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Tailoring Motivational Mechanisms to Engage Teenagers in Healthy Life-Style: a Concept

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ABSTRACT

Overweight and obesity are the first leading risk related to nutrition for global deaths, in the last few years it outranked the famine. Obesity increases the risk of several debilitating, and deadly diseases, including diabetes, heart disease, and some cancers. Due to the many health risks associated with obesity, the financial burden that the treatment of this disease exercises on the European healthcare system is enormous. For this reason, the best strategy relies in prevention. In particular, the pervasiveness of technology can leverage an important advantage for the promotion of healthy behaviors in the new generations. This paper introduces PEGASO, a technological multidisciplinary project funded by the European Commission that aims at creating an ecosystem that can enable teenagers to adopt healthy habits leading to a healthy life-style. The ICT system plays an important role in the PEGASO ecosystem. This behavior change support system integrates a Virtual Individual Model that allows characterizing the physiological status, physical condition and the psychological status for each user. This allows the elaboration of tailored interventions aiming at promoting the adoption of healthy habits by the users. This paper describes this concept introducing the Virtual Individual Model and discusses the possible interventions related to the promotion of physical exercise and of healthy dietary habits. At the end of the paper, some indications about the future development of the PEGASO project are provided.

Keywords: Persuasive Technology, Human Factors, Wearable Technology, Obesity Prevention

INTRODUCTION

Obesity is epidemic and a general alarm has been issued worldwide. Obesity is due to several factors as genetic contributors, metabolic conditions, psychological, and behavioral issues. Concerning the last two factors, an important role is played by an inadequate education, in particular about health literacy (Weinert et al., 2001). The World Health Organization reported that over 60% of children who are overweight before puberty will be overweight in early adulthood. PEGASO aims at developing a whole ecosystem that would be able to motivate teenagers to learn and to apply a healthy life-style effortlessly in order to prevent obesity in adulthood (PEGASO, 2013).

In the PEGASO ecosystem, the multi-dimensional and cross-disciplinary ICT system plays a key role. This system includes game mechanisms, multimedia services and social activities to influence users' behaviors in order to fight and prevent overweight and obesity in the younger population by encouraging them to become co-producers of their wellness and take an active role in improving it. In this system, the motivational mechanisms are crucial to engage the teenagers and tailored interventions have been demonstrated to be very effective. In fact, they make the information personally relevant and researches demonstrated that computer-tailored health education is more effective in motivating people to make dietary changes (Brug et al., 2003) and that it could be also a good practice to promote physical activity (den Akker et al., 2011). The tailoring of the motivational interventions is based on a virtual model of the user, which is personal. This model is called Virtual Individual Model and it aims at integrating biological parameters of human functioning, the lifestyle behaviors and psychosocial externalities that are relevant for the development of overweight and obesity conditions, especially in young people (Lafortuna et al., 2014). The Virtual Individual Model is an abstract representation of a cross-disciplinary knowledge about the characteristics of an individual. In order to integrate such a model in a digital system, it is necessary to develop an ontology that allows the virtualization of this knowledge. The digitalized model allows the modification and the elaboration of the information in order to select the best interventions.

The system starts from a general virtual individual model and progressively gets to know the user's preferences in order to tailor the model on the actual user characteristics and behaviors. Automatic tailoring involves the adoption of advanced machine learning techniques to opportunely specialize and personalize the model. In particular, reinforcement learning algorithms allow dynamically selecting the most successful strategies, e.g., (Maes and Kozierok, 1993), that in this case aim at motivating the user to exercise and to promote a healthy alimentary behavior. Different interventions are implemented in the system, which are based on the strategies provided by experts working in the domains of the nutrition, physiology and psychology. The design of the interface for these interventions is based on the results of focus groups in three different countries and sessions of participatory design.

The rest of the paper is organized as follows: the next section provides an overview of the system in order to provide a general idea of the different parts that have to be developed in the PEGASO project. In Section 3, the Virtual Individual Model is described with reference to the different aspect that integrates: physiological status, physical status and psychological status; moreover, there is a brief explanation of how this model will be integrated in the ICT system. The Section 4 discusses some possible interventions that will be tested during the PEGASO project. The last section is dedicated to the conclusions.

SYSTEM OVERVIEW

The ICT system plays a key-role in the PEGASO ecosystem. The influence that technology can exercise on people is recognized by the scientific community and currently a new domain in the computer science, known as Persuasive Technology (Fogg, 2002), focuses on formalizing the design and development of computing products that can change the way users act and think. In the persuasive technology field, the Behavior Change Support Systems became an important object of studies since this name describes the persuasive systems that integrate additional software features as continuous accessibility and social support, unobtrusiveness, ease of use, and improved dialogue between the users and the system (Oinas-Kukkonen, 2013). The PEGASO project aims at pushing this concept further introducing the feature of dynamically selecting the opportune tailored interventions based on the user's individual characteristics and interaction context. Tailoring the intervention involves modeling the user's characteristics and for this purpose it has been developed the Virtual Individual Model, which comes from the concept of the Virtual Physiological Human. The latter is a methodological and technological framework for integrated modeling of a living human body that describes the interaction of all the physiological components of individuals from molecular to apparatus level (Fenner et al., 2008). The Virtual Individual Model aims to include individual's characterization composed of physiological, physical, and psychological determinants. This allows integrating biological aspects of human functioning with lifestyle behaviors and psychosocial externalities that are crucial for the determination of the adoption of a certain life-style. This model is integrated in the system through an ontology-based virtualization. This process allows turning the information contained in the Virtual Individual Model into a structured knowledge that can be dynamically updated and elaborated by the computer to select the best interventions for each individual (see Figure 1).

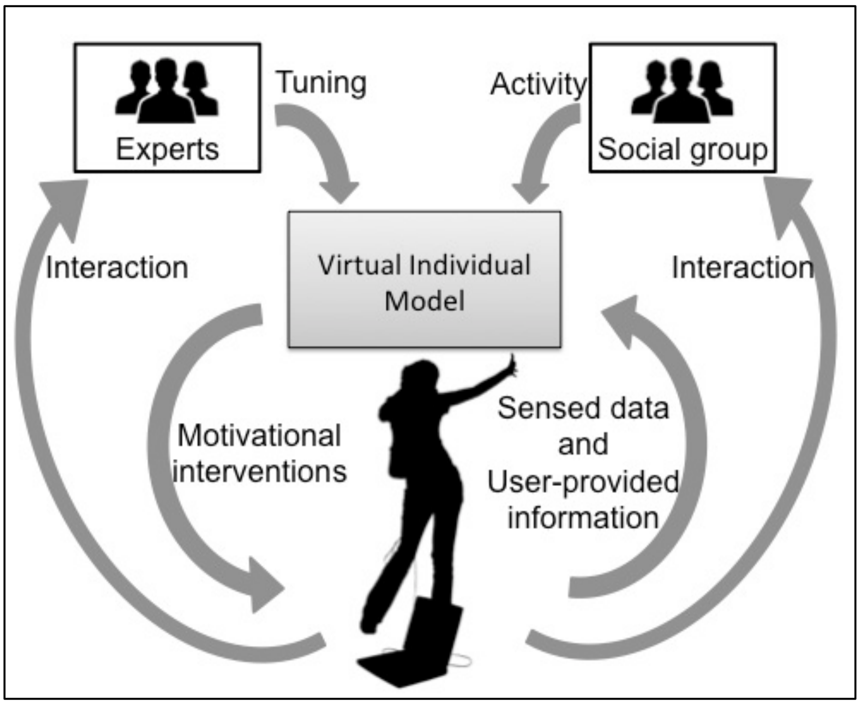

Figure 1. The concept for the generation of tailored motivational interventions based on the virtual individual model.

The Virtual Individual Model characterizes the user's nutritional habits, physical status, and psychological status to provide personalized intervention to foster the adoption of a healthy life-style. Obviously, the interaction between the system and the user plays a crucial role in the tailoring process and to facilitate the effectiveness of the intervention. Since the teenagers are the targets of the PEGASO project, the smartphone has been chosen as the mediator of the interaction. Indeed, the smartphones are already perceived as a companion and it is most likely that this relationship between user and smartphone will strengthen in the future (Carrino et al., 2014). The smartphone is the perfect companion because it is personal and it is ubiquitous. It will provide the possibility of interacting directly with the user asking to enter some information or in a discreet and implicit manner allowing monitoring the user activity. The sensed data referring to the parameters that concern the selected characteristics modeled for the tailoring will be updated constantly in the Virtual Individual Model. Moreover, with the many connection possibilities, the smartphone can allow accessing the information stored in the cloud and can connect to other devices, such as wearable accessories that can improve the physical activity monitoring. Since it is ubiquitous, it can always provide the appropriate trigger to influence the user's behavior. This is very important, since Fogg observed that "without an appropriate trigger, behavior will not occur even if both motivation and ability are high" (Fogg, 2009). Moreover, the many sensors integrated in the smartphone allow capturing the contextual information, which can help to generate the trigger at the opportune moment maximizing the effectiveness. Moreover, the smartphone allows installing many applications as media services and games that will motivate the teenagers to interact with the system. The integration with social networks will add the social aspect of the users' life to the parameters for the tailoring of the interventions and, most importantly, the social factor represents a very effective motivator.

VIRTUAL INDIVIDUAL MODEL

The tailoring starts from a general virtual individual model provided by experts, which is the core of the system. The generation of this model requires the identification of several parameters, which determine the reciprocal interferences and concur to the health status. Some of these parameters concern the physical condition: characterization of body structure, physiological status and physical activity behaviors. Other important parameters are psychosocial factors (which are related to patterns of dietary and exercise-related behavior) and psychosocial determinants (which underpin attitudes, behavioral skills and motivation to engage in healthy lifestyle behaviors). The latter includes the family and social group context. In particular, teenagers are likely to be deeply and easily influenced by their social group and the current fashion trends.

Physical Status

The elements characterizing physical status (i.e. the information concerning body structure) will be identified among the indicators of body adiposity and risk factors for the development of the disease conditions related to overweight and obesity, as interpreted on the basis of standard reference values (Dulloo et al., 2010). Among adults, although body composition is a prime quantificator of adiposity (), body mass index (BMI), a parameter calculated from the ratio between body mass and squared height, is in first approximation utilized to set cut-off values to stratify individuals according to the concept of underweight, normal weight, overweight and different degrees of obesity (World Health Organization, 2000). By contrast, BMI in childhood changes substantially with age, and to define juvenile obesity a cut off point related to age should be used (Cole et al., 2000). Moreover a structural parameter such as waist-to-height ratio (waist circumference/height2), besides detecting central intra-abdominal fat tissue deposition, has been demonstrated to be also highly predictive of cardiometabolic risk associated with obesity in children and adolescents (Mokha et al., 2010).

Indeed severe metabolic derangements occur with obesity, such as type II diabetes and dyslipidemia, which considerably increase the risk of hypertension and cardiovascular disease. In particular, obesity plays a central role in the development of the metabolic syndrome (MetS), an important clustering of metabolic abnormalities and anthropometric characteristics also in adolescents (Lafortuna et al., 2010). MetS can be characterized also in the juvenile age according to International Diabetes Federation (Zimmet et al., 2007) diagnostic criteria (including high blood pressure, low levels of high density lipoprotein cholesterol, high triglycerides levels, high plasma glucose concentration and central obesity as assessed by waist circumference). Although not included in key diagnostic criteria, pro-inflammatory state (as indicated by elevated high sensitivity C-reactive protein, or inflammatory cytokines) and insulin resistance (quantifiable through homeostatic model assessment method, HOMA-IR) are functional metabolic derangements considered to be notably predictive for cardiovascular disease and/or diabetes (International Diabetes Federation, 2006).

Psychological Status

As the number of children and adolescents who are classified as being overweight or obese continues to rise, it is necessary to focus on understanding the range of factors that may contribute to this important public health issue. An in depth critical understanding of the factors that contribute to obesity in adolescents is of paramount importance in order that effective interventions can be designed and implemented as well as properly evaluated. Understanding the factors that may contribute to health-related behaviors in adolescence, such as dietary behavior, demands an in depth analysis of both the individual and environmental determinants of those behaviors. For example, in the case of dietary behavior a range of individual factors (e.g. taste preferences, attitudes, social influences as well as perceived behavioral control) will undoubtedly be relevant. However, it is important not to lose sight of the fact that environmental influences are likely to be influential in terms of shaping and supporting both healthy and unhealthy habits in adolescents. In the example of dietary behavior, healthy eating habits among adolescents are more likely when the adolescent is motivated to eat healthily, has the necessary behavioral skills to do so and the environment is supportive through the opportunities it creates.

The eating behavior is not only related to homeostatic reasons. In fact, an important factor that influences people's need and choice of food is represented by the emotional state (Carroll et al., 2013). In fact, it is commonly known that emotional states can have major effects on eating behavior. For example, a first psychosomatic interpretation has been that obese individuals tend to overeat in response to a negative emotion in order to reduce the negative state (Kaplan and Kaplan, 1957). Another important mechanism is the reward-based eating behavior, which consists of the stress-induced drive for hypercaloric food (Adam and Epel, 2007). Although these psychological states are intertwined in physiological responses, these non-homeostatic eating patterns can be reeducated (Gilhooly et al., 2007); and this is part of the goal of the PEGASO system.

Dietary Habits

Inadequate or excessive nutrient intake can have important health consequences, such as nutritional deficiencies and an increased risk of several metabolic diseases. Possibly the main nutritional concern at this age could be grouped in the prevention of normal physiological nutritional deficiencies observed like for example special needs for normal growth (iron, calcium, protein, etc.); and wrong dietary behaviors like the lack of breakfast consumption, the low fruit and vegetable intake, and the high soft and alcoholic drink intake. Skipping breakfast is somehow common among young people among European countries, which usually increase with age. For example, around 71% of 11-year-old takes breakfast everyday; while at the age of 15 it is considerable reduce to 55%. In the context of fruit consumption, its prevalence is reduced between ages 11 and 15, and in all ages it could be considered that the percentage of adolescents that eat at least one fruit a day is worryingly low (31 to 42%). While the consumption of sugar-sweetened beverage, including soft drinks, has risen across European countries; and this late could be associated with lower intakes of milk, calcium and other nutrients (Vartanian et al., 2007). Changing also these tiny habits can have a huge impact on the teenagers' health and modeling the individual dietary patterns can provide useful information in order to apply the opportune intervention to lead the user towards a healthier life-style.

Ontology

The Virtual Individual Model is an abstract representation of a cross-disciplinary knowledge about an individual, its characteristics and its relationships. It is important to distinguish the model itself from the virtualization of it, which in this particular project is achieved by ontology.

Ontology, as a content theory, is able to describe all the terms and all the relations existing in every domain of knowledge building at the same time an organized hierarchy of classes and subclasses of the domain. Building ontologies means to clarify the structure of knowledge, to find a way to deal with its changing nature and to enable the sharing.

One of the challenges of the PEGASO Project consists on creating a common perspective toward the individual in a way that guarantees objectivity of its components, consistency and coherence between the different approaches, completeness of the definitions and also a common vocabulary and standardization of the terms. Semantic web technologies, in particular ontology, were considered the path for making this complex scenario more schematic and easier to understand (Gruber, 1995).

To cope with such common perspective is needed to define a most general level: it's represented by the so-called "Upper Ontologies" (or Top-Level Ontologies): it's a sort of "ontology of domain-ontologies". It will help to maintain the requested approach.

Between the existing upper ontologies already developed for the sector, it was decided to use the Basic Formal Ontology (BFO) developed by Barry Smith in (Arp and Smith, 2008) and in (Smith et al., 2012).

TAILORED MOTIVATIONAL INTERVENTIONS

In order to develop any health behavior intervention, there are a number of key activities that must be undertaken. In the PEGASO project, the fundamental approach is that of designing an evidence-based intervention that draws upon the psychosocial determinants of adolescent health-related behaviors through systematically reviewing the extant literature. Systematic review methodology allows key individual and environmental determinants to be identified and together with preparatory 'elicitation research' being conducted with adolescents in three European countries, behavior change techniques can be determined and embedded within the PEGASO platform through its game, smartphone application and interactive multimedia diary. A key strength of the PEGASO lifestyle intervention is the fact that it uses an up to date evidence to identify the key determinants of important behaviors linked to obesity (i.e., dietary behavior and physical activity) in such a way as to develop a Virtual Individual Model.

Promoting Physical Activity

According to collective views of international groups of experts (World Health Organization, 2000; Commission of European Community, 2005), the role of lifestyles as determinants of conditions such as overweight and obesity has been thoroughly evidenced, with particular focus to juvenile age. Studies using motion sensors have shown that children who spend less time in physical activity are at higher risk of becoming obese during childhood and adolescence. Television and video games have contributed to more sedentary leisure activities and are associated with the consumption of energy-dense snacks and beverages. The findings from the 2009/2010 survey in EU countries from Health Behavior in School-aged Children (HBSC) international report (Currie et al., 2012) indicate that young people who are overweight/obese are less physically active and watch television more, beside being more likely to exhibit unhealthy alimentary patterns. Therefore, the PEAGASO VIM will identify parameters permitting the characterization of Physical Activity Behaviors expected to have a direct influence on both Physical and Functional Status. Evaluation of sedentariness can be achieved through the monitoring of individuals' movements in their free-living context, which enables the characterization of physical activity through the determination of its amount and intensity. By using specific recognition algorithms, the type of activity can be assesses (e.g. walking, stepping, running, cycling), and the actual energy expenditure required to sustain that given activity can be determined. A wide body of knowledge is available about the energy cost of human activities in a large context of daily life and leisure pursuits (Ainsworth et al., 2000) and during specific sports scenarios (Glass & Dwyer, 2007). Activity intensity, sex and body mass are also important determinant of energy expenditure attained during body movements, and as such, they have to be accounted for in the evaluation of the energetic daily budget.

An important aspect of individual's profiling concerns the evaluation of the level of physical conditioning accounting for the individual's capacity to perform exercise, based on physiological responses to exercise in terms of heart and respiratory rate. The assessment of the relationship between exercise intensity and heart rate permits to appreciate the degree of the individual's involvement in activity and estimate of his/her maximal aerobic capacity, which is a determinant of the maximal work capacity. The excess of body mass due to overweight/obesity condition has considerably negative effects on the capacity of individuals to sustain prolonged efforts associated with exercise or even everyday life activities (Lafortuna, 2003), and limits the use of physical activity as an effective tool to contrast obesity. Profiling of exercise capacity provides therefore an important aspect in VIM building as it determines individuals' potentialities in life activities, which can undergo relevant changes in accordance with changes in behavioral choices towards physical activity.

The adoption of a smartphone as a companion allows implementing pervasive games that can link the physical activity to the dynamic of a game. Many examples of pervasive games showed promising results in motivating people in changing behavior towards the adoption of healthier behavioral patterns, as in (Lin et al., 2006) and in (Fujiki et al., 2008). One important motivator also in this kind of intervention is the social dimension, which can provide intrinsic motivation. In fact, it is clear that people are motivated to do things that win them social acceptance. Sometimes even more dramatically, people are motivated to avoid being socially rejected (Fogg, 2009). The self-determination theory argues also that social-contextual events that conduce toward feelings of competence during action can enhance intrinsic motivation for that action (Ryan and Deci, 2000). A very popular example can be found in the Nike+[1] web community, which stemmed around the software and the wearable devices developed by the sport enterprise in order to allow people to track their physical performances. The Nike+ web community allows users to create an online profile where they can showcase their personal statistics, such as how many goals have been met and how many points have cumulated. The profile also displays the trophies and achievements an individual has unlocked, and can be integrated with the most important social networks in order to connect with friends. The introduction of the social dimension led to build a large community that counts more than 11 million users.

[1] https://secure-nikeplus.nike.com/plus/

Promoting Healthy Dietary Habits

Early and continued interventions are important since eating habits developed in youth are likely to continue into adulthood (Merten et al., 2009). Simple and easy changes in behavior could gain more benefits in the nutritional status than complex modification in dietary behavior. For example, some data suggest that breakfast consumption is associated with higher intakes of micronutrients, fruit and vegetables and less frequent use of soft drink. In addition, school-based interventions are effective in promoting healthy eating habits by increasing fruit and vegetable intake through developing education programs that actively involve teenagers. In this context, two objectives have been placed in the nutritional assessment, monitoring and educative programs recommendation within the PEGASO system:

1. The promotion of health for the preservation of normal growth and development

2. The prevention of chronic diseases associated to inadequate dietary habits such as obesity and other metabolic diseases.

The evaluation and monitoring of dietary habits will be faced as cycles of continuous assessments in periods of two months that may include an initial diagnosis of individual dietary habits; information that will be used for clusterization for deter-mining cluster group special intervention needs, that will able the system to determine specific objectives for the stimulation of behavior changes driven by serious games or the e-health companion. And finally, to close the initial cycle, a second evaluation of eating habits to determine the effectiveness of the proposed intervention.

The justification for this kind of approach is based on the complexity of dietary habits at different ages, gender and country of residence. To underpin the behavior change it is necessary an initial diagnosis to determine the most important and effective actions to be improved.

The dietary habits will be determined by means of food frequency questionnaires, with which can be estimated the energy and nutrient intake and dietary pat-terns in relation to diet quality, diversity and equilibrium. Finally, the total assessment of dietary habits can be expressed as a diet quality index, which measures its adherence to country specific dietary guidelines. The advantage of the use of such index is that it captures the complexity of human diets in a single value, taking the interactions between nutrients, food preparation methods and eating patterns.

As depicted in Figure 2, the main outcome of the initial evaluation will be the identification of nutrient intake adequacy (percentage of nutrient intake in relation to the recommended dose) and the dietary patterns in terms of the amount of food ingested in each food group (e.g., cereals, vegetables, fruits, meats, etc.). Specific nutrient intake, such as total fat and fat type distribution, protein, calcium and iron could be estimated as well as the main food items that contribute to each nutrient intake.

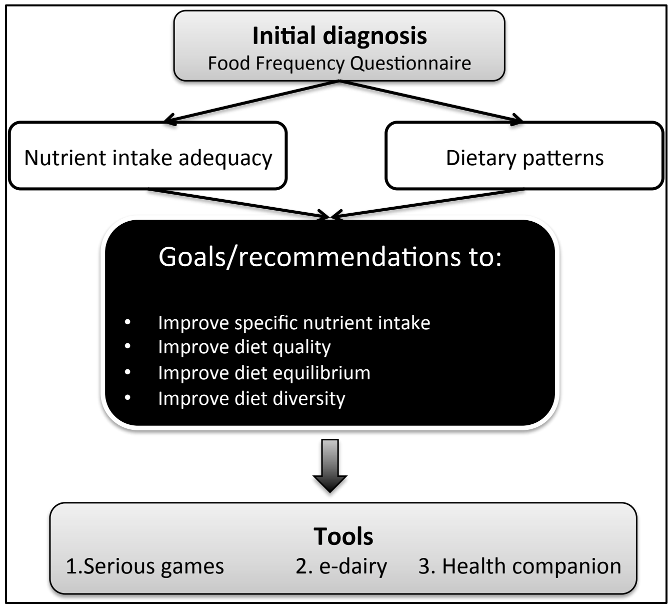

Figure 2. Domains of human systems integration. (Adapted from U.S Air Force, 2005)

Such information is the base information for planning objective for behavior change strategy that could be divided in the improvement of:

1. Specific nutrient intake

2. The diet quality in terms as whether the adolescent made the optimal food quality choices within a food group

3. The diet diversity in terms of the degree of variation of the diet.

4. The diet equilibrium in terms of the adequacy of intake in food group based on country specific Food Based Dietary Guidelines.

As a further step, the PEGASO system includes nutritional counseling to facilitate the change of dietary habits. Nutritional counseling strategies have evolved over the last decades, and nowadays most nutritionists use a combination of three models namely, cognitive behavioral, transtheoretical and social cognitive behavior; for prescribing dietetic recommendations to their patients. Cognitive behavioral strategy is based on the assumption that all behavior is learned and that environmental and internal factors are related to one's behavior. This model endorse strategies such as self-monitoring which make people more aware of internal and external factors that may affect their behavior. The transtheoretical model describes behavior change as a series of stages and provides a rationale for matching counseling strategies to different strategies of change. While the social cognitive behavior is based on the idea that people learn by observing other`s social interactions, experience, and outside media influences. Strategies like observational learning, skill development training are use to facilitate the learning process. This last model is commonly used in group settings, and seem to have and attrition rate 30% higher that the observed in the individual counseling (Renjilian et al., 2001).

The PEGASO ecosystems will be designed to include the three strategies exposed previously. The Virtual Individual Model and sensory systems able the user to record day-to-day physical and nutritional variables allowing self-monitoring for the improvement of goal acquisition. Moreover, the analysis of variables in the initial diag-nosis of the Virtual Individual Model sets specific goals for behavior changes that must be improved, serving as a guide to the user. Additionally the Health Companion application may provide recommendations that may help the users to achieve their personal goals.

In a transtheoretical model, the system will offer several applications in a Serious Game format that will allow the user to gain nutritional education based on the stated goals after the initial diagnosis. As an example of education applications could be mention:

- Can I eat it? (Diet Quality) A bar code reader for any food item in that based on the age, sex, physical activity and food habits could generate a recommendation suggesting the relevance of the consumption of the specified food item.

- What to eat? (Diet diversity & equilibrium) Designed to be used for gain information of recommended food items to be taken based on food preferences, age, sex, physical activity and in a specific time of the day.

- How good is it? (Diet Quality) An easy to interpret food composition database that can be consulted to answer nutritional adequacy of the requested food item.

- Do it myself and recipe creator. (Diet diversity & equilibrium) An application where the adolescents could create balances menus and recipes ac-cording to the age, sex, physical activity and special needs.

And finally, the use of social media applications, which are common for the teenagers, will gave certain social pressure to acquire healthy nutritional behavior. As soon as there is a social change to good eating habits the individual behavioral changes objectives proposed by the initial analysis could be gained easily.

In order to track the emotional eating behavior, the companion will ask every day how the user is feeling. This mechanism has a twofold aim: establishing an affective relationship between the user and the companion, and creating an emotional log in order to provide enough information for the learning algorithms. In fact, this information can be used to find some specific behavioral patterns related to emotional eating in order to generate the best feedback. The emotions will be also recorded in the food diary and using wearable systems (when available). All these data, elaborated also with the information about social interaction, physical activity, food intake and health condition will provide the correct trend in order to identify the key factors that will help the system to encourage and support the user in keeping his/her healthy life-style.

CONCLUSIONS

In this paper, the PEGASO project has been introduced and the concept that constitutes the foundation of the persuasive system has been described. The system is designed to provide personalized interventions through the smartphone for teenagers in order to foster healthy habits for obesity prevention. The core of the system is the Virtual Individual Model, which integrates functional, physical and psychological aspects to allow the development of a more individualized strategy for the enhancement of healthy lifestyles through increasing motivation. This model considers an individual's health as resulting from the balance among physical, mental and social well-being. The Virtual Individual Model is constantly updated in order to follow the user evolution and to take into account the behavior change that is introduced by the PEGASO ecosystem; this aims at always providing the best interventions in order to keep supporting the adoption of a healthy life-style and to make these new habits last longer. The main interface element is the smartphone, which aims at becoming the health companion of the teenagers. It will allow interacting with different applications to insert information about food intake and, at the same time, it will act as a monitoring tool to track physical activity, which can also augment its features connecting to other wearable devices. The motivational mechanisms that constitute the different kinds of intervention are applied through videogames with social connectivity, gamified multimedia services as the e-diary and the motivational triggers as context-aware tailored messages.

Currently, the PEGASO project is in the design phase, where all the experts from the different domains are working to create the cross-disciplinary Virtual Individual Model with the related ontology for the digitalization. At the same time, some participants coming form the Psychology, the Industrial Design and the Computer Science domains are conducting focus groups and participatory design events in schools in three different countries (Italy, Spain and United Kingdom) for the design of the system.

In a later stage when the system will be developed, three pilots in different countries will take place (Italy, Spain and United Kingdom). These pilots will allow validating the effectiveness of this approach and examining the cultural differences that may impact on teenagers' life-style.

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