Adaptive Ambient Empowerment of the Elderly

Deliverable 3.3 Update II

State of the Art Documentation

A Framework for Using Virtual Coaches

for Breaking Sedentary Life Styles:

The Separate Role of Expert, Motivator and Mentor

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Introduction

This update document will present a framework that aims to be a guide in how to use digital agents in helping people with breaking a sedentary life style, increase their overall level of physical activity and enjoy a 'healthy' day.

There is a worldwide acceptance among medical authorities that physical activity constitutes a fundamental element of healthy living (World Health Organization, 1995 in Edmuntds, Ntoumanis & Duda, 2006). However, research also demonstrates that more than 70% of adults fail to meet current physical activity recommendations (Department of Health, 2004 in Edmuntds, Ntoumanis & Duda, 2006). In addition, problems related to physical inactivity nowadays are one of the major behavioral risk factors to health in modern society (United States Department of Health and Human Services, 1996 in: Edmunds, Ntoumanis & Duda, 2006).

Physical activity is an essential part of healthy living, although it is in some cases difficult for people to perform. Astrup (2001) concludes that at the moment issues concerning healthy living and physical activity are becoming increasingly prevalent, especially in developed countries. The occurrence of obesity, for example, is increasing rapidly in all age groups in most EU countries and is one of the fastest growing epidemics. He also observes that there is vigorous evidence from cross-sectional and longitudinal studies to support that physical inactivity is one of the risk factors for weight increase and obesity (Astrup, 2001). The conclusion, that people in general and specific target groups in particular have to be more physically active, seems to be a given fact. Focus for new approaches that achieve this is

urgently needed.

Virtual agents

Recently there is a growing amount of studies on different kinds of *'serving' digital agents* or virtual agents designed to help people in daily task activities. Research by Lin et al. (2006) has confirmed that virtual agents are effective in several domains: especially in motivating exercise.

Virtual characters or agents act as a new medium to interact with system information (Zanbaka, Goolkasian & Hodges, 2006). The characters are far ahead in high-quality graphics and make numerous types of interfaces possible. Another benefit is that they can be helpful for a variety of trainings: for example technical trainings (e.g. nurses, medical students, actors, technicians, etc.) and social skills trainings (e.g. practicing your presentation skills, job interview skills, etc.). In addition, the gender, age, race, physical attractiveness, apparel, or even types of a virtual character can be changed simply in a substance of minutes to match the needs at hand (Zanbaka, Goolkasian & Hodges, 2006).

Focus of this document

This update document concentrates on increasing physical activity by mediated communication and virtual persuasion. The concept of virtual characters needs more public attention as it can be very useful in several domains, especially in health domain. Change in physical activity will be explained by persuasive communication performed by a virtual character.

Yet in most studies, theories regarding the influence are absent. Even

today it is still a question how exactly virtual agents influence people and sufficient frameworks are lacking.

As a contrast to this, there are a great deal of theories that aim to explain how people intend and decide to do physical activity. Our approach is to use the field of social science theory that is developed to describe and predict intentions and decisions on physical activity as a guideline for incorporating virtual coaches.

What follows is a description of several social science theories on physical activity. We start with a description of theories that focus on changing subjects' intention for activity. This description will end with a discussion on how virtual coaches can be introduced to help people change their intentions to break sedentary lifestyles. In particular we will distinguish between using three separate virtual coaching roles: The expert, the motivator and the mentor role.

Next we will focus on theories that describe why people have difficulty to commit to the intentions they have made. These theories deal with the notion of Multiple Selves and intra personal dilemma's. This ends with a section on how the expert, the motivator and the mentor roles would fit in such multiple self theories.

Then follows a short section on how using virtual agents can be a way of increasing overall implicit intrinsic motivation to change activity patterns. In particular we discuss that the dimension of gaming and entertainment that virtual coaches can introduce to 'serious' tasks activities like knowledge acquisition and exercise.

Finally, we conclude that the combination of intentional change theory

with multiple selves theory is recommended as a framework to guide the use of virtual coaches that help subjects break a sedentary life style.

Changing intentions

An example of an intentional change theory is the Theory of Planned Behavior (Ajzen, 1991). Ajzen's theory is one of the most dominant and central theories in the Communication Science domain that predicts behavior. The theory attempts to predict behavior with a focus on human intentions. Intentions are an important aspect of physical activity behavior, it represents the motivational factors that affect behavior and indicates how much effort a person is likely to devote to perform a behavior (Ajzen, 1991).

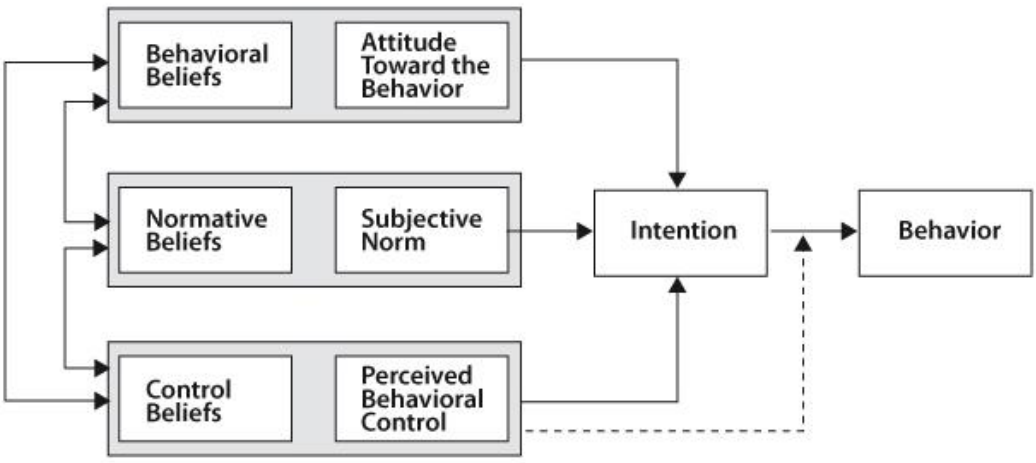
Theories that focus on the determinants of intention provide insight to the progression of physical activity. The Theory of Planned Behavior (TPB) is the most widely applied model of the cognitive antecedents of health behaviors (Ajzen, 2002). It is also the most extensively studied social cognition theory and it is relevant to both intention and behavior change (Hardeman et al, 2002). Meta analytic studies have demonstrated significant support for the approach, which accounts for 27% of the variance in behavior (Armitage & Conner, 2001).

The predecessor of the TPB is the Theory of Reasoned Action (TRA). The TPB is very similar to the TRA as the TPB is merely an extent of the TRA. The TRA distinguishes two dimensions in a person towards a behavior: *attitude* and *subjective norm*. Attitudes are degrees to which a person has a favorable or unfavorable evaluation of the behavior; subjective norm (also called perceived social pressure) includes questions on whether to perform or

not perform behavior. These two dimensions lead to *intention*, and intention is used to predict person's behavior (Fishbein & Ajzen, 1980).

The TPB adds a third component to this pattern: the *perceived behavioral control*. Perceived behavioral control refers to the person's appraisal of his or her ability to perform a behavior (Ajzen, 1998) and would also lead to intention. In addition, perceived behavioral control can predict behavior directly (see figure 1 for a schematic representation of the theory). In sum, the TPB proposes that perceived behavioral control and intention are the most proximal antecedents of action. The TPB has been applied mainly to predict and explain a wide range of behaviors, including health relevant behaviors such as smoking, sexual behavior, exercise and food choice (Godin, 1993; Godin & Kok, 1996; Conner & Armitage, 1998).

figure 1.



Theory of Planned Behavior, Ajzen (2002)

The three dimensions are underpinned by sets of beliefs. For the attitude component these are behavioral beliefs regarding the perceived likelihood

that performing the behavior will lead to certain outcomes and the extent to which these outcomes are valued (Ajzen, 1991). For the component subjective norms there are normative beliefs focusing on the perceived social pressure from certain referents and the person's motivation to comply with these referents. The last component, perceived behavioral control, contains beliefs that focus on the presence or absence of obstacles, impediments, resources and opportunities that may influence to the ability to perform the behavior.

As mentioned earlier, the TPB has often been applied in health care; Brickell, Chatzisarantis and Pretty (2006) examined the utility of the TPB along with additional constructs in predicting exercise. They divided two kinds of intention: autonomous and controlling intention. The measures for the several aspects were completed during the first phase of data collection. After two and three weeks the behavior of the participants was assessed. The authors concluded that attitude and perceived behavioral control predict intention. They also demonstrated that subjective norm predicts the controlling intention. In addition, they confirmed that intention predicts behavior. The authors conclude their study with the fact that the TPB is a fairly useful model for predicting behavior and that valuable information can be gained when other measures of intention are explored.

Furthermore, the TPB is applied commonly to healthy eating or to physical activity for young people. Yet, nowadays the application is increasingly used with people aged over 65 years. Kelly and Abraham (2004) report in their study the behavior of patients older than 65 years amongst healthy eating and physical activity after a theory based promotion

intervention. The intervention consisted of a healthy living booklet; it stated persuasive arguments targeting the most proximal cognitive antecedents of behavior specified by the TPB. Cognitions and behavior were measured before the intervention and at a two-week follow up. The authors concluded that the intervention was successful: 34% of intervention participants set an activity goal, 51% reported 100% success in enacting these goals.

Another theoretical approach to human motivation that is receiving attention in the physical activity domain is the Self Determination Theory (SDT, Deci & Ryan, 1985). This is a theory of human motivation and personality, concerning people's intrinsic growth tendencies and their native psychological needs. Essentially, the SDT proposes that human motivation varies in the extent to which it is *autonomous* (self-determined) or *controlling*. The SDT focuses on the degree to which an individual's behavior is self-motivated and self-determined (Deci & Ryan, 2000). The authors identified several needs that appear to be essential for facilitating optimal functioning of the natural propensity for growth and integration, as well as for constructive social development and personal well-being (Ryan & Deci, 2000). Here, when behavior is controlled, an external force regulates it. The individual in this instance feels pressured to engage in the behavior.

Based on the distinctions of self-motivation and self-determination, the SDT proposes that three forms of motivation exist; *intrinsic motivation*, which is the most autonomous form of motivation and refers to an inherent tendency possessed by all humans to seek out novelty and challenges, to extend and exercise their capabilities, to explore and to learn. The second one is the *extrinsic motivation;* this can be defined as exercising either to appease an

external demand or to attain a reward. The third motivation is *a-motivation*, which, based on the level of autonomy, lying on a continuum ranging from high to low self-determination (Deci & Ryan, 1985).

In their study, in accordance with the SDT, Edmunds et al. (2006) examine the relationship between autonomy support, psychological need satisfaction, motivational regulations and physical activity. Participants of the study were recruited from fitness, community and retail settings. Performance of the three basic psychological needs (competence, autonomy and relatedness) was related to more self-determined motivational regulations. Identified and interjected regulations emerged as positive predictors of strenuous and total exercise behaviors. The findings of this research supported the SDT only in the exercise domain.

According to the theories mentioned above, the ultimate determinants of any behavior are sets of behavioral beliefs concerning consequences and normative beliefs concerning the prescriptions of relevant others. To influence a person's behavior, therefore, it is necessary to change these primary set of beliefs. By producing sufficient change in primary beliefs it should be able to influence the person's attitude toward performing the behavior or his/her subjective norm. Depending on their relative weights, changes in these components should then lead to changes in intention and actual behavior.

As described above, the TPB makes the distinction of three dimensions to predict intention; attitude, subjective norm and perceived behavioral control. Each dimension has its own kind of beliefs. Changing these beliefs will lead to changing the intention to behavior.

Using separate virtual coaching roles: Expert, Motivator and Mentor role

When virtual agents are used to influence different set of beliefs, the effectiveness of persuasion can be enhanced by using separate agents for each set of beliefs. Each virtual agent then has a separate role in strengthening, changing and updating beliefs. That is, it would be most efficient to use separate virtual agents for persuasion of attitude, subjective norms, and perceived behavioral norms.

More specifically, an *expert* role can be performed by one virtual agent focusing on attitude beliefs; a *motivator* role can be performed by a virtual agents focusing on beliefs on perceived behavioral control; and a *mentor* role can be performed by a virtual agent focusing on beliefs on subjective norms. This would make for three virtual agents: the expert, the motivator and the mentor.

The assumption is that every digital agent would be 'specialized' in the manipulation of a specific set of beliefs. There are three beliefs sets that need to be manipulated; this means that there will be three digital agents. The digital agents that appertain to the dimensions are: an expert for attitude change, a motivator agent for perceived behavioral control change, and a mentor for subjective norm change.

The reason for this set up is the following: attitude requires an agent that gives general information about the benefits of physical activity. For example the benefits for weight control, examples of performing simple physical activity and so on. Subjective norm requires an agent, which will give examples of other people who do physical activity. Finally, perceived behavioral control requires an agent, which gives information on how to do

physical activity.

So when virtual agents are used to influence motivation and activity behavior we suggest to perform studies using more than one agent to influence people. There are a variety of studies regarding the use of virtual agents (Zanbaka et al, 2006; Zanbaka et al, 2004; Skalski & Tamborini, 2007). There is indeed empirical support for the use of separate virtual coaches over using one agent. For example, Baylor (2003) examined the question as to whether it is more effective to have one pedagogical agent (mentor) with combined several coaching roles or using separate agents that focus each on one role. The results of her experimental study about learning provide support for the notion of using more virtual agents: separate pedagogical agents representing different roles had a more positive impact on both learning and the perceived value of the agents. She concludes that this provides initial evidence for a pedagogical agent *Split-Persona Effect*; suggesting that separate agents representing different functional roles may be preferable over one agent representing all roles. Linking the empirical findings of Baylor's (2003) to intentional theory would imply that every belief set will need its own agent to get manipulated for intention change.

Dealing with the problem of temptation and intrapersonal dilemma's

Yet, there are some issue's with the above mentions theoretical models. Some studies do demonstrate the predicted behavioral changes in physical activity, others do not; often outcomes of the studies contradict each other. One criticism is that the focus on intention is insufficient to explain the paradox that people do not always behave according to their plans and

intention. Intentional theories do not take into account issues of temptation and differential weighing of outcomes over time. One theoretical solutions is to combine intentional theories with theories that explain the problem of commitment to intention and temptation. In this way a two stage theory is achieved that would achieve a larger descriptive, predictive and explanatory power.

Multiple Selves Theory (MST) refers to a set of theories that describe the problem of commitment (Elster, 1986; Read and Roelofsma,1999). MST is likely to have an additional value to this research as it explains behavioral differentness as a function of time.

The MST explains the decision-maker process differently than the TPB. In both theories the distinction between a *planner* and a *doer* (Thaler & Shefrin, 1981) can be realized. In the case of the TPB the planner indicates the intention. This is certainly reasonable when a person intends a behavior; he or she plans to activate the behavior without actually performing the behavior. The action is not fulfilled yet. The doer on the other hand, represents the behavior; the action is fulfilled, the doer has performed the behavior. The TPB suggests that intention leads to behavior (Ajzen, 2002). Intentions actually are important antecedents of behavior, but are not always adequate to produce action. In most of the cases the doer, who activates the behavior, is the dominant actor, and this is the supposition of the MST.

While in the TPB the planner was the decision-maker, in the MTS it is the doer who performance and commits. The multiple self-models have been studied for a long time and different ways (See: Elster, 1986). Read and Roelofsma (1999) treat this feature as follows. They describe the

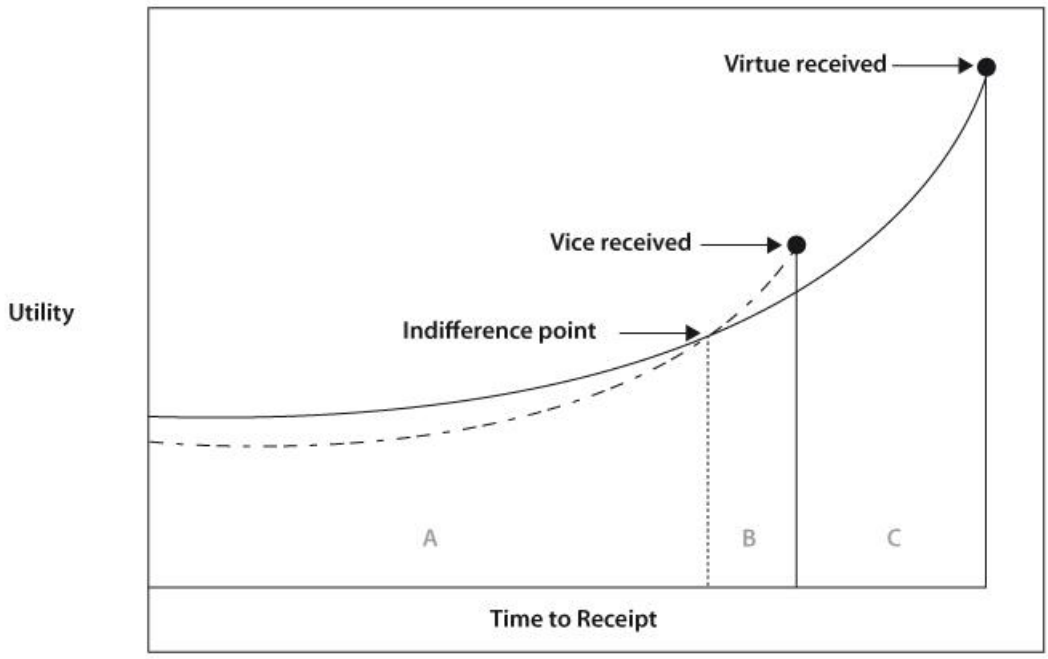
phenomenon of intrapersonal dilemmas like procrastinations and temptation and explain how the concept of multiple selves explains why people attempt to control their behavior but often fail to do so. Two factors for intrapersonal dilemmas are discussed: the individual actor, that is a bundle of egoistic 'selves', all of which put more weight on their own desires than on the desires of their compatriots (also called personal- or social selves). The second factor is experienced utility; the happiness that we get from what we choose. Other personal selves can add this utility experienced by each personal self, to the experienced utility. After, the total utility from different selves can be compared.

To have intrapersonal decisions, subdivision of individuals is necessary; as a result, they are 'different people' in the same skin. These different people (or selves) have interests that now and then disagree. One of the most widely applied multiple-self models treats the individual as a sequence of selves distributed over time, with each self-taking the baton, as it were, from its predecessor. The wishes and desires of the currently active self receives special status when decisions are being made. Some thought may be given to the desires of future selves; but the natural disposition is to give them little weight. Anslie (1975) refers to these selves as successive motivational states, and argues that they arise because of hyperbolic discounting (Ainslie, 1975; Loewestein & Read, 2004).

Read and Roelofsma (1999), model the MTS use the hyperbolic discounting referring to two rewards that differ in magnitude and delay (see figure 2 below for a schematic representation). The rewards consist of *perceived reward from a vice* and *perceived reward from a virtue*. Virtues

(increasing physical activity) are alternatives that are good for a person in the *long term*, but often do not give a positive reward in the short term. Vices (sitting on the couch and watching television) on the other hand are alternatives that are satisfying in the *short term*, but may produce dissatisfying consequences later. The *utility* depends on the received time, received vice and the received virtue. The reward of the virtue is larger, but the realization comes later. On the other hand, the vice reward comes sooner but is smaller. There is an *indifference point* where the value of the rewards cross. Previous to this point, the virtue is preferred. After the edge, the vice is preferred (see figure 2 below for the schematic representation).

figure 2.



Multiple Selves Theory, Read & Roelofsma (1999)

The crossover point divides the decision maker into three selves: A, B and C. Self A is the self before the crossover point; it has little share in the decision, because the two alternatives are so distant, neither of them are valued very

much. When the self A chooses, it will choose the virtue because that has a higher present value. Once the crossover point is passed and self B is present, we can say that the vice is dominant and the consideration of that present now leads the decision maker to prefer it. At last, once the vice has passed, there is a third period in which the decision maker regrets it's impulsive choice or feels relief over it's self-control, that period is named self C.

Similar to the TPB, the doer and planner can be positioned in the MST. The planner is here the self before the crossover point (self A), who wishes to desire the virtue; the self does not activate a behavior yet. The doer on the other hand, is the self who actually makes the decision and that is more often than not the self who prefers the vice; here the doer already took action to realize a behavior. In sum, according to this theory the doer seems to have the last word in actual performance and decision commitment.

Identical to the TPB also by the MST there is the distinction of three dimensions. These three dimensions need three different agents for manipulation. The order of the agents is more diverse than by the TPB. Here, the expert agent will manipulate self A, and the motivator agent can manipulate self B, the mentor agent can manipulate self C. The predictions for the MST can be different than the predictions for the TPB for the reason that by the MST there is a chronological time order that is taken into consideration. Note that self A of the MST can be related to attitude of the TPB; The self B to perceived behavioural control, self C to subjective norms.

Virtual coaches: Entertainment and gaming

The use of virtual agents has the advantage effect of introducing a element of gaming into activities. Using virtual agents changes a standard serious human performance like a knowledge acquisition task or and exercise into game of playing. This is also referred to as 'serious games': players do not only entertain themselves, they also implicitly learn something from this type of game. These games are promising future educational tools due to the focus of increasing implicit motivation.

Susi *et al.* (2007) wrote a report that discusses some issues concerning serious games. The authors define it as follows: "serious games are (digital) games that are used for purposes other than mere entertainment. These games allow learners to experience situations that are impossible in the real world for reasons of safety, cost, time, etc., but they are also claimed to have positive impacts on the players' development of a number of different skills." (Susi *et al.*, 2007). In their report, the authors shape three types of serious games: government games, educational games, corporate games and healthcare games. The most attractive is the last one, as this type of games is becoming more common (Susi *et al.,* 2007). Introducing a gaming element can have direct or indirect positive physiological and psychological effects on the players (Watters *et al.,* 2006), which is exactly the aim of serious games in health and healthcare.

Conclusion

In this document we have introduced a two stage model that provides a guideline for how virtual coaches can be used to help individuals break their sedentary lifestyle. More specifically, following the model we have introduced three separate virtual coaches: The expert, the motivator and the mentor. In the first stage they guide the subject to change intentions when needed with specific instructions and feedback. In the second stage they help the subject to commit to these plans and provide support when they fail. Finally, it is concluded that the use of virtual agents will have an overall enhancement of implicit motivation as a result of the game and entertainment element that it will bring in. We suggest to use the elderly healthy living intervention by Kelly and Abraham (2004) as content for the separate virtual coaches and include coach instruction and feedback derived from MST to this content.

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