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SHORT-PAPER

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Analysis of Motivation Strategies in Running Tracking Applications

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ABSTRACT
In the last years, a large number of sport and fitness applications for smartphones were developed for supporting a healthy lifestyle by not only encouraging people to follow a balanced diet but also to motivate them to engage in physical activities. In particular running applications received increasing attention in research in recent years. In this paper, we analyze fourteen commercial running tracking applications concerning their functionalities to identify which motivation strategies are supported and also to identify possible directions for future research. For this purpose we concentrate on the three most popular motivation strategies that are usually used for sport and fitness applications: music and audio feedback, visualization, as well as competition and comparison with others.

Categories and Subject Descriptors
H.5.m [**Information Interfaces and Presentation (e.g., HCI)**]: Miscellaneous

General Terms
Human Factors

Keywords
Motivation strategies, Mobile device, Smartphone, Sport and fitness applications.

1. INTRODUCTION
Applications for all purposes have turned the smartphone into a multi-functional device that pervades everyday life [1]. This trend is also visible in the sports domain, in particular for running – a topic that is also increasingly getting attention in research. Research considers a versatile portfolio of approaches how technology can assist the running experience. GymSkill [1] is a smartphone system for comprehensive physical exercising support. Their system showed good evaluation results comparable to expert assessments of video-recorded trainings. Jogging the distance [2] is a system that facilitates a social experience between people running at different locations. Based on heart rate audio is spatialized such that the different paces are perceivable and may encourage the runners. Joggobot [3] is a robot companion flying next to the user when jogging; like a coach it motivates to ran faster and further and can also be used similar to jogging with a dog.

From a health perspective, a major challenge lies in the aspect that recreational runners – exercisers who work out at submaximal intensity for, e.g., health purposes [4] – may lose motivation to run quickly, for instance, due to physical strain while running, and dismiss the idea to engage in a sports activity before they have actually started with it [5]. Therefore, motivation and enjoyment are particularly important factors for recreational runners [4] and the positive effects of these factors have been proven to be significant [4].

Various strategies exist to motivate recreational runners (e.g., music and audio feedback, visualization, competition and comparison with other runners, etc.) and information technology (IT) can be used to enable and support these strategies. In this paper we outline motivation strategies for recreational runners and identify and analyze commercial running tracking applications concerning their functionalities to identify (a) which strategies are supported and (b) possible directions for the future research.

The remainder of this paper is structured as follows. Section 2 and Section 3 give an overview of the different types of motivation and of motivation strategies that have been used for sport and fitness applications. The procedure of the analysis of the running applications is presented in Section 4 and the results according to the different motivation strategies are given in Section 5. In Section 6, we discuss the findings and also show possible directions for the future. Finally we conclude the paper in Section 7.

2. MOTIVATIONAL FACTORS
Motivation is considered as one of the most important variables in sport [6]. Basically, there are two different types of motivation: *intrinsic* motivation and *extrinsic* motivation [6, 7]. Intrinsic motivation is based on the pleasure and satisfaction a person derives from a certain activity. Extrinsic motivation refers to engaging in an activity derived from some kind of rewards that are external to the activity itself, such as achieving a reward or avoiding punishment [6, 8]. Intrinsic motivation may contribute to developing positive emotions leading to a higher degree of experienced autonomy and competence. Nevertheless, some individuals would cease from participating in sports activities without any rewards assuming that no coercion is executed [8].

For the sports domain, a lot of research exists with respect to sports participation motivation. For instance, the Sports Participation Motivation Inventory [9] covers of the following relevant motivational factors: friendship, skill development, fun, achievement/status, energy release, fitness, competence/competition, and situational factors. Afsanepurak et

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al. [10] identified social energy, fitness, working off energy, intrinsic motivation, group work, entertainment, extrinsic motivation and competitions as possible motivation types. Particularly for mass sports ('sports for all'), competition and entertainment were repeatedly identified as significant motivators (e.g., [11, 12, 13]).

3. MOTIVATION STRATEGIES

In this section we provide a short overview of the three most promising motivation strategies that have been used for sport and fitness applications in the last years: music and audio feedback, visualization, as well as competition and comparison with others.

3.1 Music & Audio Feedback

Music is not only listened for entertainment, but is also deployed for certain purposes [14]. In training, for instance, it is appreciated for its influence on arousal regulation, synchronization, or attainment of flow [15]. Furthermore, music has long been acknowledged for its motivational qualities [14, 16, 17], which are particularly useful and effective in mass sports and/or for beginners [18].

However, identifying the *ideal* piece of music is complex: It has to be wisely selected and tailored to the individual's situation to be most effective [17]. For instance, music has been found to be motivating if it matches the runner's taste, if the lyrics are pleasant for the runner, if it evokes positive associations, and if it is selected by the runner himself or herself [17].

3.2 Visualization

For the analysis of sport competitions, visualizations play an important role for exploring different player strategies or statistical data on individual participants or teams, for example for monitoring, controlling, and improving the performances of the sportspeople (e.g., [19, 20, 21, 22]). For example, Oliveira et al. [23] present visualization designs for analyzing running competitions in particular heart rate, speed, and GPS information about the athletes.

However, such visualizations are not only of interest for analyzing data in professional sports, but also for people who want to increase their fitness level for a healthy lifestyle. For example, a visualization of their paths, their body response measurements, and statistics about their activities (e.g., run duration, frequency of workouts per week or month) may encourage them to achieve their fitness goals (see e.g., [24, 25]).

3.3 Competition & Comparison with Others

Comparison with other runners may be operationalized in two ways: (1) in form of direct competition (contest) or (2) as benchmark (comparison) with best practices. Franken and Brown [13] showed the motivational qualities of competitions. The main reason for motivation are rooted in the urge to win, improvement of one's own skills, and the fact that one keeps pursuing the same activity over a longer term as preparation for a competition [13].

Visualization may be used to compare an individual's running activities to those of others (see e.g., [26]). Furthermore, shared information of running activities with other people may also encourage to try other paths or to plan future workouts [26].

Over the last year gamification – i.e., integrating a game design and mechanics into non-game context – has become a trend to motivate people to engage in more physical activities such as running (cf. [27]). The concept of gamification is based on reward and positive feedback to achieve users' goals. An example for a combining competition with a gamification strategy is the commercial product Fitbit [28, 29]. The concept allows for starting a challenge and inviting one's friends and family to jointly achieve more 'steps' in the challenge. Furthermore, users may enlist friends to support them reach goals by sharing statistics, joining fitness challenges or competing on leaderboards. Another example is Teemo [30] that allows players to share their achievements and rewards with others via Facebook.

4. RUNNING APPLICATION ANALYSIS

We analyzed the top free running tracking applications on the market with their functionalities to identify which motivation strategies are supported by these applications in 2013.

Figure 1 displays the methodical procedure of our analysis and can be divided into seven steps: 1) search for running tracking applications, 2) collection of application, 3) screening of applications, 4) analysis of application, 5) assign the functionalities to categories, 6) grouping the categories to the motivation strategies, and 7) comparison.

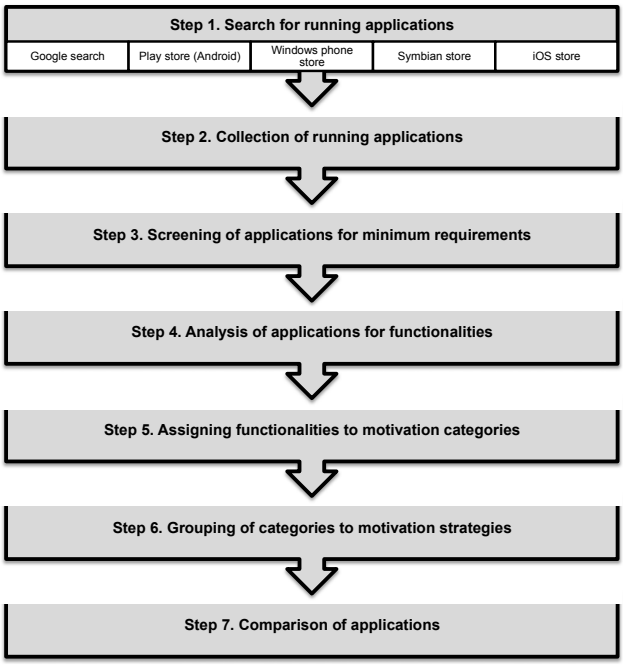

Figure 1. Methodical procedure for the analysis of mobile running applications.

As first step, we searched the most common online databases for Android, iOS, Symbian, Windows Phone for applications description containing following keywords: sports tracking, tracking, running, trainer, GPS trainer, audio run, bpm run, or audio sport. 50 running applications were found and the listed applications were manually examined for the following minimum requirements: (1) distance measurement functionality (in order to qualify as running tracking application), (2) the possibility to analyze the measured data in the application portal, (3) high popularity (a minimum of 50,000 downloads and a minimum of 100 user ratings in the respective store), and (4) availability of the application for all platforms (as a further indirect indicator of high popularity).

Filtering for these requirements resulted in fourteen applications as listed in the columns of Table 1. In order to elicit all

functionalities of the applications, we installed the applications, registered user accounts, performed test runs with every application (using a Samsung Galaxy S), and used the application portals for data analysis. Finally the applications were analyzed and compared with regard to the three motivation strategies, for which the functionalities of the applications were indicatively elicited while testing the applications.

Informed by related work on motivation factors in sports (see Section 2), the authors grouped the applications' functionalities, which were identified by performing test runs with the applications, by motivation factors. The two authors individually assigned each of the functionality to a respective category. Then, the authors talked over the functionalities where disagreement emerged until they reached consensus on the assignment. Analytical group discussion led to a consolidation of the grouping structure. For instance, the two subcategories 'music feedback' and 'audio feedback' were joined to one category. 'Social interaction' was integrated into 'competition'. In a final step, names were given to the resulting categories, which represent the three main motivation strategies. The resulting categorization is presented in Table 1.

5. RESULTS

In the following sections, results of the analysis about the three motivation strategies and how they are supported by the provided functionalities are given in detail. Table 1 summarizes the functionalities supported per application and motivation strategy.

5.1 Music & Audio Feedback

An interesting functionality offered by nine applications is the integration of music tools: these applications integrate songs from the device's library (e.g., from iTunes) to entertain the runner. Four applications allow the user to specify different playlist for different workouts. However, these playlists have to be defined manually. None of the analyzed applications, though, offers specialized jogging/running music for workouts or adapts to the users actual workout.

Typically, the applications offering to specify goal-oriented modes and also provide audio feedback on the set goals: seven applications provide audio feedback on distance and time respectively, six applications provide also feedback on the estimated kilocalories expended while exercising, and three applications provide audio feedback on pulse frame and in interval training

5.2 Visualization

All fourteen applications provide visualizations as motivation strategy for runners. Visualizations of the tracked distance, time, expended kilocalories, and tempo are provided by all analyzed applications. Thirteen of the fourteen applications offer additional visualizations to present the expended kilocalories and pace. The average tempo can be visualized by twelve applications and distance visualizations are offered by eleven applications. Six of the fourteen applications allow visualizing autopause and pulse of the runners. For example, the application Cardio Trainer (Noom) offers autopausing that recognizes standstill after five seconds, which can be visualized as spheres on Google Maps [31] (see Figure 2). Five applications of these six applications also provide to visualize the average pulse.

All of the fourteen applications with visualizations provide the option to visualize traces on maps and runners' history on their devices. Thirteen applications also allow runners to analyze a visualization of their history on a web portal. The functionality to export the data is offered by ten applications, which gives runners the possibility to visualize their tracks also on Google Maps [31] (see Figure 2 as an example).

Table 1. Functionalities of running tracking applications according to the three motivation strategies.

running tracking applications → / functionalities ↓	Adidas miCoach [32]	AllSport GPS [33]	Endomondo [34]	Cardio Trainer (Noom) [35]	iCardio = iRunner (iTMP) [36]	Imapmy Run [37]	Nike+ Running GPS [38]	Runstar [39]	Runtastic [40]	RunLog [41]	RunKeeper [42]	SmartRunner [43]	Sports Tracker [44]	Zombies, Run! [45]
Music and Audio Feedback (AF)														
linking to music application	✓	-	✓	✓	-	-	✓	✓	✓	-	✓	-	✓	✓
AF on pulse frame	-	-	✓	✓	-	-	-	-	-	-	✓	-	-	-
AF on interval training	✓	-	-	-	-	-	-	-	-	-	✓	-	-	✓
AF on distance	✓	-	✓	✓	✓	✓	✓	-	-	-	✓	-	-	-
AF on time	✓	-	✓	✓	✓	✓	✓	-	-	-	✓	-	-	-
AF on kilocalories	✓	-	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
AF on tasks	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Visualization														
distance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
time	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
altitude distance (min/max)	-	✓	✓	✓	✓	✓	-	✓	✓	-	✓	✓	✓	-
altitude distance (ascend/descend)	✓	✓	✓	✓	✓	✓	-	-	✓	-	✓	✓	✓	-
expended kilocalories	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
pulse	-	-	✓	✓	✓	-	-	-	-	*	✓	-	✓	-
average pulse	-	-	✓	✓	-	-	-	-	-	*	✓	-	✓	-
tempo	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
average tempo	✓	✓	✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓
pace	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-
goal (achieved)	✓	-	✓	✓	-	-	✓	✓	✓	-	✓	-	-	-
pulse frames	✓	-	✓	✓	-	-	-	-	-	-	✓	-	✓	-
map visualization	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
autopause	-	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	-
generated training schedules	✓	-	-	-	-	-	-	-	-	✓	✓	-	-	✓
training control / link to training control	✓	-	-	-	-	-	-	-	-	✓	✓	-	-	-
personalization of generated training schedule possible	✓	-	-	-	-	-	-	-	-	✓	✓	-	-	-
time goal	✓	-	✓	✓	-	-	✓	-	✓	-	✓	-	-	✓
distance goal	-	-	✓	✓	-	✓	✓	-	✓	-	✓	-	-	-
kilocalories goal	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-
Competition and Comparison with Others														
interval training	✓	-	-	-	-	-	-	-	-	-	✓	-	-	✓
ghost running	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
general competitions available	✓	-	✓	✓	-	-	✓	-	✓	✓	✓	✓	-	-
competition against a friend's workout	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-
defining individual competitions	✓	-	✓	✓	-	-	✓		✓	-	✓	✓	-	-
competition against personal best time	✓	-	✓	✓	✓	✓	✓	-	✓	-	✓	-	✓	-
social interaction via Facebook, Twitter, or forum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

✓ functionality supported; - not supported; * has to be set up manually

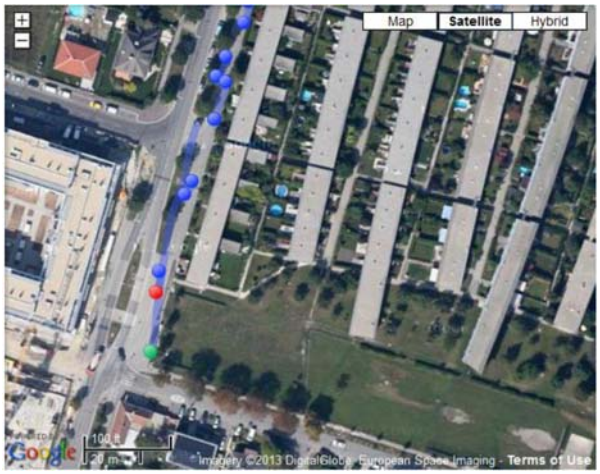

Figure 2. The example shows a visualization of a Cardio Trainer (Noom) track with autopause (visualized as sphere) on Google Maps.

For the visualization of traces, the traces are frequently visualized as lines on a map to allow runners to analyze their path (see Figure 2). For the representation of runners' history often chart diagrams, such as line charts, are used to allow runners to see their progressions (see Figure 3). Furthermore, we could observe that the applications provide runners to analyze their tracks and history separately or in combination (see Figure 4 as an example).

Figure 3. Adidas MiCoach application offers runners the possibility to analyze their history via chart diagrams such as in this example which uses line charts for analyzing their progression of their pace.

Figure 4. Sports Tracker application shows the tracks as lines on a map (left) and history information as chart diagrams (right).

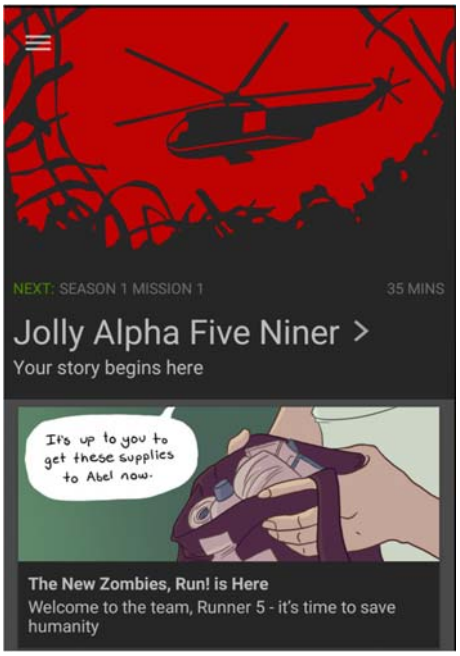

Figure 5. The example shows a screenshot of Zoombies Run! when a user starts a new challenge of the game [45].

5.3 Competition & Comparison with Others

Only three applications allow integrating one's defined training plan that may then be used for training control. Four applications offer the functionality of generating goal-oriented training plans; these training plans may be modified to fit individual needs. For example, personal goals can be set concerning time, distance, or expended kilocalories.

The so-called *Ghost Running* functionality (by Nike+ Running GPS) allows competing with one's previously performed workouts. Runners earn Nike Fuel for every move they take, which users may also compare with their friends' earnings. A prominent functionality of Adidas miCoach and Endomondo is the possibility to compete with a friend's workout. Interestingly, interval training is only supported by three applications.

Eight applications offer (general) competitions that users can participate in. The same applications, except RunLog, also allow defining individual competitions. Furthermore, nine applications provide the functionality to compete against one's own best times already achieved in the application.

Zombies Run! [45] (see Figure 5) is a gamification example, which integrates real-time tasks for the user and provides real-time feedback on these tasks' achievement. This application offers several missions to escape from the 'zombies' with the goal to encourage users to run faster and supporting them to monitor their progress. This functionality appears to be the only context-adaptive one, compared to the other functionalities that do not trigger a certain behavior of the application but are merely reproduce the gathered information either in numbers, visualizations, or as audio feedback.

Furthermore, social interaction via Facebook and Twitter is offered by every analyzed application, which allows for emphasizing the competition aspect (see e.g., Figure 6).

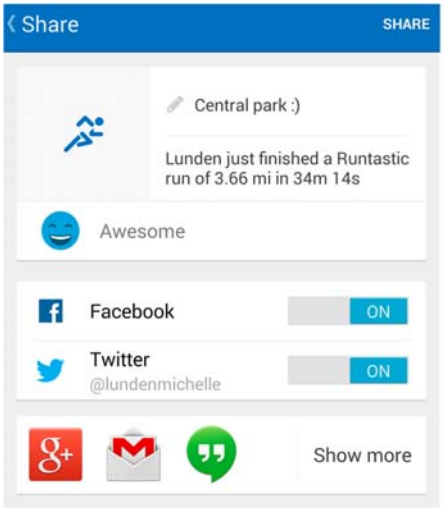

Figure 6. Runtastic application allows for sharing one's performance results with additional messages on several social networks [40].

6. DISCUSSION & FUTURE DIRECTION

Based on our analysis, it appears that visualization as motivational strategy in running tracking applications is already well elaborated. Many data related running is visualized and the runner may analyze his or her performance after the exercise. Audio feedback as motivation strategy is not as much used as visualization, as only some information is provided to the runner during the exercise. An interesting fact is that visualization is a result-oriented motivation strategy as it may only be analyzed after the exercise, while audio feedback is a motivation strategy that addresses the runner during the exercise. Further research on what information should be given as audio feedback to motivate the runner during exercise would be interesting. A comparison with the motivational effect of visualization as motivator is highly encouraged.

Moreover, competition with oneself (i.e., comparison with one's historical performance) tends to be a strong motivator for runners. The applications in our sample seem to draw on that with their functionalities. In addition, the visualization of the collected data may enhance the motivational effect of the competition with one's prior performances. Competition against other people could be better supported by the applications. The social aspect is typically a strong motivator for endurance and the applications could call on that more specifically [2]. An interesting functionality would, for instance, be to provide audio feedback on competition aspects such as how a runner performs at split time compared to a friend's performance. Thereby the runners do not have to run synchronously but historical split times could be used. An analogous functionality could be to provide audio feedback on split time compared to one of one's personal, historical performances (e.g., best time, last week's performance, etc.).

Furthermore, the gamification concept could be more intensely exploited for motivation. The gamification concept is increasingly used in many areas, partly also for its motivational qualities [46]. A more thorough integration into sports tracking applications may be a worthwhile path to raise runner's motivation to engage in running and to increase endurance during the exercise.

The motivating aspect of music is also not fully exploited in current running tracking applications. As smartphones allow for analyzing its integrated sensors' data on the device, music may, for instance, be selected and/or adapted to the motivational requirements of a runner in real-time (see e.g., [5, 18, 47]).

Overall, topics of interests for future work include the factors that hamper knowledge transfer from research to sports applications on the market and user needs for features to be included in running applications. The use of motivational music, considering the social aspect of running, and the gamification aspect are topics that were already picked up by research. Further investigations should advance work in the realm of these topics.

7. CONCLUSION

In the last years, a large number of applications for all purposes were developed for smartphones to support people in their daily life. Especially for supporting a healthy lifestyle various applications were developed with the goal do not only encourage people for a balanced diet but also to motivate them to engage in physical activities such as running. In this context, motivation and entertainment strategies – such as music and audio feedback, visualization, as well as competition and comparison with others – play a very important role for sport and fitness applications. Since we could observe that running applications in particular receive increasing attention in research in the last years, we focused on promising motivation strategies for recreational runners. For this purpose we identified and analyzed fourteen commercial running tracking applications concerning their functionalities to identify which strategies are supported and to identify possible directions for the future research.

8. ACKNOWLEDGMENTS

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