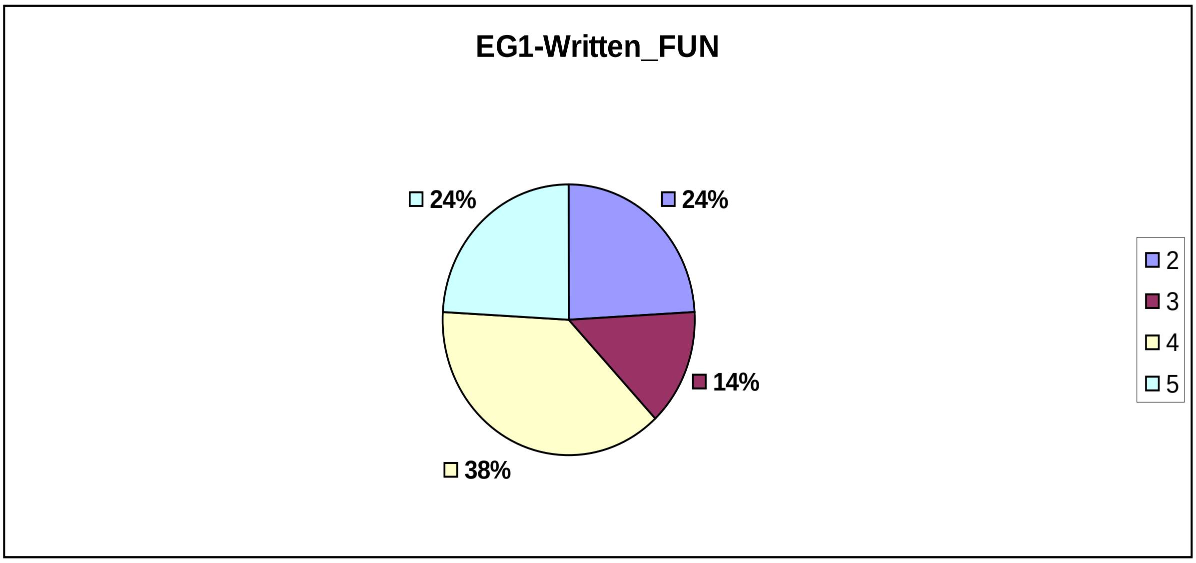
To all participants it was also asked to express their own opinion about the whole protocol and/or to give some suggestions. The most common answers were: to give the possibility to personalize their own avatar; to give a choice of different music for the Active Shaking Meditation; to make more natural movements of their avatar and of the Assistant; to make the assistant interact with them, for example by encouraging during the exercises; less time between a screen and the other and also during the Assistant's speech; someone suggested to improve graphics, someone else wrote that is good; some participants of the traditional training have found tools suitable, others said that a pc training would be more suitable for their age.

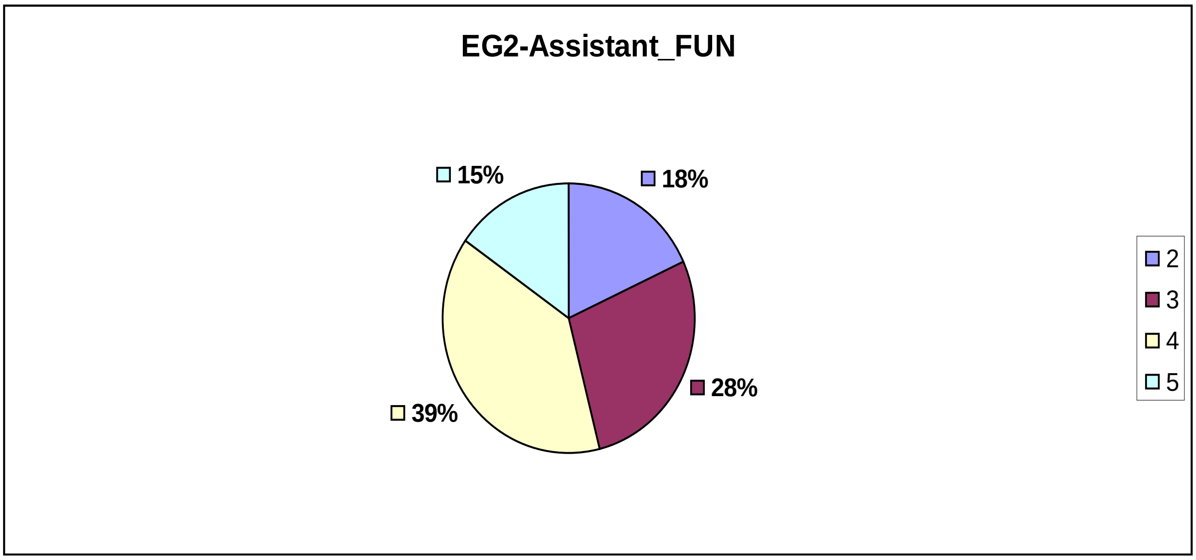
The results in percentage are reported for each group in the following pie charts:

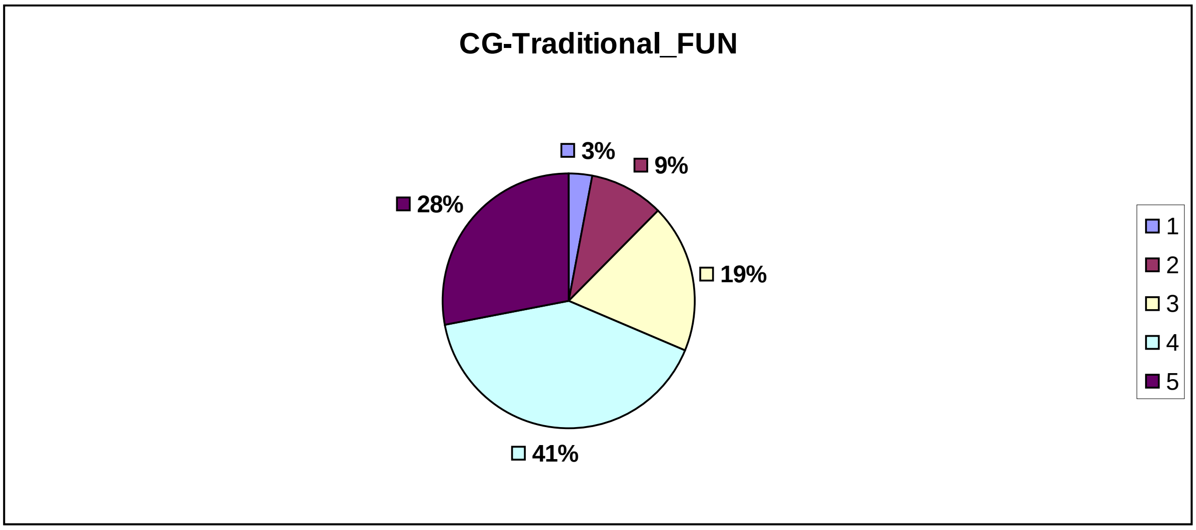

EG1-Written_MOTIVATION
3%
28%
52%
17%
2
3
4
5

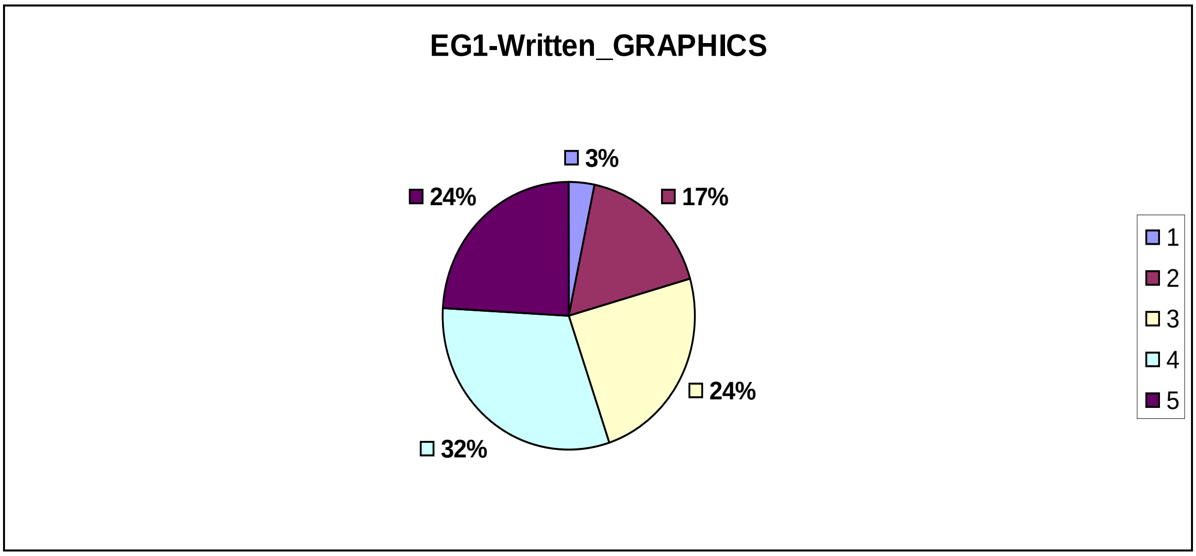

EG2-Assistant_MOTIVATION
18%
3%
13%
15%
51%
1
2
3
4
5

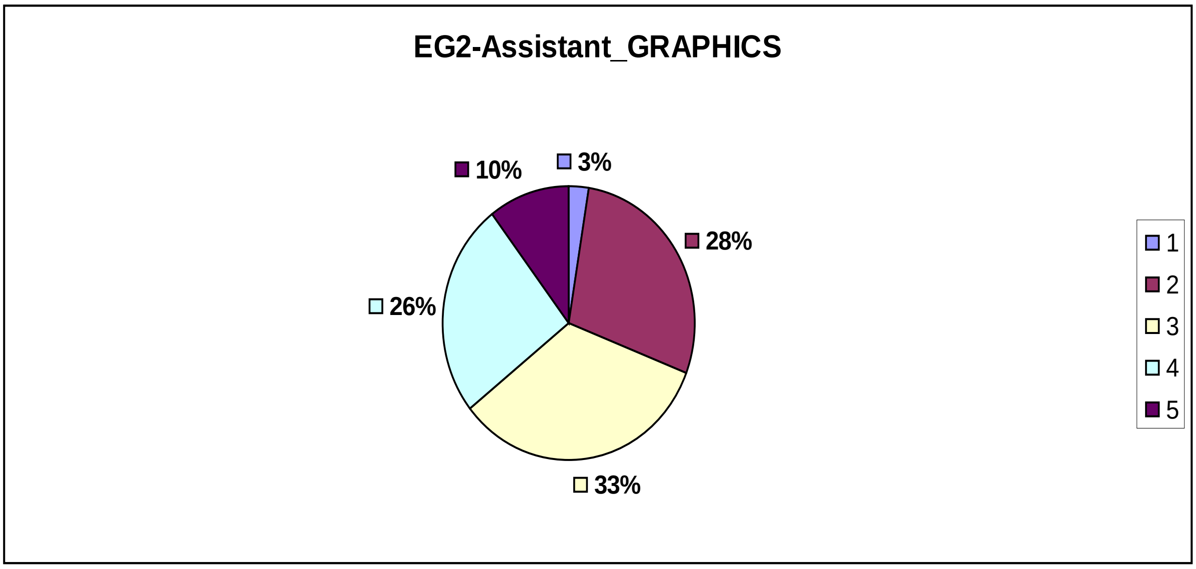

CG-Traditional_MOTIVATION
3%
22%
28%
47%
2
3
4
5

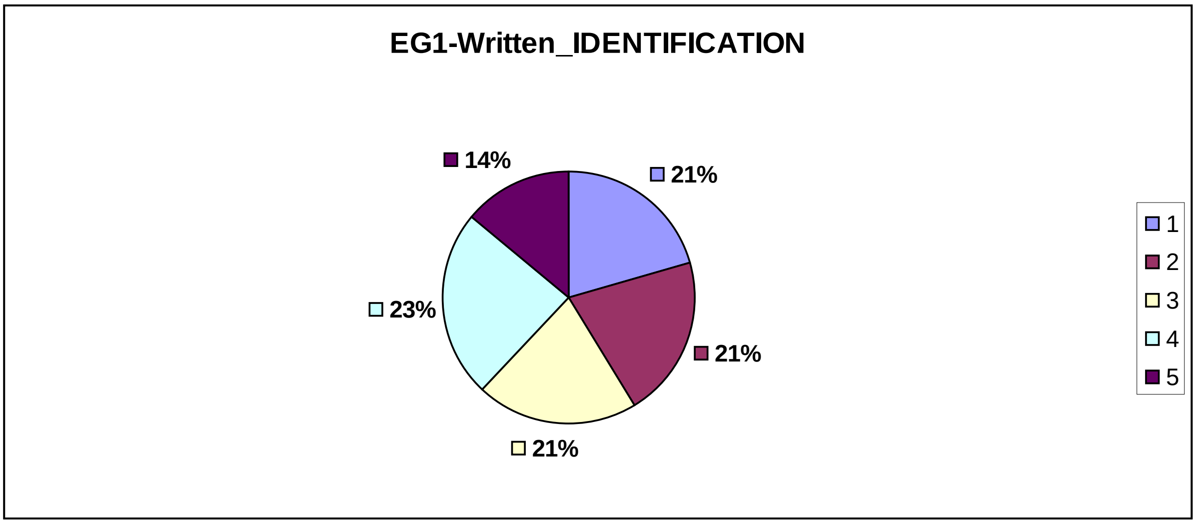

EG1-Written_FUN
24%
24%
14%
38%
2
3
4
5

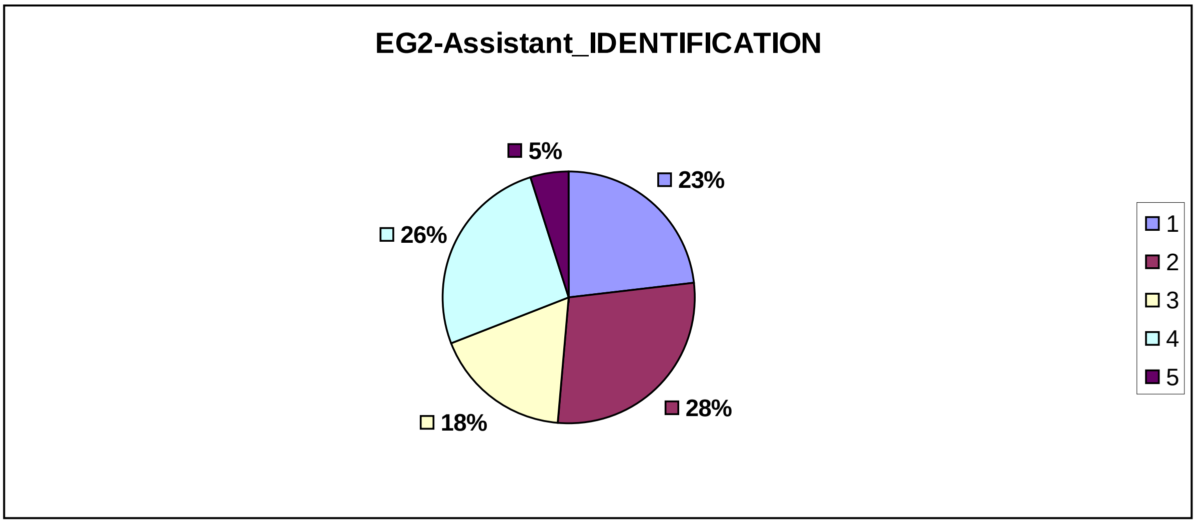

EG2-Assistant_FUN
15%
18%
28%
39%
2
3
4
5

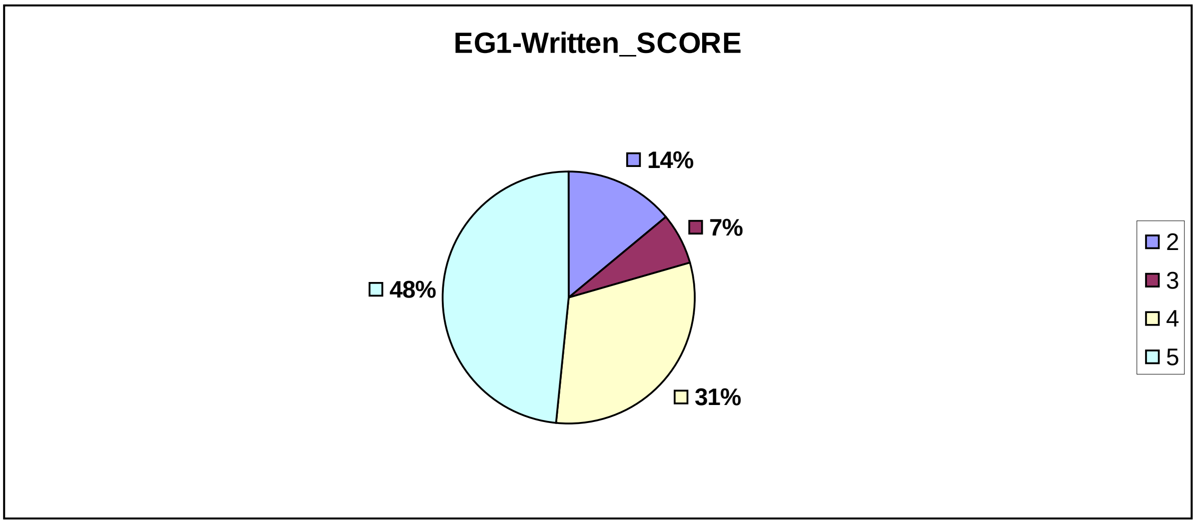

CG-Traditional_FUN
3%
9%
28%
19%
41%
1
2
3
4
5

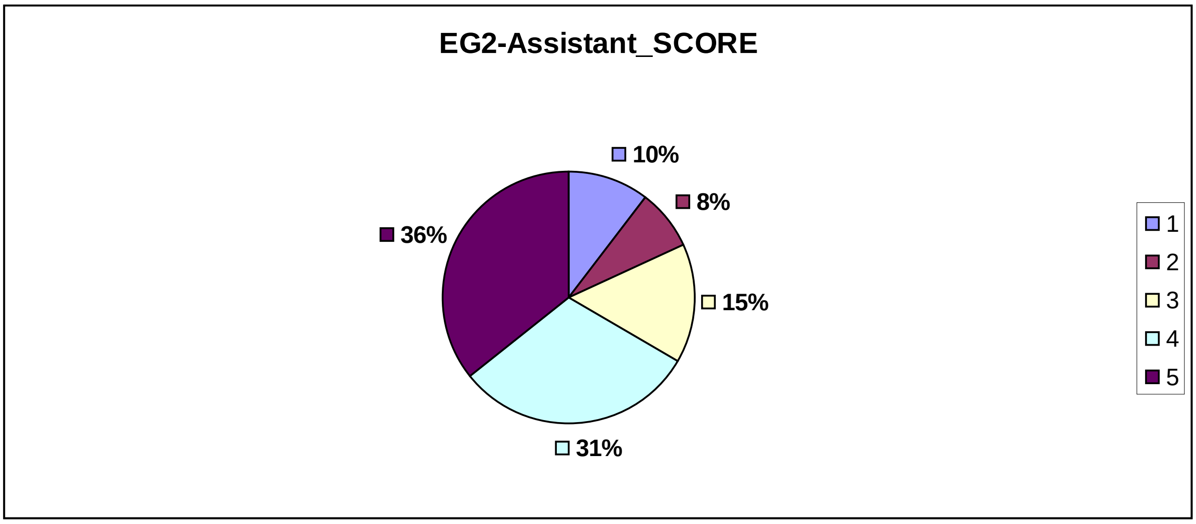

EG1-Written_GRAPHICS
3%
17%
24%
32%
24%
1
2
3
4
5

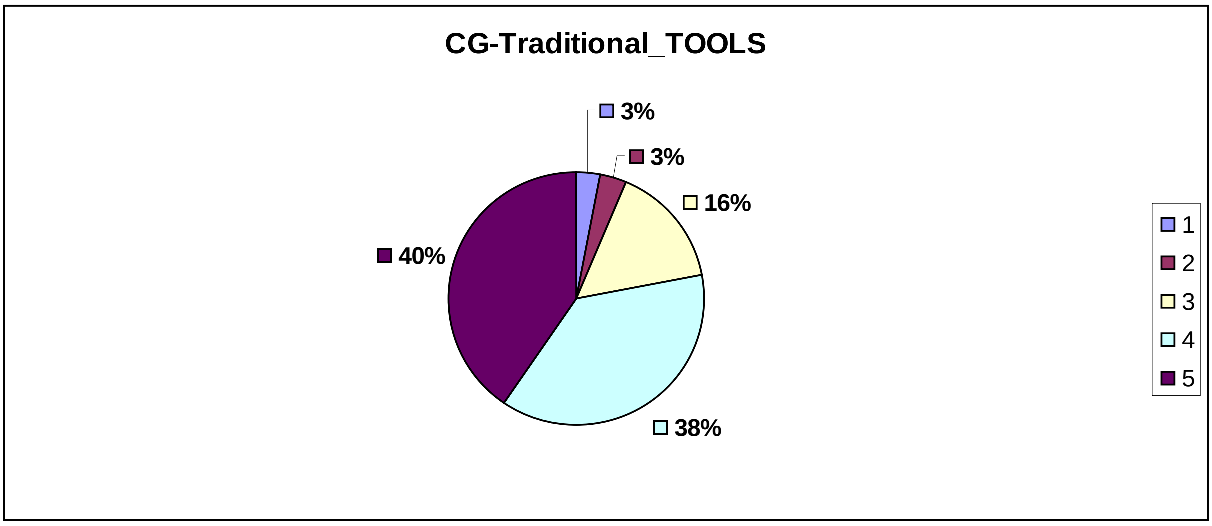

EG2-Assistant_GRAPHICS
10%
3%
28%
26%
33%
1
2
3
4
5


EG1-Written_IDENTIFICATION
14%
21%
23%
21%
21%
1
2
3
4
5


EG2-Assistant_IDENTIFICATION
5%
23%
26%
18%
28%
1
2
3
4
5


EG1-Written_SCORE
14%
7%
48%
31%
2
3
4
5


EG2-Assistant_SCORE
10%
8%
36%
15%
31%
1
2
3
4
5


CG-Traditional_TOOLS
3%
3%
16%
40%
38%
1
2
3
4
5

5.5 Discussion

The main objective of the present study was to evaluate the efficacy of selected sessions in the technology-enhanced adaptation of the BEAR training protocol (Pat-Horenczyk et al., 2012) in a sample of youth between the ages of 12-19.

The results showed that all the 3 versions of the revised protocol were effective in decreasing state anxiety, perceived stress and negative affect, as well as in increasing perceived calm and positive affect. More specifically results between versions 2 and 3 (EG2-Assistant and CG-Traditional) were more similar to one another than to version 1 (EG1-Written).

Overall the data suggests that even taking part in one session of the training is useful in reducing psychological stress and trait anxiety, regardless of the version, but that notwithstanding some important differences emerged.

Though no significant differences were found between versions in the self-report measures of engagement, higher activation and involvement in each exercise was seen in the physiological data in version 2 (EG 2). This finding suggests that the presence of the Avatar-Assistant has an significant impact. Further, significant correlations were found between how the Avatar-Assistant was perceived and the level of engagement and usability reported by the participants, highlighting the influence of the dimension of believability.

The main strengths of the present study are the combination of different advanced technologies: gamification aspects, virtual characters and wearable physiological sensors. In addition, the comparison between three different versions of the same session could help others decide how best to implement new technologies into intervention programs..

Wearable biosensors were used for all the 3 groups, even though the heart rate value was only always visible on the PC monitor for participants in versions 1 and 2 (EG1 and EG2). In version 3 (CG) participants didn't use the computer and thus did not see their heartrate, and were asked to instead pay attention to their HR and muscle activation during the exercises.

As stated previously, most recent theories highlight that emotions are multidimensional and multicomponent processes, stressing the importance for multi-modal assessment methods (Scherer, 2001). Furthermore, it is widely recognized that stress detection technologies can help people better understand and relieve stress by increasing their awareness of heightened levels of stress that would otherwise go undetected (Dishman et al., 2000; Hernandez, Morris & Picard, 2011; Vrijkotte, van Doornen, & de Geus, 2000). In addition, in the focus groups adolescents displayed low levels of physical awareness when it came to their physiological responses.. The possibility for a user to see his/her HR allows for him/her to receive immediate feedback trains the user to gain control over his/her physiological activation as related to his/her stress level.

A limitation of this research was that any VR-biofeedback was associated to the HR, and as demonstrated by Ratanasiripong, Ratanasiripong and Kathalae (2012) and by Gaggioli et al. (2014), and as emerged in the findings of the study introduced in the previous chapter, VR-biofeedback is more effective in inducing relaxation than simple audio and visual cues.

With regards to gamification aspects, in the last couple years, gamification has been a trending topic and a subject to much hype as a means of supporting user engagement and enhancing positive patterns in service use (Hamari & Koivisto, 2014; Hamari & Lehdonvirta, 2010; Huotari & Hamari, 2012), such as increasing user activity, social interaction, and quality and/or productivity of actions (Hamari, 2013). Participant's scores – via-points awarded during the session – were visible in versions 1 and 2 (EG1 and EG2) for the duration of each session and participants reported this feature as being one of the programs main motivating factors. It is important to note that participants in version 3 (CG) did not have this motivator.

Another limitation of this study was that only one session was tested and no follow-up sessions were possible. When seeking to explore coping enhancement, it can be assumed that one session isn't sufficient to achieve enhanced positive coping abilities, but that the whole training is necessary, as emerged with the BEAR groups evaluated in Singapore who completed all 8 sessions of the original protocol (Pat-Horenczyk et al., 2014).

All together the results of this study are in line with two recent lines of research.

Many researchers and clinicians have proposed using VR in adjunct to in vivo exposure therapy to provide an innovative form of exposure to patients suffering from various psychological disorders. The rationale behind the 'virtual approach' is that real and virtual exposures elicit a comparable emotional reaction in subjects. To test whether virtual stimuli are as effective as real stimuli, and more effective than photographs in the anxiety induction process, Gorini et al. (2010) tested the emotional reactions to real food (RF), VR food and photographs (PH) of food in two samples of patients affected, respectively, by anorexia (AN) and bulimia nervosa (BN) in comparison to a group of healthy subjects. The two main hypotheses were the following: (a) that virtual exposure elicits emotional responses comparable to those produced by real exposure; and (b) the sense of presence induced by the VR immersion makes the virtual experience more ecological, and consequently more effective than static pictures in producing emotional responses in humans. Results showed that RF and VR induced a comparable emotional reaction in patients, which was higher than the one elicited by the PH condition. They also found a significant effect in the subjects' degree of presence experienced in the VR condition about their level of perceived anxiety (STAI-S and VAS-A): the higher the sense of presence, the stronger the level of anxiety. This study showed that VR is more effective than PH in eliciting emotional responses similar to those expected in real life situations and speaks to the potential impact of VR in a variety of experimental, training and clinical contexts, with a range of extremely wide and customizable possibilities.

Further, several studies investigating the effectiveness of different types of treatments have demonstrated that exposure-based therapies are more suitable and effective than others for the treatment of anxiety disorders. Traditionally, exposure may be achieved in two manners: in vivo, with direct contact to the stimulus, or via imagery, in the person's imagination. However, despite its effectiveness, both types of exposure present some limitations that might be mitigated through the use of VR. But can VR always serve as an effective stressor? Are the technological breakdowns that may appear during such an experience a possible risk for its effectiveness?

Pallavicini et al. (2013) compared changes following exposure to an academic examination, one of the most universal examples of real-life stressors, in a sample of 39 undergraduate students. The same experience was offered using text (TX), audio (AU), video (VD), and VR. However, in the virtual environment they manipulated the experience and introduced technological breakdowns.

The Post Media Questionnaire (PMQ) and the Slater-Usoh-Steed Presence Questionnaire (SUS) were administered to each participant in order to evaluate self-report measures of anxiety and relaxation and the level of presence experience during media exposure. electrocardiogram (ECG), thoracic Respiration Signal (RSP) and Facial corrugator supercilii muscle electromyography (EMG) were recorded so as to obtain objective measures of subjects' emotional state. The analyses found a significant increase in anxiety scores and a mirrored decrease in relaxation scores after all simulations, showing that each of the conditions was effective in inducing a negative emotional response. However, psychometric scores and psychophysiological indexes showed that VR was less effective than other procedures in eliciting stress responses. Moreover, no significant difference was observed in SUS scores: VR induced a sense of presence similar to that experienced during the exposure to the other media. This study suggests that technological breakdowns significantly reduce the possibility of VR in eliciting emotions related to complex real-life stressors. Without a high sense of presence, the significant advantages offered by VR disappear and its emotional induction abilities are even lower than the ones provided by much cheaper media.

The present empirical contributions compared three versions of the same training each of which adopted a different tool (Computer based (Written); Avatar-Assistant; and Traditional) and the main findings are in line with the results seen in Gorini et al. (2010) and Pallavicini et al.'s (2013) research. , In fact, similar results were obtained in the psychological measures obtained in version 1 (EG1-Assistant) and version 3 (CG-Traditional). Further, one of the main limitations noted by participants in the evaluation questionnaire was the excessive time that passed between one screen and the next. In version 3, the Avatar-Assistant version, participants remarked on the long pauses in the avatar’s speech.

These breaks or pauses were due to technical considerations relating to the time required by the software that was used. These are limitations that must be overcome and that are comparable to the technological breakdowns in the study described (Pallavicini et al., 2013).

In conclusion, though preliminary, the present results provide initial evidence of the potential of the technology-enhanced protocol in the Avatar-Assistant version.

An aspect that is both a strength of this research and a point to explore is the individual use of the training. We can presuppose that the promising results of training with the avatar-assistant are partially due to the fact that the participant doesn’t interact with a person, and this feature, particularly in work with adolescents, might be more comfortable, especially for the type of required exercises. Despite maintaining the same time allotment given in the other versions, during which the researcher went out of the classroom to let the user more freely play the Active Shaking Meditation (which required him/her to move/dance to the music), it may be that in general, the fact that the user primarily interacted with the PC created more of a personal space. In addition, unlike, the written version, the avatar's presence increased the involvement. Further, as we found that only version 2 (EG2) achieved a higher perceived feeling of calm following the training, we can suppose that this was due to characteristics of the avatar-assistant, such as gestures and speech, that led to a more relaxed state; in addition, the behaviour of the avatar-assistant couldn’t change from person to person and couldn’t be influenced by it personal mood, while this could have occurred with the human-trainer.

In the future it would be interesting to develop a version where the user could personalize his/her own avatar, as well as to develop a group technology version, where users could interact together, in order to see if and how the psycho-physiological results would change.

CONCLUSIONS

The present empirical contribution's research question aims to identify whether new technologies can support adolescents in coping with stress and in enhancing their emotion regulation (ER) abilities, proposing an innovative technology-enhanced approach.

There is now considerable evidence that coping with stress and the regulation of emotions are important psychological processes that share many key features. These include their basic definitions and conceptualisations, measurements, and interventions that have been created to enhance skills in both domains in the prevention and treatment of psychopathology (Compas et al., 2013). However, while coping skills and ER are closely linked, they are not synonymous, which suggests that there is potential benefit in examining these separate constructs together in future research. As stated by Compas et al. (2013) it is time for researchers who study coping and ER to break down the barriers between these two lines of research and further examine the possible linkages between these constructs. This can take at least two forms: one at a broad, macro level and the other at a more focused, micro level. At the macro level, it is important to test the developmental pattern and possible sequences in the emergence of skills to cope with stress and regulate emotions over the course of childhood, adolescence, and adulthood. At a micro level, coping efforts that are initiated in response to a defined stressful event are supported by efforts to regulate emotions before and after a stressful encounter. Poor ER skills prior to stress may contribute to the onset or occurrence of dependent stressful events, that is, stressors that are at least in part the result of actions by the individual (e.g., Conway, Hammen, & Brennan, 2012).

As stated by Saarni (1999), a child doesn't learn how to be aware of his or her feelings or to understand what others feel in a piecemeal fashion, and an ever-increasing amount of research provides support for the role of systemic, ongoing, social-emotional education plays in optimal cognitive and behavioural development (Bear, Manning, & Izard, this issue; Elias et al., 1997). Moreover, the World Health Organization (WHO) has defined life skills as "the abilities for adaptive and positive behaviour that enable individuals to deal effectively with the demands and challenges of everyday life" (Pohan, et al, 2011). Among the five basic areas of life skills identified by the WHO, coping with emotions and coping with stress both appear. Furthermore, life skills education needs to be developed as part of a whole school initiative designed to support the healthy psychosocial development of children and adolescents. With this in mind, it is important to note that today's students are the so called "digital natives:" they have grown up with new technologies and these technologies are their natural habitat. As a result, today's generation has developed cognitive and learning specific styles, different to those of the previous generation (Michael & Chen, 2006;

Palfrey & Gasser, 2008). The school must take this into account so as to play its educational role in an effective way. For the digital natives, new technologies and Health eGames can be an attractive alternative to traditional teaching methods (Kalapanidas et al., 2009).

With the present empirical contribution the efficacy of positive technologies in promoting stress management and emotion regulation abilities was tested in a sample of young people aged 12-19. Two empirical studies were carried out with the aim to first test the effectiveness of the Positive Technology App in inducing relaxation (PTA; Riva, 2013) and second, to test and to evaluate the efficacy of selected sessions of the BEAR training protocol (Pat-Horenczyk et al., 2012) in the technology-enhanced versions that were developed.

Overall, results show the efficacy of positive technologies not only in reducing perceived psychological stress and feelings of anxiety, but also in promoting engagement and motivation, as well as in improving the awareness of body sensations and the well-being of young users.

In particular, the main result of the first study (PTA) needs to be highlighted: only the group who used biofeedback in addition to the app obtained a significant decrease of stress and anxiety levels. We propose that this is due to the fact that biofeedback increases the awareness of our physiological state. One of the main areas explored in the present empirical contribution started from the user needs analysis, and in which adolescents expressed relevant particular difficulties. The biofeedback gives users the opportunity to enhance their physical awareness and to subsequently obtain better results (Gaggioli et al.,2014; Repetto et al., 2009). In addition, we assume that the opportunity to use an innovative tool, the POLAR-BT, may have allowed participants to feel more engaged. Further, smartphones and tablets give participants the opportunity to perform stress management exercises of the PTA anywhere and any time, confirming that availability and comfort is an important component of intervention efficacy (Preziosa et al., 2009).

The second study's results highlight that the technology-enhanced version of the BEAR training with the avatar-assistant was as effective as the traditional version conducted by a human trainer in the decrease of state anxiety, perceived stress and negative affect, as well as in increasing perceived calm and positive affect. These findings are in line with the emergent trend research and results obtained by Gorini et al. (2010) and by Pallavicini et al. (2013). In addition, the presence of the avatar-assistant induced higher activation, measured through physiological data. The results showed that engagement and usability were significantly correlated with how the avatar was perceived, with believability a particularly important aspect of said perception.

Other dimensions related to the user's perception of the avatar that emerged as influential on the final outcome, engagement and usability, were likeability, perceived intelligence and perceived safety. Each of these dimensions was significantly correlated with the autotelic experience dimension. All together, these findings bring this version in line with devices developed within the Human Computer Interaction (HRI) framework, where Virtual agents (VA) are software interfaces that allow natural, human-like, communication with the machine and where believability is one of the primary programming goals (Paiva et al., 2005).

But what does it mean that something is believable?

This is the question that researchers have tried to answer in many contexts (Andrews, Netemeyer, & Durvasula, 1991; Beltramini, 1982; Berkos, 2003; Ewing, 1940; Hovland, Janis, & Kelley, 1953).

Towards the end of the 20th century, computer scientists in the field of autonomous agents began to analyze how the artistic principles of animated characters could be used to design believable agents (Bates, 1994). The term believability is often used in the VA context (Bach, 2003). The growing interest in this technology renders the question concerning the characteristics that virtual agents should display quite significant. Believability is not a precise concept, but many authors agree that it goes beyond the physical appearance (Bates, 1994; Bach, 2003) of the virtual agent. Rather, it includes the emotions, personality and social capabilities of the agent (Botelho & Coelho, 2001; Gomes, 2010). However, given the nature of the concept "believability," several aspects are still open. One of them is the character's appearance. Are realistic characters more believable? And what about cartoon-like characters? A second factor that leads to believability is the character's autonomy. Again, some results show that the more autonomous characters may seem more believable (Paiva et al., 2010). Another aspect to consider regarding believability is the character's perceivable actions and expressions (Paiva et al., 2010). Expressivity is perhaps one of the most challenging problems of synthetic characters, and work such as that conducted by Pelachaud and Poggi (1998), Bindiganavale et al. (2000), or Cassell (1999) focuses on this challenge (Paiva et al. 2010). In particular, the expression of emotions is understood as fundamental to achieve some degree of believability.

With the second study only some of these aspects have been explored and even if the development was basic, compared to the expectations of adolescents expressed during the focus groups, the main findings are promising and challenging.

Further, the results suggest that in the future it would be interesting to develop a version where the avatars became agents able to understand the emotions of the user and respond accordingly. FAtiMA modular was adopted in this first development because in a future pilot version of the technology-enhanced training we would like to make agents able to understand the emotions of the user be able to respond them; for example, the avatar-trainer could encourage the user if necessary. The Emotional Intelligent Component will be specifically used since this will allow for the possibility of making the virtual trainer as similar as possible to a human facilitator.

In the initial prototype version, we've only used part of FAtiMA's capabilities. The emotional reactive capabilities were used to make the avatar-assistant able to react emotionally to the user's progression in the application. However, given that we wanted the user's experience to be the same across subjects, we fixed the appraisal process so that the emotions generated by the avatar were always the same. This will be changed in the future so as to allow the agent to react differently according to the successful/unsuccessful progression of the user in several exercises. FAtiMA's Deliberative Component was used to create interaction goals that made the avatar able to take initiative to talk with the user (when necessary to provide instructions about a new exercise or when the user pressed the *help button).*

Further, based on the main findings of the first empirical study, it would be interesting to include biofeedback as an added value to the training itself and to explore if and how the physiological reactions would change accordingly and if they would be different from the results found in the second empirical study.

Most importantly, all things considered, the main findings of both of the empirical studies in the present empirical contribution confirm the efficacy of positive technologies not only in reducing perceived psychological stress and feelings of anxiety, but also in promoting engagement and motivation, as well as improving the awareness of physical sensations and the well-being of young users.

In terms of general impact and anticipated benefits, the present empirical contribution aimed at making progress in the state of the art of methodological solutions for the training of stress management and ER abilities, with the final goal to propose a useful tool for the improvement of these competences in adolescents. The results show that we are going in the right direction.

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