# HEAD FIRST INTO SERIOUS HEALTH GAMING

# $a^2e^2$ as a new approach of

# digital exercise coaching for seniors

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**Abstract**
With the development of an Adaptive Ambient Empowerment tool for the Elderly (a2e2) a group of technicians and media psychologists confront the challenge to change habituated unhealthy life styles. The main goal is to increase physical activity in seniors who are at risk of acquiring or are already suffering from chronic diseases. The a2e2 system incorporates exergames and applies a daily structure by using a digital coach. Several psychological processes must be taken into account if the system wants to stand a chance to achieve the behavioral change it wishes to mould into a healthier lifestyle. From the perspective of Self-Determination Theory, competence, autonomy and relatedness need to be addressed in order to achieve well-being. Intentional modes of self-regulation to achieve well-being often fail. However, implicit self-regulation offers new opportunities that are especially suited to apply in a gaming environment. Research has already shown that a virtual coach and a virtual environment can support positive results concerning interaction with the system and physical activities. Since the available research is still sparse elaborate pilot studies are required. This paper presents a short overview of the core psychological concepts guiding the development of a2e2.

*Adaptive Ambient Empowerment of the Elderly (a2e2), Media Psychology, exergames, behavioral change, self-regulation*

This paper provides a concise overview of the psychological theories and assumptions we believe should be guiding the development of a serious health game and its virtual environment. We exemplify our approach in introducing a2e2, an ICT (Information & Communication Technologies) solution for the adaptive ambient empowerment of the elderly (www.a2e2.eu). which is currently being developed with funding from the AAL (Ambient Assisted Living) Joint Program. The system is build around a virtual coach who guides through life style changes in order to prevent and manage chronic diseases in individuals who are at least 55 years old.

By means of this system we aspire to introduce new and enriched activities into the lives of senior citizens. The need for a2e2 is induced by the dramatically growing population of senior citizens in Western cultures leading a rather sedentary life style. We will soon be facing the challenges surrounding the fact that the largest part of our society is of retirement age. Many medical and care taking professionals, government officials and companies are already warning that the current health care system will not be able to cope with the increasing need for services. However, it's long been known that life style diseases such as Diabetes type 2 or cardio-vascular insufficiency can be prevented or even reversed with increased physical activity. Unfortunately, dispensing medical advice does not necessarily result in a change of behavior. Especially sedentary behavior is largely habituated and therefore very difficult to . Even an initial motivation to exercise will soon fade if it is not nurtured with ongoing support and motivating feedback. Thus, exergames may well be useful for including fun into otherwise rather straining, uncomfortable or boring physical activity, but how can elderly individuals be motivated to use such games over longer periods of time? One answer to this question is a2e2. Its aim is the empowerment of the elderly with an intelligent digital coach who guides the elderly through every day from waking up to going to bed, while applying a push approach. With this push approach the user of a2e2 will be addressed several times a day and motivated for enhanced physical activity. The system offers five levels of physical activity ranging from breaking sedentary life style (e.g., getting up), enriched daily activities (e.g., performing little pirouettes while clearing the table), the introduction of new behavioral patterns (e.g., walking the stairs instead of taking the elevator), intentional exercises (e.g., core stability exercises within a gaming environment), up to a highly efficient strength, balance, and endurance training module that has proven very effective with heart and vascular patients among others (presentation by J. Hoff at the VU University, November 30, 2009). The user's needs and preferences are hereby taken into account as well as environmental conditions, such as weather conditions. The system selects the most appropriate recommendation for each time slot and controls the user's behavior and well-being with an interactive self-report tool and multiple body (e.g., activity monitor) and ambient sensors (e.g., web cam). Taken together, a2e2 uses the full potential of each individual to establish and sustain a healthy and independent lifestyle for as long as possible.

As both the technical field and the field of media psychology have made great progress during the past few years, the time seems right for such an ambitious health application. The development of a functional virtual coach who responds to input from ambient and bio-sensors, acts upon individual preferences of the user and his/her past experiences with the system demands state-of-the-art technology. Implementing a virtual coach into the life of a user in a functional way provides another challenge completely. Psychological knowledge is required to introduce a coach who has impact and is being perceived as helpful. If the state-of-the-art technical development is not in synergy with an equally state-of-the-art psychological approach the durable implementation into the user's life is likely to fail.

A2e2 is console-based, has a touch-screen interface as well as a key-board and uses multiple sensors to gather information. On this platform a virtual environment is created with an intelligent agent as the digital coach and an avatar for the user's self-representation. Both, the coach and the self-representation are currently being developed together with selected members of the target group in order to assure a maximum fit in appearance, style, and behavior.

The digital coach acts upon a prototypical structure of the day with multiple for increased physical activity implemented as modules. While the system adapts itself to the lifestyle of the user, offering physical activities corresponding to his/her level it will not wear off, but sustain its value for the user. Based upon his/her progress over time the system will be able to provide accurate and motivating feedback. All the information and activities in a2e2 can be accessed and reviewed by the user; this is the pull-component similar to those in commercial exergames such as the Wii fit. However, most of the interactions will be instigated by the system.

In order to develop a functional push approach we suggest employing a comprehensive understanding of human behavior and the underlying psychology, as well as the human-computer interaction. This understanding results in several motivational strategies that can be implemented into the system. The following paragraphs provide an overview of the theoretical concepts we have identified as useful. Ongoing formative evaluation and a comprehensive final assessment will eventually provide us with the empirical evidence to decide whether this approach is as successful as intended.

This overview starts with a brief discussion of serious games and exergames before diving into what it is these applications aim to accomplish: behavioral change. First, Self-Determination Theory is introduced which claims that competence, autonomy and relatedness are essentials for sustained behavior change. We will then argue that with respect to self-regulation rational choice models are too limited to explain the selection and sustainable use of a life-style changing ICT application. Instead, a psychologically valid virtual environment with a social entity such as the coach appears advantageous to guide the complex process of behavioral change: The user establishes a so called para-social relationship with the coach and is therefore no longer left alone to face these critical steps towards a more healthy life.

**Changing the game**

There has been extensive research in the field of behavioral change; especially change of health behavior. This body of research has led to several health behavior change models that offer a variety of strategies which can be applied to facilitate these changes. A few factors can be identified that play a role in several models as significant predictors for behavior changes: Self-efficacy, susceptibility, perceived benefits and barriers and threat severity. One important limitation of most health behavior change, models, however, must be acknowledged: They are primarily built as cognitive models assuming high levels of rationality and logic within the user. It seems therefore promising to extend the assumptions of such models with other, less rational strategies such as heuristic, fun and affect-driven mechanisms. A gaming environment is well-suited to apply these alternative strategies and the development of this idea unfolds itself in the field of serious games (Ritterfeld, Cody, and Vorderer, 2009).

Strictly speaking, serious games are all games that are considered serious by some agency without taking into account whether the implied promise of a well-intended effect holds true. In search of an overview Ratan and Ritterfeld (2009) created a database of all self-acclaimed serious games in 2007 and found that more than half of those games were devoted to academic education, whereas games for health account for roughly ten per cent of all counts. As the nature of digital games is interactive, the game play is different in each single case (Klimmt, Vorderer, & Ritterfeld, 2007). Consequently, the term serious games should be replaced by the concept of serious

gaming, as Jenkins et al. (2009) recently proposed. The concept of serious gaming allows the focus to remain on the process and the outcome ambiguent; that a serious game will lead to serious gaming is not given and should not be implied.

A new generation of (serious) games is exergames. These are games that are controlled by the users' bodily movements. Exergames were developed to increase physical activity as an answer to a sedentary lifestyle associated with new media usage especially in children and adolescents (e.g., Vandewater, Shim, & Caplovitz, 2004). According to the International Sports Science Association such digital games can push various age groups to physical activity and assist in the struggle against sedentary lifestyles (ISSA, 2007). One of the critical discussions about exergames concerns first their contribution beyond a new media novelty effect: Can the usage be maintained over time? Second, exergames require an initial motivation to be used. Even if the game itself is highly motivating and fun to lay it remains still a challenge to prompt a person who is leading a sedentary life to participate in exergame motivated physical activity. If long term usage of exergames can be initiated and established, this genre has a huge potential for behavioral change.

**Motivation**

There are many determining factors in why people do what they do. One of the perspectives on motivation of human behavior is *Self-determination Theory* (SDT) (Deci & Ryan, 1985; 2000; Ryan & Deci, 2000). This theory is based on the core assumption that people are active organisms, driven by natural tendencies toward psychological growth and development, who deal with everyday challenges in their attempts to establish and maintain a coherent sense of self. In light of SDT, personal health and well-being depend on the satisfaction of basic psychological needs. Research guided by SDT (Ryan & Deci, 2000) has examined factors that enhance or hinder self-motivation and self-regulation. This research leads to the establishment of three basic psychological needs – *competence, autonomy and relatedness*. These, when satisfied, provide for enhanced self-motivation and psychological well-being; but when thwarted, lead to lower self-motivation and reduced health. Games are motivating to the extent that players experience autonomy, competence and relatedness while playing (Ryan, Rigby, & Przybylski, 2009). The need for autonomy is met by the free choice of starting a game; the player autonomously decides to play. The need for competence is fulfilled by a task that is not too challenging but not too simple so one can feel competent. The need for relatedness can be fulfilled by the social aspects of gaming; most playing is done within a social interaction or is perceived as such. The satisfaction of these primary needs leads to the subsequent motivation to continue playing. Earlier research by the authors (Ryan, Rigby, & Przybylski, 2006) also validated the idea that having 'fun' during game play can be attributable to the satisfaction of the above mentioned needs.

Studies of health care and therapy stress the importance of support for SDT's need for autonomy. Recently Ryan, Williams, Patrick, and Deci (2009) applied SDT to physical activity, sport, and health. SDT stresses the importance of intrinsic *and* extrinsic motivation for physical activities. Autonomy and competence have great impact on enhancing people's intrinsic motivation, which in turn has been found to play an important role in sport and physical activity. Extrinsic goals that have been better internalized are found to be maintained better over time. A distinction can be made between different forms of extrinsic motivation in terms of varying relative autonomy.

These forms of extrinsic motivation affect both, persistence and performance in physical activity (Ryan et al., 2009).

There is some concern among researchers regarding the acceptance of any form of technology among the elderly and the effect this has on the motivation to use available technologies. Ryu, Kim and Lee (2009) used an elaborated version of the Technology Acceptance Model and found perceived enjoyment to be a significant independent predictor of intention of use. This effect was found over and above its effect on perceived ease of participation. Compatibility (to what extent the ICT solution is compatible with the current lifestyle) was a strong predictor of intention to participate, but not directly, as it seems to be fully mediated by perceived benefit and perceived ease of participation together.

In conclusion, the satisfaction of our most basic needs can be done by playing a game and this fulfillment will lead to sustained gaming. This same need fulfillment will enhance intrinsic motivation, which in turn influences physical activity, and enhance extrinsic motivation, which in turn influences persistence and performance of physical activities. When elderly people perceive such a game as enjoyable, beneficial and easy to use along with being compatible with their lifestyle, confidence is high that they will use it and continue to do so.

**Self-Regulation**

While there are many demonstrations that people are able to set personal rules and follow them, there is considerable evidence indicating that people have difficulty in keeping them. However, intentional self-regulation is one of the most frequently prescribed ways to prompt behavior change, and often fails. Becoming aware of the necessity to self-regulation makes many people find excuses and justifications to rationalize non-compliance. Human beings have a strong tendency to stick to habituated behavior and are very reluctant to change once established habits – although they may know better. The challenge for any life style change intervention is to provide strategies of empowerment that go beyond intentional self-regulation. Ainslie (1992) suggests that we solve the problem of binding ourselves by manipulation of attention. For example, one can use entertainment as a means to control attention, so that one is not reminded of the availability of temptations, potential costs, efforts and dangers. Self-control in this way is achieved in an incidental and more implicit way. A variety of attention control strategies are provided by immersive media such as games. However, attention control can be revoked at any time so it may require continued effort.

Implicit and incidental self-regulation are closely associated with integrative processing, a cognitive style that is largely independent of linguistic encoding, is impressionistic, parallel, flexibly attuned to multiple meanings, and closely coupled with emotional and sensorimotor systems. Implicit self-regulation is optimally suited to maintain the global integrity of an individual's personality system. This global adaptive function operates in three distinct ways. First, implicit self-regulation has been shown to promote *volitional efficiency*, such that the individual is capable of forming appropriate intentions and effectively translating these into action. Second, implicit self-regulation has proven to promote flexible and efficient *affect regulation*, such that the individual can avoid becoming overwhelmed or stuck in emotional or motivational states (Koole, 2009). Third, implicit self-regulation has been shown to promote an implicit sense of *meaning* in life, such that the individual is capable of creating meaning out of new experiences and maintain meaningful cognitive representations (Heine, Proulx, & Vohs,

2006). This implicit mode of self-regulation is not mediated by explicit intentions, but rather by integrated feelings or intuitions about appropriate courses of action (Baumann & Kuhl, 2002). The conceptual independence of implicit and explicit self-regulation is further corroborated by findings that the two kinds of self-regulation can mutually interfere with each other. For instance, an emphasis on explicit goals may disrupt a person's cognitive access to implicitly represented needs, thereby leading to overall reductions in psychological well-being (Baumann, Kaschel, & Kuhl, 2005). Conversely, focusing on one's broader values in life can lead people to disengage from a specific goal that was recently frustrated (Koole, Smeets, van Knippenberg, & Dijksterhuis, 1999).

In short, people do not always behave according to their own best interests and intentional self-regulation often gives out to habituated behavior, accompanied by a multitude of rationalizations for non-compliance. One solution might be implicit self-regulation through manipulation of attention (Ainslie, 1992) by immersion in a virtual environment. Implicit self-regulation is associated with integrative processing and the global integrity of one’s personality system: It has positive influence on volitional efficiency, affect regulation, and is able to give meaning. This facilitates any behavior change initiated by implicit self-regulation, integrates into the personality system, and supports the ideal that any change made will be a robust one.

**Virtual interaction**

Several studies have already indicated the relevance of a virtual environment for the promotion of physical activity: Exercise is perceived as less tiring, performed more enduring, calorie consuming and enjoyable if performed within a virtual environment compared to training without such a virtual encounter (Chuang, Chen, Chang, Lee, Chou & Doong, 2003; Plante, Aldridgem, Bogden & Hanelin, 2003). As any environment, virtual environments can be inhabited by their users and consequently, enjoyed or disliked. Specifically, cues negatively associated with aging or death contribute to existential fear (Greenberg, Koole, & Pyszcynski, 2004; Magee & Kalyanaraman, 2009). Such mortality salience contributes to unhealthy habits (Das & Bushman, 2009).

Even though virtual coaches have become increasingly popular, scientific research about the phenomenon is still sparse. Blanson Henkemans (2009) researched the effects of the presence versus absence of an animated virtual coach, and, if there is an animated coach, the effect of its feedback style (cooperative versus directive). The author found that using an animated persona can be stimulating and improve the human-machine interaction. He also found that non-professional users had significantly better results with a cooperative feedback style than a directive one. It should be noted that the preference for a directive coach was higher for those with a low score on computer experience, reading speed, or education level, a high fear of invalidity, and an internal locus of control. However, a cooperative feedback approach was still most effective and preferred before other feedback styles.

The presence of a virtual coach as a mediated entity offers the possibility for para-social interactions between the coach and the user of the system. According to Perse and Rubin (1989), para-social interactions are similar to interpersonal interactions in three ways: They are voluntary, offer companionship, and they are evoked by social (not physical!) attractiveness. Over time, para-social interactions can lead to a para-social relationship, which entails that a viewer would think of and "interact with" the

media character not only during media usage, but also beyond, much like a person would think of his or her "real" friends in their absence (Giles, 2002). Recently, para-social relationship theory was applied to virtual entities (e.g. Jin & Park, 2009), but there is still a lack of knowledge which elements facilitate para-social relationships.

As can be deduced from the above-mentioned text, virtual environment will increase a positive perception of exercising by the user, but caution must be applied as to what is included in this virtual environment. Specifically, any clues to aging or death must be avoided. To have an animated persona present in the virtual environment has been found to improve human-machine interaction. Such a virtual coach should interact with non-professional users in a cooperative rather than a directive feedback style. These interactions between the virtual coach and the user can be seen as para-social interactions, which are similar to interpersonal interaction because they are voluntary, they offer companionship and are evoked by social attractiveness. Repeated para-social interactions are likely to lead to a para-social relationship, which will form the bond between the virtual coach and the user that our a2e2 system relies upon.

**Translating theory**

To integrate any application truly into the user´s lifestyle in order to change behavior three separate processes for sustained use are identified. There must be a first incentive for selection; secondly the user should persist in using a2e2 which drives the third process: habituation. Without habituation, the selection would always have to take place consciously and intentionally, which is something we deem unlikely to continue over a longer period of time. The first incentive will be mainly driven by a new media novelty effect. The system has a daily adaptive update and uses several real-time online applications (such as a weather-feed) to entice and vary the daily selection of use. To help guiding a2e2 from selection to persistence of use it is important to create numerous para-social interactions in order to establish a para-social relationship. This para-social relationship with the a2e2 virtual coach motivates users to keep using a2e2 and thus form habits that are part of a healthier lifestyle. In order to ensure the likelihood of such a para-social relationship it is of utmost importance to carefully pilot the coach's appearance and behavior and develop the agent within an iterative design model.

Following the current research we incorporate incidental and implicit motivation strategies for behavioral change and commitment to action into a2e2. This should be achieved by implementing a variety of 'manipulations of attention' techniques which avoid focus on efforts and costs of physical activity as much as possible. Presenting exercise as a gaming experience is an adequate frame to evoke such incidental and implicit motivation. Several gaming environments will be developed for physical activities of all levels as indicated above. This will most likely result in better regulation of affective states and volitional efficiency needed to commit to the course of action. In addition, the performance of the subjects will be more integrated with daily activities which will ultimately result in fewer costs to change their lifestyle.

In the overall virtual environment and the interactions between the coach and the user it is very important to avoid death salience and prime life salience instead. The environment must avoid any cue associated with mortality, but facilitate a connotation of life, future, and health. Within a2e2, for example, we avoid any health-related fear appeals in the interactions and incorporate symbols for health and growth into the environment such as flowers and animals, hereby priming life salience.

Finally, as a2e2 is intended to empower it is crucial to provide the user with the sense of controlling a2e2 instead of being controlled. Therefore, the sensory input will be ambient and non-obtrusive as to not trigger any loss of control by the user. Moreover, the system can be easily shut off at all times and push approaches can be ignored. However, the system will come back to life after some time and investigate the reasons for being shut off (i.e., asking questions which have to be answered by the user and guide future push approaches).

Taken together, we acknowledge the necessity to link the system to the essentials identified within SDT: *competence, autonomy and relatedness*. By making exergames available at different levels and adapting the system to the user's level a sense of competence can be achieved by the user. Autonomy is promoted and maintained by overtly giving the ultimate control of the system to the user and minimizing the impact of input-requirement. Relatedness can be achieved with enabling a para-social relationship from the user to the coach.

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