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# HamkeVis: InfoVis Tool for Sustainable Motivation Toward Behavioral Change in the Context of Exercise

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**Abstract**

Our HamkeVis project seeks to develop a motivational information visualization tool in the context of exercise as a means to facilitate awareness of user and peer activities. The goal is to change sedentary lifestyles to more active ones in the long-term by providing sustainable motivation to exercise. The tool will include elements of information visualization, persuasive technologies, socialization, and gamification.

**Keywords**

Motivation, information visualization, exercise, behavioral change, persuasive technology, gamification

**ACM Classification Keywords**

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**General Terms**

Design, Experimentation, Human Factors.

**Introduction**

According to the Center for Disease Control and Prevention, sixty percent of Americans do not reach the recommended level for physical activity. The most

common barriers why adults do not adopt more physically active lifestyles are lack of time to exercise, lack of self-motivation, lack of energy and resources, fear of injury, lack of self-management skill, feeling of boredom, and lack of social support [1]. Various studies and modern technologies have been developed for increasing and maintaining fitness by using elements of persuasive technology, gamification, social support, behavioral change model, and so on [2,3].

However, as far as we know, there have been fewer studies and tools providing sustainable motivation enough to maintain exercise in the long-term regardless of these barriers. Furthermore, there has been limited attention in an empirical study investigating privacy concerns when the tools provide a function of social support in the context of exercise.

### **Elements for behavioral change in the exercise context**

*Motivation* is a significant factor in achieving goals in many areas such as work, education, and sports. In the context of exercise, various theories and technologies have been developed not only to increase motivation to exercise more but also to change sedentary lifestyles to more active ones. Sports psychology focuses on two types of motivations from self-determination theory: intrinsic motivation and extrinsic motivation [4]. When individuals are intrinsically motivated, they engage in an activity for their own enjoyment and satisfaction. When extrinsically motivated, they participate in the activity for mainly external rewards.

Persuasive technology is defined as an “*interactive computing system designed to change people's attitudes or behaviours*” [5]. Examples include the

Nike+ [6] and the scoreboard for eco-driving [7]. In order to change and to maintain behavior over time. Consolvo et al. provided design requirements for encouraging physical activity.

- To give users proper credit for activities
- To provide personal awareness of activity level
- To support social influence for social supports by peers without a social pressure
- To consider the practical constraints of the users' lifestyles with considerations of users privacy and device design [8]

*Information visualization* is “the process of transforming data, information, and knowledge into visual form making use of humans' natural visual capabilities” or more concisely, as “the computer-assisted use of visual processing to gain understanding” [9]. Information visualization tools provide ways to improve efficiency, gain new insights about data and information, recognize patterns in the data, and increase user satisfaction [10, 11].

*Gamification* attempts to include game elements in non-gaming applications. Finance, health, news, user-generated content, and tutorials have applied these methods to provide improved user experience and user engagement [12]. Possible components to achieve these purposes include playfulness, scoring (e.g. ranks or levels), reward system (e.g. badges), compelling narratives, competition, socializing, and so on [13, 14].

*Social support* is considered to be an important intervention component required to support individuals' behavioral change [15], and as a means of awareness of self and others.

### HamkeVis project

HamkeVis is the compound word combining the Korean word 'Hamke' meaning 'together' and the abbreviated word 'Vis' for 'Visualization.' Aims of our HamkeVis project are (1) to develop and implement a theoretical framework to explain cognitive and motivational models in stages of change [16] when the information visualization tool is used in the context of exercise, (2) to change users' behavior incrementally and positively toward physical exercise through information visualization tools both mobile and online, and (3) to investigate how higher privacy concerns are related to external motivation. Our assumption is that an individual with higher privacy concerns may share less exercise data using the HamkeVis tool and be less responsive to external motivations provided in the tool.

The underlying assumption of our projects is that as personal fitness information in persuasively visualized representations is given to users, they will be more aware and engaged in their data, and their behaviors will be incrementally and positively changed.

### Results of a pilot study

We conducted a small pilot study with 32 participants (20 males and 12 females) from the National Institute for Fitness and Sport (NIFS) at Indianapolis to collect opinions about their motivations and willingness to accept technological aids when they exercise.

The results showed that they were motivated by both intrinsic motivation and extrinsic motivation when they exercise. Intrinsic motivation was rated significantly higher ( $M=3.99$ ,  $SD=0.60$ ) than extrinsic motivation

( $M=3.21$ ,  $SD=0.78$ ),  $t(31)=4.90$ ,  $p<0.05$ . Further, they showed moderate but still positive levels of technology acceptance rate ( $M=3.01$ ,  $SD=0.95$ ) indicating that they would use technological aids when they exercise.

In more detail, participants who had two or more years of exercise experience were significantly more motivated by intrinsic motivation ( $M=4.08$ ,  $SD=0.55$ ) than participants who had less than two years of exercise ( $M=3.36$ ,  $SD=0.63$ ),  $t(30)=2.40$ ,  $p<0.05$ . Males and females were not significantly different for either intrinsic or extrinsic motivation.

These results suggest to us that a persuasive information visualization tool for exercise has the potential as an external motivational factor for people whose lifestyles are sedentary and do yet not have strong motivation to exercise.

### Research Methods and Direction

The HamkeVis project will be based on the prototype development, testing, and experiments with users. Testing and development of the prototype will be iteratively conducted to examine features of persuasion, self-awareness of their data, and social support with peers, friends, and the broader public. The HamkeVis tool will provide a summary and a pattern of users' current and past physical activity data in visualized representations. It will also provide a feature to compare users' datasets to their own as well as peers' datasets in ways that minimize mental calculation to enhance awareness of self and peers. As persuasive elements, the tool will provide users persuasive recommendations using a non-intrusive tone, a goal-setting system, and a reward system such as virtual badges. Levels of privacy will be customized

<sup>1</sup> The questions were asked in a Likert scale of 5 points, where 1 = 'strongly disagree' and 5 = 'strongly agree'.

by the user in the tool. The HamkeVis tool will be developed using the Adobe Flex framework because it enables developers to create applications running across different mobile devices with one tool, one development framework, and one codebase. In addition, it will make it easy to convert the code for building a web-based application.

Next, experiments and interviews will be conducted with 36 participants. The goals in this phase are to investigate the changes of their levels of motivation, privacy concerns, willingness to accept technological aids, satisfaction, and degrees of their subjective concentration on their exercise once they use the information visualization tool. Then, we will analyze the results and refine the theoretical framework.

## Reference

- [1] Centers for Disease Control and Prevention. U.S. obesity trends: Overcoming barriers to physical activity. <http://www.cdc.gov/physicalactivity/everyone/getactive/barriers.html>.
- [2] Mattila, E., Korhonen, I., Lappalainen, R., Ahtinen, A., Hopsu, L., and Leino, T. Nuado concept for personal management of lifestyle related health risks. In *Proc. the IEEE Engineering in Medicine and Biology Society*. (2008), 5846-5850.
- [3] Barkhuus, L. Designing ubiquitous computing technologies to motivate fitness and health. In *Proc. the Grace Hopper Conference 2006*. ACM Press (2006)
- [4] Vallerand, R.J., and Ratelle, C.F. Intrinsic and extrinsic motivation: A hierarchical model. E.L. Deci & R.M. Ryan (Eds), *Handbook of self-determination research* (2002), 37-63.
- [5] Fogg, B.J. *Persuasive Technology: Using Computers to Change What We Think and Do* (2003).
- [6] Nike+. [http://nikerunning.nike.com/nikeos/p/nikeplus/en\\_US/plus/#//dashboard/](http://nikerunning.nike.com/nikeos/p/nikeplus/en_US/plus/#//dashboard/)
- [7] Inbar, O., Tractinsky, N., and Seder, T. Driving the scoreboard: Motivating eco-driving through in-car gaming. Ext. Abstracts CHI 2011, ACM Press (2011).
- [8] Consolvo, S., Everitt, K., Smith, I., and Landay, A. Design requirements for technologies that encourage physical activity. In *Proc. Designing for Tangible Interactions*. CHI 2006. ACM Press (2006).
- [9] Chittaro, L. Information visualization and its application to medicine. *Artificial Intelligence in Medicine* (2001), 81-88.
- [10] Lurie, N. and Mason, C. Visual representation: Implication for decision making. *Marketing* (2007), 71, 160-177.
- [11] Pfaff, M., Drury, J., Klein, G., More, L., Moon, S., and Liu, Y. Weighing Decisions: Aiding Emergency Response Decision Making via Option Awareness. In *Proc. Technologies for Homeland Security* (2010).
- [12] Deterding, S. and Sicart, M. and Nacke, L. and O'Hara, K. and Dixon, D. Gamification: Using Game Design Elements in Non-Gaming Contexts. 2011. Ext. Abstracts CHI 2011, ACM Press (2011).
- [13] Antin, J. and Churchill, E.: Badges in Social Media: A Social Psychological Perspective. Ext. Abstracts CHI 2011, ACM Press (2011).
- [14] Reeves, B. and Read, J.L. Total engagement: Using games and virtual worlds to change the way people work and businesses compete (2009).
- [15] Duncan, T., and McAuley, E. Social support and efficacy cognition in exercise adherence: A latent growth curve analysis. *Journal of Behavioral Medicine* (1993), 16, 199-218.
- [16] Prochaska, J.O. and Marcus, B.H. The transtheoretical model: Applications to exercise. *Exercise Adherence II*. R. Dishman. Illinois, Human Kinetics Press (1995).