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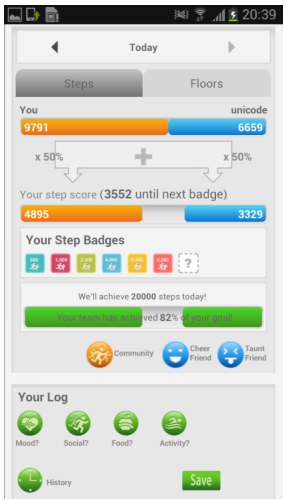
Abstract
Social incentives such as cooperation and competition are found to motivate users in pervasive fitness applications. This work investigates how social incentives work for individuals with obesity and diabetes. We used a mobile fitness application called HealthyTogether as an experimental platform, which allows dyads to achieve fitness goals together and compete in an online community. We conducted a four-week study with 16 obese and diabetic patients who used HealthyTogether to exercise with a buddy. Results show that participants exercised more with social incentives compared with their baseline. Collaborating with buddies to compete in a community was reported as motivating for dyads exercising with strong ties. Social interactions could be demotivating between dyads who did not know each other well. Finally, it is crucial to consider patients' technical literacy when designing behavior-changing technologies.

Author Keywords
Health; behavior change; mobile fitness application; competition; cooperation; community; diabetes; obesity

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.



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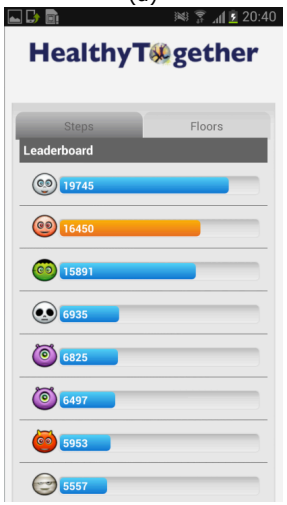

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Figure 1. HealthyTogether screenshots: (a) dyad interface; (b) community interface.

Introduction

A major challenge for designing lifestyle management systems for individuals with diabetes and obesity is to provide effective motivation methods for behavior change. Previous studies [2,3,5] showed that users exercised significantly more when they walked with a buddy than when they walked alone. Clinical research also indicated promising effects of integrating peer support provided by patients with same symptoms [1,4,6]. Such support provides diabetics with emotional, appraisal and information assistance to improve their physical, mental and social wellbeing [8]. We are interested in whether and how social interaction principles and fitness applications that are designed for the general population work for patients. In this work, we investigate the effectiveness of social incentives for obese and diabetic patients using HealthyTogether [2] as an experimental platform.

HealthyTogether

HealthyTogether is an Android application that involves dyads to exercise and earn badges together [2] (Figure 1). It retrieves users' performance in walking and climbing stairs from Fitbit trackers. HealthyTogether employs three dimensions of social incentives by allowing dyads to 1) win badges based on their average steps and floors of the day, 2) pledge the sum of steps and floors of the day and 3) compete with other dyads in the team leaderboard. Dyads can also interact with each other by sending cheering or taunting messages.

User study

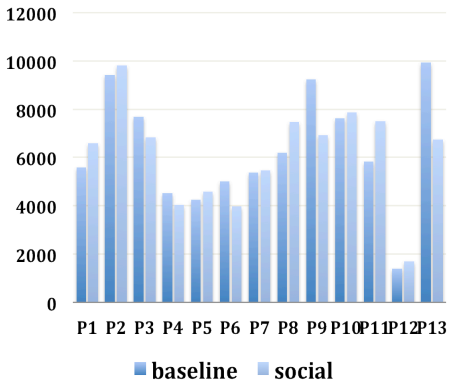
We deployed a four-week study to compare obese and diabetic patients' fitness performance when they were connected with buddies and communities with when they exercised alone. We recruited the patients from a major hospital in Switzerland. They have participated in a previous study [7] in which each individual used Fitbit to monitor physical activities for at least one month. Sixteen patients agreed to participate in the study, including five obese and eleven diabetics. They were five males and eleven females. Three of them worked full time and others were retired or housewives. They were paired into eight dyads. Four dyads were couples or friends and four dyads were strangers. We provided each participant with an Android phone with a SIM card with 1Go data plan. They could keep the phones after the study as a compensation for their time.

We invited them to the hospital for an information meeting and helped them install HealthyTogether. All participants started the study in the same week and used HealthyTogether for four weeks to facilitate community competition. Finally, they returned to the hospital to attend a 30-minute post-study interview. We conducted the interviews in French, audio-recorded them, transcribed and translated into English.

Findings

We retrieved participants' Fitbit data during their first four-week Fitbit usage as the **baseline** and that during their four-week HealthyTogether usage as the **intervention**. One dyad, who were strangers, withdrew out from the study because of privacy concerns. Another participant encountered technical issues with her Android phone, which impacted her in using HealthyTogether. So we *quantitatively* analyzed Fitbit data from 13 patients.

We conducted a Linear Mixed Model (LMM) analysis in SPSS. Daily Step count and daily floor count are the dependent variables. Intervention (before/after using



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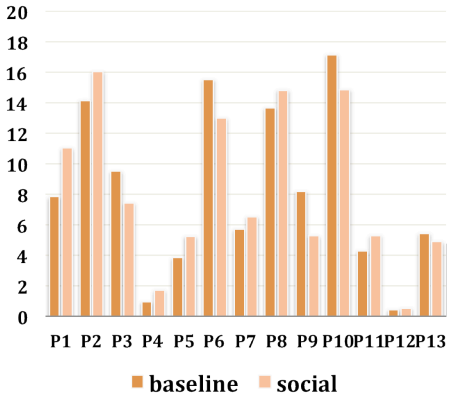

(b)

Figure 2. Average daily steps and floors in baseline vs. social settings grouped by individuals: (a) Steps; (b) Floors.

HealthyTogether) is within-subject variable, and relationship type (strong tie/stranger) is between-subject variable.

For number of floors, we found a tendency of increased performance for intervention: $F(1,753)=3.029$, $p = .082$, MeanBefore = 7.72, SE =5.15; MeanAfter= 9.17, SE=5.16. The interaction between intervention and relationship type is not significant. For steps, the number slightly increased, but the main effect of intervention is not significant $F(1,753)=1.083$, $p = .298$, MeanBefore = 6332.8, SE =187.9; MeanAfter= 6631.3, SE=216.7.

When we examined each participant, eight of them have increased their number of steps and floors from baseline. Three patients had an average increase of over 1,000 steps/day, which is considered significant improvement in health intervention literature [5].

We inductively analyzed interview results to investigate what motivates and demotivates users. The most frequently (N = 8) mentioned motivating factor is the competition within the patient **community**. Participants used their ranking in the community as a reference for their performance. As P2 reported: "*We could see what other groups are doing. The ranking is motivating. I would do more with my buddy if we do not rank well in the community.*"

Participants also appreciated **collaborating** with and being accompanied by a buddy (N = 6). For P8, achieving a better score with her husband made her happy. They cheered each other up to compete with other patients. As her husband said, "*I was trying my best, but it was not easy. Sometimes I cannot just take the stairs with my legs. Seeing her performance on HealthyTogether, I tried to exercise more by creating some occasion to go out and walk. Although my physical conditions did not allow me to reach my wife's level, I was trying and have contributed to a collective improvement.*" P10 usually sent a message to taunt his buddy when he was not moving. They participated in a group walk one hour and a half every Monday in order to achieve their common goal. P10 is happy that they could achieve the daily goal of 20,000 steps.

However, three participants who were not familiar with their buddies reported to be demotivated. Their exercise amount dropped after pairing up with a buddy. P4 mentioned that she did not know her buddy well, so she barely interacted with her buddy: "*If I did it with my best friends at another period, it would have been different*". Her buddy, P3 said: "*I hesitated in sending messages and taunting because she does not like pressure. So I just watched how she was doing.*"

Technical literacy is another issue reported by participants. Twelve out of the sixteen patients were above 50 years old, and some of them were not familiar with Android system. For example, P16 contacted us because after updating the phone, all the application disappeared including Fitbit and HealthyTogether. She was frustrated and re-installed all the apps. By contrast, earlier studies with university students hardly showed any technology issues even though most participants used iPhones as their primary phones [2]. While obesity and diabetes are not targeted at the elderly, the findings suggest that technologies should be designed simple and familiar for patients to minimize technical barriers.

Conclusion

This study investigates the effectiveness of social incentives for lifestyle changes for obese and diabetic patients. Sixteen patients participated in a four-week intervention. Compared with the baseline, there was a trend of improvement in daily floors when connecting with a buddy and competing in the community: 7.72 floors/day vs. 9.17 floors/day. Participants also slightly walked more (6332 steps/day vs. 6631 steps/day). Three of them have an increase of more than 1,000 steps per day. Participants found community competition and the support from strong ties motivating. However, pairing up with weak ties was reported demotivating. Finally, considering patients' technical literacy is essential in lifestyle intervention technologies.

This empirical study provides evidence on the feasibility of deploying social interaction principles and fitness applications to motivate individuals with diabetes and obesity to perform physical exercise. It can serve as a foundation to transplant the technologies for behavior change that are designed for the general population to patient care. In the future, we will further validate our resutls and conduct the study with more patients and they will use HealthyTogether on their primary phones.

Acknowledgements

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