FitAware: Promoting Group Fitness Awareness Through Glanceable Smartwatches

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ABSTRACT
Physical inactivity is a global public health concern. Community-based interventions that use strategies such as competition and cooperation, with group dynamics-based strategies at their core, are effective at improving individual physical activity behaviors, but they often rely on participants to actively seek out fitness information themselves. This work examines how technologies such as smartwatches that are designed to raise awareness of personal and group fitness can encourage positive fitness behavior within and across peer groups. This paper presents a study about smartwatch use by 27 people as part of an 8-week community physical activity intervention program with elements of competition and cooperation, seeking to understand fitness awareness and behavior of the participants. Results indicate generally high awareness levels of smartwatch information. In particular, members of most successful groups exhibited significantly higher awareness for feedback displayed on the smartwatch.

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

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

INTRODUCTION AND RELATED WORK
Most Americans do not meet the minimum physical activity recommendation levels [31]. These recommendations are often translated to 10,000 steps per day, and daily step counts represents an easy to-track physical activity level indicator [11,12,27]. Self-monitoring, feedback, and goal setting are the fundamental evidence-based behavior change strategies [24]. Community-based approaches are recommended for large scale interventions[24] and group dynamics-based strategies help harness the interpersonal factors that occur in small groups [17]. Example strategies include group member cooperation, competition, and interaction toward becoming more active and improving perceptions of cohesion [6].

Group dynamics-based interventions have been shown to be effective for in-person program delivery format, but are not always optimal due to cost and reach [13,25]. Interventions delivered via web-based systems typically suffer from high dropout rates [25], with technology interaction burden cited as a key factor [18].

This paper presents a study about FitAware, a smartwatch-centered system intended to facilitate behavior change via group dynamics based feedback presented on smartwatches, featuring non-interruptive glanceable updates that inform users of personal and group step progress. Feedback includes daily personal steps, collective team steps, user rank within the team, and team rank across all teams. FitAware was deployed as a part of an 8-week community intervention, where teams of varying sizes sought to increase physical activity. Surveys and system usage logs revealed when users wear the watch, they notice display indicators, recall values from the indicators, and increase perceived awareness. These findings reveal how smartwatches can provide users with sustained awareness of group focused feedback.

Prior work has examined awareness of group-focused feedback in the web environment [23] as well as with mobile devices[2][1][21], including ones that examine cooperation, competition and social engagement in the context of socially connected pairs [7]. These examples, while effective in certain ways, all require burdensome user interaction to receive feedback—even smartphones impose barriers on the user experience [3]. This work explores how smartwatches can offer glanceable notifications with promise for increased awareness [19] [20].

THE FITAWARE SYSTEM
FitAware is a three-component system consisting of a Pebble smartwatch interface, companion Android app, and a website. The system digitizes and enhances components of FitEx, an 8-week group dynamics community-based physical activity promotion intervention [15,22]. FitEx

a)

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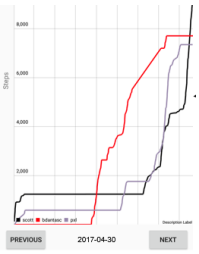

Figure 1. a) FitAware smartwatch watchface interface (Top left: personal steps. Top right: personal rank in the team. Bottom left: team steps. Bottom right: team rank). b) One of the views from the companion Android app provides detailed daily progress for the team member steps.

targets small groups in their natural environments (e.g., workplace, church, home) leveraging existing social connectedness with family, friends, coworkers, and others. The program prescribes formation of small groups (3 to 7 people) from existing social circles where one group member is encouraged to be the team captain, ideally proactive in group interaction and encouragement. Group members set individual goals, with the sum of individual goals as a group goal. They track their progress for 8 weeks, receive feedback, and compete with other teams.

The design philosophy for the smartwatch considered advantages of smartwatches for information accessibility [10,14]. Smartwatches enable faster access to information with low cognitive demand [20,28]. FitAware uses the Pebble smartwatch due to always-on display and long battery life, encouraging ease of use and glanceability important in the design. Recognizing the automaticity [4] with which users—periodically and unprompted—check smartphones [10], we provide non-interruptive passive notifications on smartwatches. Passive notifications have shown good results in the context of influencing health behaviors via smartphones [5,9]. This is preferred over interruptive updates as users react negatively to interruptions from unimportant, secondary) events [26,30]. The watchface layout (see Figure 1a) presents information in a manner that is prescribed for High Throughput Textual Displays [29]. The time and date information is surrounded by within-group (top row and bottom left) and between-group (bottom right) indicators in the four corners. *Personal steps* shows user daily step-count information computed by the smartwatch sensors. *Personal rank* shows the standing in the small team of friends or co-workers. *Team steps* show total team steps. *Team rank* shows between-team competition feedback comparing the person's team to other teams. All watchfae information resets at midnight.

Every 15 minutes, the smartwatch exchanges information via Bluetooth with a companion Android app that, in accordance with Consolvo's design considerations[8], expands the information presented on the watch face and provides more detailed information (see Figure 1b). The app exchanges data with the server to obtain group information updates and share progress and the tracked chronological logs of information displayed on the watchface and smartphone. The website also allows users to manually enter and view progress.

FITAWARE DEPLOYMENT

As outlined in the introduction, there is a need to understand how fitness smartwatches can provide sustained awareness of individual and group fitness feedback. We investigate four aspects of this issue: whether participants continually wear the smartwatch, whether smartwatches can peripherally communicate fitness information about individuals and groups, whether changes in the information are noticed, whether smartwatch wearers can demonstrate awareness of individual and team progress feedback, and whether smartwatch wearers self-report increased awareness. To investigate these questions, we conducted an eight-week field study during which some participants used FitAware.

Study

FitAware was deployed among eligible and interested FitEx participants. Prior to the start of the intervention, the participants set activity goals and completed demographics questionnaires. All study participants were assisted with website registration and FitAware setup. Study participation was voluntary with no compensation for completion.

Upon completion of the study, the participants were offered $20 to participate in a post-program survey and a debriefing interview. The survey consisted of questions aimed at capturing awareness of feedback presented on the watchface as well as the degree of group cohesion of the team measured via Physical Activity Group Environment-Questionnaire [16], used to assess the sense of competition, cooperation, interaction, and competition. The survey questions used a 7-point Likert scale, with the exception of a question asking to recall typical values for smartwatch indicators.

Participants

Nine eligible groups of participants were recruited with some assistance from community outreach organizations. These groups collectively contributed 27 FitAware users of the total 275 individuals participating in the community statewide intervention. The eligibility criteria required the groups to be composed of adults from an existing social circle, with some or all of members equipped with an Android smartphone. From the 9 groups 4 had 4 FitAware users, 2 groups had 3, another 2 had 2 FitAware users and there was one group with only one FitAware user. Of these groups two had FitAware only users while the other groups had two or more web only users(web users had to enter their progress manually).

All nine groups were composed of full-time coworkers that either shared office space, floor, or building. Occupations differed, including front desk receptionists, government clerks and university lab technicians. Participant differed in

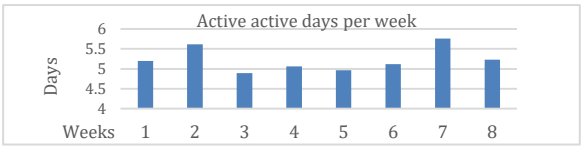

Figure 2. Average weekly active days of smartwatch use.

age (23-61 years old), gender (20 female, 7 male), and race (20 Caucasian, 5 African American, 1 Native American, 1 Asian), BMI (21 to 46) and education level (12 post college/9 college/5 some college/1 high school).

RESULTS

To explore if users could achieve awareness of information from feedback indicators of group centered information, we analyzed the system usage logs and survey responses.

FitAware use

Feedback from the smartwatch indicators requires regular smartwatch use. Of 27 participants that signed up to use the smartwatch, three dropped out early, leaving 24 participants that completed the 8-week long study. From the 24 participants that finished the study, 23 yielded usable system tracking data (one of the participants had a smartphone with faulty Bluetooth, preventing data from being received from the smartwatch), 21 responded to the survey and 20 participated in the post-survey debriefing interviews.

The system use logs show active days of wearing the watch. For these active days, we considered days during which user steps continuously increased for at least 8 hours during the day (8am-8pm) with periods of inactivity (no increase) shorter than one hour (time necessary to charge Pebble). On average, the 23 participants had 5.22 (SD=0.29) active days of smartwatch use (See Figure 2 for weekly averages) per week. Debriefing interviews revealed some of the reasons for not wearing the watches every which include leaving it charging ("*Forgot it was charging*") and forgetting to put it on ("*Simply because I would forget to put it on.*"). Correlation analysis revealed a moderate correlation between participant age and the average active days (r=-.449, p<0.05) suggesting that younger audience had more active days.

Awareness

To assess user awareness of the feedback from the four watchface indicators, a 7-point Likert survey prompted users to indicate: likelihood of visually noticing each indicator ("*Regardless of why you looked at the Pebble smartwatch display, how likely were you to notice each of the following?*"), level of awareness with the information presented from indicators ("*I was aware of the <indicator name>*"), the confidence of noticing changes in the indicators ("*I regularly noticed changes in the <indicator name>*") and the values for the indicators that they would see at the end of a typical day ("*By the end of a typical day, what were the values for the following indicators on the Pebble smartwatch display?*")

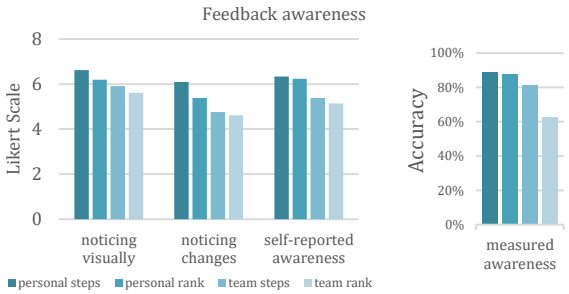

Figure 3. Results from the survey and the accuracy of measured awareness based on recall for typical indicator values at the end of day.

Peripherally noticing indicators. Visual contact with indicators should raise awareness. Participants rated the likelihood of noticing indicators for personal steps, personal rank, team steps and team rank at 6.62, 6.20, 5.90 and 5.62 (see Figure 3). Responses for personal steps and team rank were significantly different (t=4.088, P<0.01) suggesting that on average users were more likely to visually notice personal steps than team rank when looking at the watchface.

Noticing changes in indicators. Noticing changes in indicators contributes to increased awareness. Users' degree of agreement for noticing changes for personal steps, personal rank, team steps and team rank is 6.10, 5.38, 4.76 and 4.62, respectively. Responses for the personal steps indicator are significantly higher than team rank (t=4.088, P<0.01), team steps (t=3.229, P=0.03) and personal rank (t=2.096, P=0.043). User responses are reflective of indicator update frequency; personal steps update continuously while other indicators only update every 15 minutes.

Self-reported awareness. Users rated their awareness for the feedback from the four indicators comprised of personal steps, personal rank, team steps and team rank at 6.33, 6.24, 5.38 and 5.14 correspondingly. Analyzing for significant differences for the responses shows that users reported significantly higher awareness for personal steps than team steps (t=2.955, P=0.005) and team rank (t=3.344, P=0.002) but not personal rank (t=0.395, P=0.695), also the responses of personal rank are significantly higher than those for team steps (t=2.979, P=0.005) and team rank (t=3.369, P=0.002), which is suggestive of stronger within-group awareness.

Measured awareness. To measure awareness of feedback from the indicators, the survey asked participants to recall indicator values for a typical day. 21 survey participants provided responses for personal steps and personal rank, 19 for the team rank, and 17 for team steps and team rank. Shapiro-Wilk normality tests showed all 21 participants exhibited distributions close to normal for personal steps, but 4 participants did not have normally distributed end-of-day values for team steps due to some group members self-reporting progress (P<0.05), and 4 participants did not

provide answers for team steps. Thus we were able to measure team step accuracy for the 13 participants.

For all participants with normally distributed 'end of the day' indicated personal and group steps we define *accuracy* as $A_s = \frac{|S_r - S_m|}{S_r} * 100\%$ where S_r is the value reported by the user and S_m is the median end of the day value for the active days (i.e. the actual 'end of the day' typical or most frequent value).For the ranking indicators we measured accuracy differently since the values are often repeated. We define *ranking accuracy* as $A_r = \frac{R_r}{R_1} * 100\%$ where R_r is the frequency of occurrence of the reported rank and R_1 is the frequency of occurrence of the most common rank that was displayed on the watchface at the 'end of the day' time indicated by the user.

Accuracy for personal steps, personal rank, team steps and team is 88.7%, 87.5%, 81%, and 62.6% respectively, see Figure 3. Independent samples t-tests reveal no significant difference between goals and reported steps (t=-1.749, P=0.088). We found significant differences between team rank accuracy and the other three indicators but no significant differences between personal steps, personal rank and team steps. This is suggestive of less overall awareness for the team rank than the other three indicators.

Variances for the accuracy measures for personal steps, personal rank, team steps and team rank are 1%, 3%, 4% and 9% respectively. Correlation analysis for team rank accuracy responses reveals significant correlations with the median of steps displayed at the end of the day (r=0.504, P<0.05) and competitiveness in the group (r=0.61, P<0.01). There is a significant correlation between the proportion of the active days during which the team rank was on the 'pedestal' (top 3 places) and accuracy of the team rank recall by the team members. The average accuracy of team rank recall for the participants whose 'end of the day' team rank indicator was in the top 3 for the most time (frequency of 50% or above) was 84.11% while other participants showed an average accuracy of 42.7%. Two tailed independent sample t-test analysis shows significant differences in the accuracy of the responses between these categories of participants (t=4.005, P<0.01). The participants in top 3 all came from the groups that had at least 3 active Android users. On average the members from these groups reported significantly higher competitiveness than participants from other groups (t=2.388, P=0.027), as well the median of steps displayed at the end of the day (t=2.289, p=0.034). There was no significant difference in the active days between the two categories of participants nor in Android app use. There were also no significant differences in terms of the self-reported awareness or noticing changes of team rank between these categories of participants.

DISCUSSION

The use of the smartwatch resulted in high awareness for personal steps and personal rank. For team steps, 4 out of 21 participants could not recall a typical value. For the remaining 13 eligible participants, strong correlation between accuracy of recalling team steps and active days suggests that, unlike personal steps and personal rank that can be 'learned' rather quickly, awareness of the typical end-of-day team steps benefits from increased exposure to the information. Survey results for self-reported awareness are reflected in recall accuracy results and suggest that users were more aware of personal steps and personal rank than of other indicators. For the team steps indicator, some users could not remember the typical values ("*Oh goodness… I will be honest I don't really remember*") or difficult to read ("*The team steps [indicator] were hard [to read] because it is a higher number*", "*This one [team steps] got hard to read once there were five digits*").

For between-team information represented by team rank, the overall awareness levels were much lower than for the within-team information (personal steps, personal rank and team steps). However, the average measured awareness levels for the team rank feedback were significantly higher for the participants whose teams were in the top 3 for the most days (84.11% vs 42.7% for the other teams). The participants from these teams were also significantly more competitive and active (based on the median daily indicated step values). Another distinctive characteristic of teams with higher awareness of team rank was the presence of proactive group captains that were openly competitive ("*As the team captain I wanted to be like 'We must win!'*"), attentive to other group members ("*I liked to keep an eye [on the team steps indicator] to make sure that everyone was syncing properly*"), supportive ("*I would go and I would check with everyone to make sure their watches are syncing*"), and encouraging ("*She[captain] would say '<name>, I put you on this team because I know you walk a lot and you are not walking enough today!' [laughs]*"). This is suggestive of a positive influence from such proactive and competitive captains on feedback awareness for all group members.

CONCLUSION AND FUTURE WORK

The goal of this study was to investigate glanceable smartwatch indicators as part of group fitness program to facilitate awareness of within-group and between-group progress feedback. The results show high awareness levels for within-group feedback. Participant awareness levels for between-group feedback (team rank) revealed significant dependence on group characteristics. Participants in teams with a proactive, competitive, encouraging captain exhibited measurably stronger team rank feedback awareness as well as higher activity levels and competitiveness.

These results are encouraging as they show that passive glanceable watchface updates can facilitate awareness of the group fitness related feedback. The findings revealing the differences in the awareness levels of the feedback from the team rank indicator, motivate further exploration of how the personal and group factors influence the feedback awareness levels. Our next step is to gain a deeper

understanding of how the encouragement and reminders from the team captains lead to an increased group members' awareness of the feedback, and then formulate a list of design considerations for a group-fitness oriented smartwatch centered system with a focus on communicating, augmenting and amplifying the effects of such encouragements and reminders, exemplified through a working system based on a modern smartwatch platform with better information visualization, physical activity tracking and user interface interactivity capabilities.

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