FitAware: Channeling Group Dynamics Strategies with Smartwatches in a Physical Activity Intervention

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Abstract
Physical inactivity of the general population is a major public health concern in the US and around the world. Community-based interventions, with group dynamics strategies at the core, are effective at improving individual physical activity behaviors. The use of technologies such as smartwatches has potential to channel and amplify the underlying program principles in such interventions. This work presents a smartwatch-centered system to encourage group cohesion in physical activity interventions, exploring it as part of an eight-week study that revealed participant awareness of group performance through smartwatch interactions.

Author Keywords
Physical activity; health informatics; group dynamics; community intervention; persuasive technology

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

General Terms
Human factors; Design; Experimentation

Introduction and Related Work

Less than half of Americans meet recommendations for physical activity [30]. In recognition of this problem, various efforts have been put in place to promote physical activity. The Task Force on Community Preventive Services recommends community-based interventions due to their demonstrated effectiveness [22]. Such interventions often target groups in their natural environments to achieve stronger population level impacts and enable a variety of mechanisms that can influence one's behavior [22]. This paper explores how small group use of fitness monitoring tools, focused on smartwatch interfaces, can leverage and encourage group cohesion.

A number of interventions use strategies that leverage interpersonal factors that arise in small groups [15]. Behaviors and social processes occurring in small groups are referred to as *group dynamics*, targeting improving perceptions of cohesion defined as "a dynamic process that is reflected in the tendency for a group to stick together and remain united in pursuit of its instrumental objectives and/or for the satisfaction of member affective needs" [5]. *Group cohesion*, which differentiates aggregates of people from groups [29], consists of four dimensions: individual's *attraction* to *task* (e.g., do you have the most steps) and *social* (e.g., let's have a beer) aspects of the group, and individual's perceptions that the group is *integrated* around the *task* (e.g., do members of your group know who has the most steps) and *social* (e.g., are members of the group interested in socializing) aspects [6]. Perceptions of group cohesion can be altered by actively facilitating strategies that align with principles of the group environment, group structure, and group processes. Strategies that align with these principles include group goal setting, member interaction, cooperation, competition, and sense of collective efficacy [6].

While a group dynamics approach has shown a robust effect on increasing physical activity, these interventions have largely been limited to in-person program delivery, which is costly and may limit reach [15][12,21]. Web-based systems can lessen the costs but suffer from user engagement decline and high drop-out rates problematic for group dynamics [24].

Many studies show how smartphones encourage communication [9], progress sharing [2], competition and collaboration [1,8] to increase physical activity. Smartphones have been shown to be valuable tools for supporting social interactions among members of a community [20] and for providing awareness of the activities of friends [16]. Smartwatches can avoid interruptive updates from unimportant secondary events that are disliked by users [25,27] by providing greater information accessibility via their glanceable nature [26]. While developers have combined smartwatches and smartphones to support health initiatives (e.g. Moto360, FitBit), this project is unique and novel as it uses the evidence based strategies from group dynamics-bases physical activity interventions and combines the strengths of automatic tracking and smartwatch glanceable interface affordances to convey group cohesion facilitating information to the users via non-interruptive smartwatch watchface updates. This project uses both cooperation and friendly competition to encourage health outcomes.

This work introduces FitAware, our smartwatch-centered system intended to facilitate physical activity

Figure 1: Overview of the system features.

behavior change via channeling of group-dynamics principles to small groups. Building on our ongoing community-based program FitEx [14,19], FitAware highlights fitness data on a smartwatch that supports individuals' attraction to and integration into fitness tasks from a social perspective, encouraging mobile and web interactions. We report results from an 8-week deployment of FitAware that explored its use as part of an established group-dynamics based community physical activity program with the FitEx community, seeking to observe occurrences of group cohesion across the four definitive dimensions: attraction to the task and social aspects of the program, and perception of integration around the task and social aspects.

FitAware

FitAware is a three-component system consisting of a Pebble smartwatch interface, companion Android app, and website. The system digitizes and enhances components of FitEx, an 8-week group dynamics community-based physical activity promotion intervention[14,19]. FitEx targets small groups of people in their natural environments (e.g., workplace, church, home) leveraging existing social connectedness with family, friends, coworkers, and others. The underlying group dynamics principles align with a) group structure (each group as a team captain and is limited to 6 individuals); b) group environment (limiting the group size); and c) group processes (group goal setting, communication, competition). For example, the FitEx "team captain" is proactive with relation to group performance, providing encouragement and reminders for the team. Individual norms are established via goal setting and the awareness that individual progress contributes to the shared group progress. Team members are aware of the individual contributions of their team members thus enabling a sense of competition among the team members. The collective progress of the team members is viewed as team's overall performance and then compared to the other teams' performance, thus enabling a sense of cooperation within the team.

Prior to the digitization, the intervention was successfully delivered by health practitioners from local community organizations. The practitioners recruited teams from the local community and then utilized various means of communication (face-to-face, phone, mail and email) to conduct the intervention which included aggregation of participants' self-reports and providing feedback that included other team's performance, rankings and trends. The design of FitAware is driven by the goal of offering the convenience of automated tracking while also facilitating group cohesion by presenting information to the users based on the group process strategies embedded in the intervention. FitAware automatically tracks steps and exchanges data between the smartphone/smartwatch bundle and the server in order to provide regularly updated information to the users. The information allows users to reflect on their own and team progress, their ranking in the team and the ranking of their team among all other teams. The information presented with different degrees of granularity depending on the device. The smartwatch face provides an overview via data summaries, whereas the smartphone and web offer increasingly more detailed comparison views for the data.

Smartwatch

The design philosophy for the smartwatch component of the system took into consideration the advantages of

Figure 2: The design of the FitEx smartwatch watchface and the home screen on the companion Android app.

the smartwatches in terms of information accessibility afforded by the form factor [7,13,17,28]. Smartwatches enable faster access to information with low cognitive demand [18,26]. FitAware uses the Pebble smartwatch due to its unique set of characteristics comprising of the always-on monochrome e-paper display, fully programmable watchface and long battery life. Recognizing the *automaticity* [3] with which users periodically check their smartphones [27] and Smartwatches [11] even without notifications, we provide non-interruptive passive notifications in the form silent interface updates directly on the custom watchface. Passive notifications have shown good results in the context of influencing health behaviors via smartphones [4,10]. We preferred this strategy over interruptive updates due to the fact that users react negatively to interruptions from unimportant (or secondary) events [25,27]. Pebble smartwatch enabled us to present users with a regularly updating custom glanceable watchface interface.

The watchface layout (see Figure 2) positions time and date indicators in the center of the watchface while placing the intervention-related indicators in the four corners. The indicators seek to channel group process strategies of self-reflection, encouragement of others, and competition. The top left corner shows user daily step-count information computed by the smartwatch sensors to enable reflection on personal goals. The top right corner displays rank within the team, encouraging competition. And finally, the bottom right corner displays team rank among all teams for the day, promoting competition between teams and cooperation and mutual encouragement within the user's team members to improve rank. Every 5 minutes, the smartwatch periodically receives new ranking and team step information from the smartphone.

Smartphone
The smartphone app connects to the smartwatch via Bluetooth for syncing of individual and group steps. Syncing occurs automatically every 5 minutes, or it can be initiated by a 2-button smartwatch action. For smartphones with a step-counter sensor, FitAware records the maximum steps between smartwatch and smartphone. The app interface design consists of five screens, with a home screen that expands on the watchface interface's data with an identical layout (see Figure 2). Tapping on a rectangle opens a detailed information view showing visualizations of the individual and group data, and allowing the user to look at previous days and weeks (see Figure 5).

Website
The system leverages a web data repository for syncing, storing, interpreting, and exchanging progress and ranking data between the client phones and watches. The website is required for text-heavy actions, like user account creation, goal setting, manual update of entries, and the user baseline physical activity assessment survey. The website is most useful for in-depth examinations of participant and team rankings.

Deployment
Following Klasnja et al.[23] recommendations for health behavior change technology evaluation in HCI, an initial field evaluation of the system was performed. We deployed the system for 8 weeks with 7 community members (4 females) between the ages of 35 and 60: a

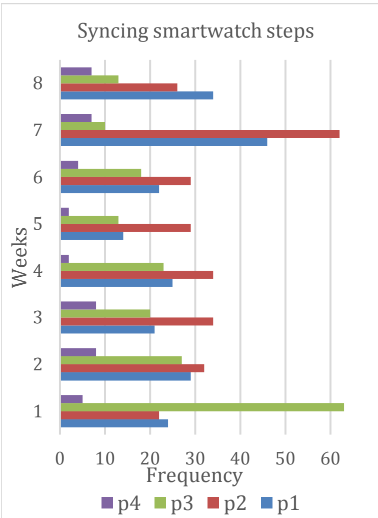

Figure 3: Instances of users manually syncing their steps.

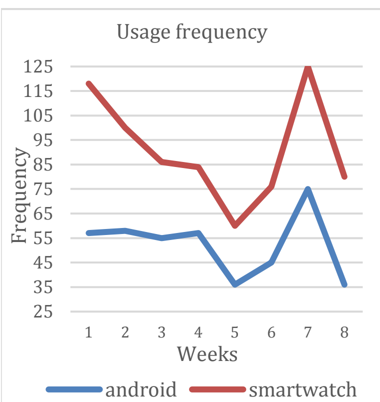

Figure 4. Overall weekly Android app usage and smartwatch sync frequency.

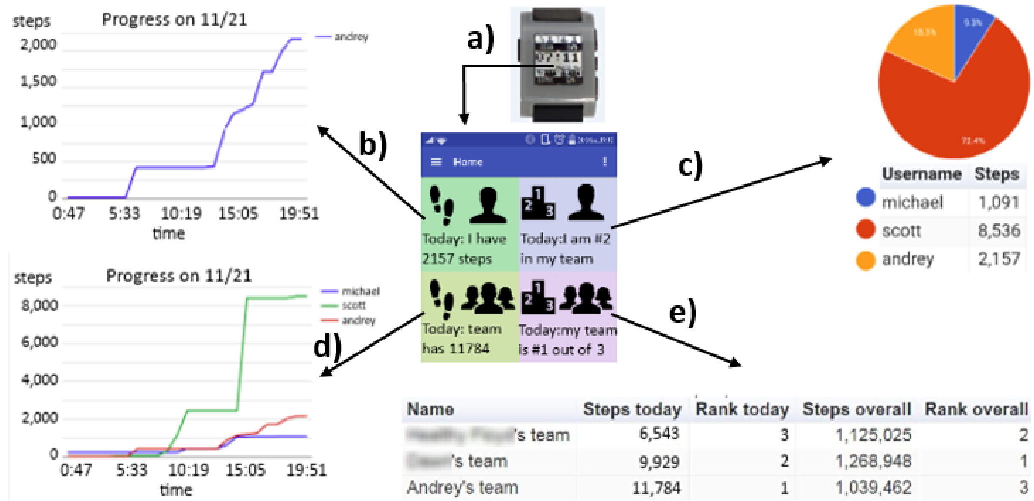

Figure 5: FitAware smartwatch watchface and the companion app interfaces explored. The elements on the watchface (a) directly map to the four squares on the Android app's home screen where tapping the top left square opens up a screen with the user progress chart ("my info") for the day (b). Tapping the top right square opens a visualization and table displaying each team member's contribution ("my rank") to the team steps (c). The bottom left opens up a progress chart ("team info") for all team members (d) and the bottom right square leads to a table with intervention statistics ("team rank") for the day and the whole period of the competition.

team of 3 coworkers and 4-person team of two married couples (P3-P4 and P5-P6). One participant (P7) withdrew in the first days, and another (P6) used the system minimally and declined to be interviewed. A team of researchers experienced with FitEx and FitAware also took part in the program to encourage and monitor user experience. All participants owned an Android smartphone and were given a Pebble smartwatch. Prior to the study, a researcher met with all participants, briefed them about automated data collection methods and post-deployment interviews, obtained signed consent forms, and assisted them in getting started with FitEx and FitAware.

Results

This paper provides initial examples from the data that highlight the group dynamics of people using FitAware, particularly focusing on the four dimensions of group cohesion: individual's *attraction* to *task* and *social* aspects of the group, and individual's perceptions that the group is *integrated* around the *task* and *social* aspects [6]. Results come from watch, phone, and web usage logs. We also conducted and recorded semi-structured phone interviews lasting between 20 and 40

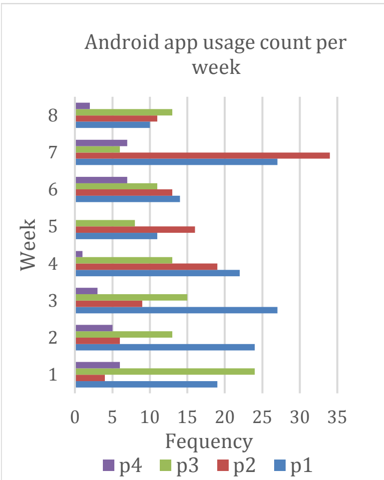

Figure 6: Weekly instances of users opening the Android app.

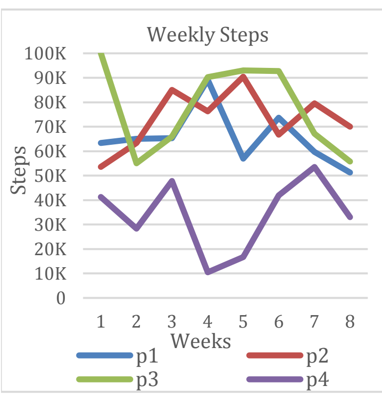

Figure 7: Weekly steps for the participants. Note that P1 and P2 repeatedly overtook each other throughout the program.

minutes. The interview recordings were transcribed verbatim and analyzed.

Participants synced their smartwatch steps with the smartphone on average 2.6 times per day throughout the study (Fig. 3-4), suggesting participants stayed engaged with the fitness task. Also, the smartphone app averaged 1.5 uses per day, also throughout the study (Fig. 4,6). Participants did not seem to favor any of types of information when using on the smartphone, opening the "my info", "my rank", "team info" and "team rank" views 287, 212, 248, and 244 times, respectively. The participants noted all information had value, noting *"[the four pieces of information] were all fairly important"* (P2) and *"the visual graphs I think are very beneficial"* (P3).

Participants seemed to be attracted to both task and social aspects of the activity monitoring. P3 claimed he was able to reflect on his physical activity levels by regularly monitoring the smartwatch, noting *"at the end of the day [it] made me really realize how much I was moving around"*. The married couple P3 and P4 talked about how P4's job limited her activity, with P3 noting that *"we were noticing her job and more of an office setting…didn't really get her walking much"*. P4 realized her husband is competitive and active, noting she wanted to be more active too.

While some participants seemed to care only about their team, others were aware of and motivated by other teams. P2 regularly checked his smartwatch to compare steps with his coworker P1, plus his team's standing. He kept his team and himself in the lead, performing additional physical activities as needed, stating *"I'd watch [P1's] numbers go up and go up…I had it on my watch, right there…I could keep track of where I was at and if I needed to…walk some more"*. P1 also checked the smartwatch numbers, using it as motivation: *"it is awfully easy… to spend a lot of time on the computer…sometimes I just need a little bit extra intensity to get me going. So seeing the numbers made me do it"*. P2 and P1 claimed they would joke with each other about the competition, reflected by frequent swaps in step count leads (Fig 7).

It is worth noting that some participants did not seem to actively use FitAware. P6 did not integrate with the program in a meaningful way, and P5 (P6's spouse) noted that she did not feel engaged with the others on the team, perhaps because her spouse did not participate. Certainly the commitment to new program and technology that is necessary for an intervention like FitEx and FitAware will not appeal to everyone, but it is encouraging that many users found significant and sustained appeal from the commitment.

Conclusion and Future Work

FitAware is using the knowledge from group dynamics-based physical activity interventions and utilizes glanceable information presentation of Pebble watchface to display non-interruptive updates aimed at encouraging positive group cohesion. The display layout on the FitAware smartwatch balances individual and group performance, allowing users to connect with their (and the group's) information in ways that work for them. While our initial study results provide examples of smartwatch-driven interactions, deeper analysis and a larger study should reveal more about the type of interface elements and user interactions that are effective, and the type of people and situations for which the interface can support group cohesion.

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