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Integrating Health Theories in Health and Fitness Applications for Sustained Behavior Change: Current State of the Art

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Two hundred million people in the US are overweight or obese mirroring a worldwide trend that is associated with high morbidity and mortality rates. Health and fitness mobile technology applications have great capacities for supporting dieters' life-style changes and could profit from and provide input of health behavior theories. Those theories have been demonstrated with massive clinical evidence to be efficient for fostering healthy lifestyle changes and weight loss. This research reviewed the 100 most popular mobile technology applications from iTunes App Store's Health and Fitness category in respect coverage of health behavior theories' concepts und chose 14 of those for a complete analysis. Applications provide good support for athletes' workouts and have great potential to be extended to serve overweight users as well. Missing features could be easily implemented given the current state of technology. These developments look promising for tackling sustained weight loss in many mobile technology users.

Keywords: Health and Fitness Applications; Health Behavior Theories; Mobile Technology Applications

Introduction

Overweight users of health applications face complex daily challenges when trying to change their lifestyle. Not used to low calorie food and not ready yet for advanced exercise, they have to integrate new procedures into already established daily routines. Often there are knowledge gaps to be filled. They may be overwhelmed by the scale of the project, lack motivation, and may need support for coming back on track after relapses. When using health and fitness applications for supporting these aims, overweight users need to know with confidence why they are doing what they are doing and what the health benefits from those exercises will be.

The interplay of all these factors is covered in intensively researched health behavior theories. Mobile applications can nicely complement those theories because of their computing power, multimedia and communication capacities, and their capacities for tracking daily activities of patients who are seen by their healthcare provider only on weekly or monthly basis. Health behavior theories use detailed information about a person for predicting the likelihood of initiation and maintenance of health behaviors. Health applications can support the process of behavior change by providing in time, user- and stage-specific advice and encouragement.

Current health and fitness applications use already successful smartphone capabilities for supporting goal oriented behavior and it does not take effort much to integrate the remaining components of health behavior theories. The benefit of doing so would be huge in terms of user adaptation. Current health and fitness applications are well adapted to athletes who experience workout and exercise as rewarding by themselves. They are not well adapted for the potentially 200 million overweight and obese smartphone users in the US. The majority of those might have never seen a gym from the inside. When combining the strengths of health behavior theories and mobile phone technologies, both can greatly profit. Mobile technology can provide much more precise input to health behavior theories than from participants' self-evaluation. Health applications developers could win huge numbers of new customers.

For this research, we have evaluated 14 mobile technology applications from the Health and Fitness category of the iTunes App Store in respect to already covered components of health behavior theories. The conclusion of our work will indicate there is already good coverage for some of those components and first implementations and great potential for the remaining components. In this paper, we describe the prevalence of obesity and briefly review evidence that mobile technology has been successfully used to tackle that epidemic obesity problem. Then we will briefly sketch the health behavior theories and our method and analysis of reviewed health applications. Finally we will review results using *5K Runner* as an example und review suggestions for further development.

Obesity Prevalence

According to World Health Organization figures (WHO, 2010), in 2008, 63% of deaths worldwide were caused by non-communicable diseases, including cardiovascular diseases, cancers, diabetes, and lung diseases. These diseases are strongly associated with health risk behaviors, such as smoking, unhealthy diet, insufficient physical activity, and alcohol abuse (WHO, 2010). Between 1980 and 2008, worldwide obesity has almost doubled (WHO, 2010). In the American WHO regions, 62% were overweight. In other regions, prevalence statistics are similar. For example, in Bahrain diabetes type 2 prevalence was 15% in 2010 with 61% of Bahraini males and 67% of Bahraini

females being overweight or obese (Shaw et al., 2010). There is evidence that habitual energy imbalance of only a few kcal can result in a slow, but substantial gradual weight gain (e.g., Mozaffarian et al., 2011). At the same time, modest life-style changes can reverse that trend and result in sustainable weight loss (e.g., Hall, 2012).

Mobile Technology and Obesity

Mobile technologies with their advanced computing and communication capabilities can promote efforts for lifestyle changes (e.g., Boulous et al., 2011). There is also increasing evidence that mobile technologies can be efficiently used for supporting those aims (e.g., Free et al., 2010; Web et al., 2010). For example, shoppers provided with food substitution advice continued buying healthier alternatives after program completion (Huang et al., 2006). Weekly emails on patients' stage and specific goals impacted their eating habits (Patrick et al., 2009).

In 2009, 67% of inhabitants globally had a mobile phone subscription (Geneva, International communication Union, 2010). In 2011, 34% of US households had wireless phones only (Blumberg et al., 2012). In Qatar, the mobile phones subscription rate reached 121% during that time (IctQatar Landscape, 2009, update 2011). This indicates that patients in need of changing their lifestyle can be reached and supported via mobile technology. Indeed, many smart phone application stores, including iTunes App Store, Google Play, and Amazon Appstore, provide a "Health and Fitness" category.

When promoting a healthier lifestyle, mobile technologies should implement prevalent health behavior theories that have been successfully implemented for obesity and diabetes management, smoking cessation, and other health related habits in clinical settings. These include the *Health Belief Model* (HBM; Becker & Rosenstock, 1984), *Theory of Planned Behavior* (TPB; Ajzen & Fishbein, 1970; Ajzen, 1991), *Transtheoretical Model or Stages of Change Model* (TTM; Prochaska & di Clemente, 1984; Prochaska et al., 1994) and the *Health Action Process Approach* (HAPA; Schwarzer, 1992; Schwarzer et al., 2008). Because the HAPA integrates components from the other theories, we review here briefly the HBM, TPB, and TTM only. Each of the theories provides a slightly different perspective on the issue of behavior change.

The **Health Belief Model** (HBM) focuses on a person's health related cognitions for determining their behavior. For example, when deciding whether to schedule an appointment for cervical cancer, a woman would consider whether she is likely to have that cancer, how severe the disease would be, and what her costs and benefits of screening would be.

If her sister would be diagnosed with cancer, that might trigger scheduling an appointment herself (Murray & McMillan, 1993).Mobile health applications could support decision making by providing relevant health information and by popping up reminders, for example for scheduling exercise.

The **Theory of Planned Behavior** (TPB) acknowledges that a person's health behavior is only indirectly impacted by their beliefs and be social influence and is mediated by a person's intention resulting from those distal factors.

For example, perceived behavioral control based on earlier experience and social norms predicts whether a person would start to exercise and maintain that new habit (Armitage, 2005). Many mobile health applications include options for social networking or provide role models and social norms. Detailed feedback on workout performance can foster perceived behavioral control.

The **Transtheoretical Model** (TTM) suggests five stages that a person progresses through over time: During the pre-contemplation stage, a person has not recognized yet that they need to quit smoking, for example. During the contemplation stage, they start thinking about changing. During the preparation stage, the person plans when to throw away cigarettes and what to do instead of smoking. During the action stage, the person implements those plans. Finally, during the maintenance stage, the person aims to maintain abstinence and integrates new routines in their life-style. During relapse, a person leaves that cycle, for example by smoking, and returns thereafter to any of the five stages (DiClemente et al., 1991). Obviously, mobile health applications cannot serve users during the pre-contemplation stage, because those do not even consider yet changing their lifestyle. During contemplation stage, users could profit from relevant health information. During the planning stage, mobile health applications could help to set specific and achievable goals, maybe supported by healthcare providers' feedback. During the action phase, there is a challenge to provide specific and detailed instruction on one side *and* to enable users to perform on their own. Otherwise mobile health application work like car navigation systems: They tell you the way to the airport, but they do not introduce you to a new city. This balance is even more important during the maintenance stage, when users try to integrate new routines in their daily life. Finally, lapse and relapse management should encourage users to get back to their aims as fast as possible for limiting potential damage.

Methods

For this review, we have chosen the ten components of the three health behavior theories that were straightforward to analyze and not overlapping. We evaluated whether applications addressed perceived costs (1) and health benefits (2) and whether they provided cues for action (3; HBM). We evaluated whether applications supported subjective norms or social support (4) and promoted behavior control (5; TPB). Finally, we discussed which of the six stages (6 – 10) of the Transtheoretical Model could be supported. Because people in the pre-contemplation stage do not yet consider changing, we excluded that stage. We assume that people might browse for applications from the contemplation stage on.

We have focused on ITune's *What's Hot* section of most downloaded applications for IPhones and IPads from the *Health and Fitness* category. Most applications offered in that store are also offered for other platforms. From that section, we selected the top 100 applications (US store, state of September 1, 2012) and successively reduced the number of applications to 14 (see **Table 1**) by excluding applications that were not offered in English, were offered for free, did not cover health style related diet or physical activity behaviors, or had several very similar applications from the same publisher. We excluded free applications to reduce redundancy because most of those had paid siblings with very similar features. In addition, users demonstrate some commitment to changing their lifestyle when paying some money for downloading an application.

From the original list of 100, 59 applications were for free, the remaining applications cost between $0.99 and $5.99. The

Table 1.
Analyzed applications, publisher, short description and analyzed components: cues to action (HBM3), subjective norm (TPB 4), behavior control (TPB 5), contemplation phase (TTM 6), preparation phase (TTM 7), action phase (TTM 8), maintenance phase (TTM 9), relapse phase (TTM 10).

Application	Publisher	Description	HBM 3	TPB 4	TPB 5	TTM 6	TTM 7	TTM 8	TTM 9	TTM 10
5K Runner	Heavy Duty Apps	8 week running program aiming for 5K	0	1	1	1	1	1	0	1
C25K TM - 5K Trainer Pro	Zen Labs LLC	8 weeks running program aiming for 5K	0	0	0	1	1	1	0	0
Daily Workouts	Daniel Miller	workout program and tracker	0	0	1	0	1	1	0	0
Endomondo Sports Tracker Pro	Endomondo LLC	workout organizer and tracker for distance based sports	1	1	1	0	1	1	1	1
Food Substitution Calculator	Lean Bodies Consulting	provision of healthier food alternatives	0	1	0	1	1	0	0	0
Gorilla Workout: Athletic	*Heckr LLC*	*workout program and tracker*	1	1	1	1	1	1	0	0
MapMyRIDE+ GPS Cyc	MapMyFitness Inc	biking and running tracker	0	1	1	0	1	1	1	0
Mountain bike PRO	*Runtastic GmbH*	*GPS based bike computer*	1	1	1	0	0	1	1	0
myWOD - All in one WOD Log for CrossFit	Jimmy Tangeman	workout organizer and tracker	1	1	1	0	1	1	1	0
Points Calculator Plus Tracker	*Greg Ellis*	*diet tracker*	1	0	1	1	1	1	1	0
Seal Fitness Challenge	Jgo Labs LLC	fitness program	1	1	1	0	1	1	0	0
Walkmeter GPS Walking	*Abvio Inc.*	*GPS-based fitness computer*	0	1	1	0	1	1	0	1
Workout Hero TM	Storeboughtmilk Inc.	workout program and tracker	1	1	1	1	1	1	1	1
Zombies, Run!	*Six to Start*	*running game and audio adventure*	1	1	0	1	1	1	1	1

same range holds for the final selection. The final 14 applications required between 3.2 MB and 322 MB space on the device (M = 45 MB, SD = 84), and were ranked by customers with at least four stars (M = 4.7, SD = 0.15).

Results

As an illustration, *5K Runner* provides a 3 days for 8 weeks running program for beginners with the final aim to master 5,000 m. As most other applications, *5K Runner* does not link to relevant health information for the HBM. Under the *Learn* tab, the *Help & Tips* section informs about health requirements, what is needed to start, and about the best way to warm up. It also suggests to "consult a doctor before beginning".

For the TPB, *5K Runner* provides several cues for perceived behavioral control: While running, the application provides visual and auditory feedback on progress and a halfway notification (TPB5). It awards different badges after completing a workout and automatically tracks and records training sessions. However, it does not track distance or physiological parameters or contributes to changing personal attitudes toward running. For implementing subjective norms (TPB 4), there is an option to use social networking tools to broadcast accomplishments, but no role models or options to team up for running.

For the TTM, *5K Runner* provides support for the preparation phase (TTM 7) under its *learn* tab, *help & tips* section. By providing detailed instruction, when to walk and when to run, it guides the action phase (TTM 8) for 3 days a week. This might also contribute to the beginning of the maintenance phase (TTM 9) because it is tailored for 8 weeks. Still, there is no instruction on how to maintain performance once a user has reached the 5K goal. For relapse stage (TTM 10), there is a message in the *help & tips* section, but not a complete relapse management.

In total, ten applications had options for social networking (TPB 4), for sending emails or getting applause and encouragement from friends. This kind of social support is as good as your friends are. *Workout Hero TM* provided a list with heroes, benchmark girls/boys, etc. as an implementation of subjective norms. *Daily Workouts* and other exercise programs provide videos with demonstrations on how to perform an exercise. These can contribute to subjective norms (TPB 4) and to behavioral control (TPB 5, N = 11). What is missing in all programs we evaluated is an interface for the healthcare provider that could either feed performance data back to the healthcare provider or for enabling guidance for the patient. There was also no relationship between provided instruction and relevant health information (HBM 1 and 2). For example, the *Food Substitution Calculator* might suggest substituting bread with green beans, but would fail to explain how this serves health goals.

Contemplation and relapse phases (TTM 6, N =7, and TTM 10, N = 5) were neglected by most applications. *Zombies, run!* starts the first time with a little story explaining the scenario. In contrast, most of the workout programs start immediately with choosing an exercise (TTM 8, N = 13). In case of a relapse (TTM 10), *SEAL Fitness Challenge* ranks the user back to 'wannabe' canceling out all accomplishments made so far. This might trigger motivational issues for users when attempting to get back on track. In contrast, *5K Runner* provides encouragement for "I had a really bad run" saying that even Michael Jordan had occasionally bad days under its *Help & Tips* section.

This kind of (re-)lapse management is especially important because there is evidence that, for example, dieters in preload studies tend to loose control and overate after consuming a high calorie milkshake in the morning, the 'what-the-hell effect' (Herman & Mack, 1975). It seems many dieters think in all-or-none terms and do not have a backup plan in case of lapse. While the *SEAL Fitness Challenge* supports that kind of thinking, the *5K Runner* invites for reframing the problem and getting back to track. The milkshake in the morning spoils today's diet. Whatever comes after that, could spoil the whole last week's effort!

Many reviewed applications did also miss to address the maintenance phase (TTM 9, *N* =7). Once a *C25K TM - 5K Trainer Pro* user has reached the magical 5,000 meters, how shall they keep up performance and fitness?

Discussion

Most health and fitness applications on iTunes' *What's Hot?* list provide instruction and tracking how to perform health-related behavior, but are only loosely associated with detailed health information. They also cover some, but not all components of health behavior theory. This makes it impossible to predict success for adopting healthier behaviors using those applications based on these theories. Technology has sufficiently advanced to implement the theories. They can take the burdens from patients tracking their performance and can provide much more precise measures, for example for physical activity than patients could approximate.

To return to our *5K Runner* example, the application could integrate HBM components more, by taking, for example, Body Mass Index and other variables as input and tailoring the running program accordingly. Alternatively it could allow the Health Care Provider (HCP) to do so and send alerts to the HCP if, for example, the blood glucose levels are too low. More general, *5K Runner* could display health benefits as motivating pop-up messages after completing the day's program. For the *cues to actions* component of the HBM, *5K Runner* could push-up automatic reminders or suggest to 'book exercise in your calendar' or to keep the running shoes in a prominent location as a reminder to run next time. All these can contribute to having users come back and complete their running program.

For the TPB, *5K Runner* could provide benchmark or role models for implementing subjective norms (TPB 4) or simulate an workout competition. For behavioral control (TPB 5), the application could integrate distance or physiological measures tracking and not just reference to GPS programs or runner forums as external sources.

For the TTM, *5K Runner* could support users to make achievable and measurable plans for performance outside of a running session (TTM 7 and 8). It could suggest days for running and remind users to run. The application could keep sending those reminders after completing the program (TTM 9) to keep up high performance and fitness. For managing relapses, it probably takes more than a message in the *help & tips* section. Again, health care provider could contribute toward winning users back after a phase of relapse.

In general, for getting the best from both worlds, we would wish for integrating user's motives and aims for tailoring personalized advice that is integrated in a treatment plan for that person. It would be good to implement physiological benchmarks for alerting patients and healthcare provider, for example if a person has too high heart rates during workout. This is associated with an interface for the healthcare provider allowing for monitoring, guidance and feedback. Health and fitness applications should not only build performance, but also support building planning competence, support the perceived cost/benefits analysis, and provide long-term motivational support and relapse management. For implementing those, developers can greatly profit from mathematical modeling efforts in the health theory community.

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