Goal-Setting Considerations for Persuasive Technologies that Encourage Physical Activity

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ABSTRACT
Goal-setting has been shown to be an effective strategy for changing behavior; therefore employing goal-setting in persuasive technologies could be an effective way to encourage behavior change. In our work, we are developing persuasive technologies to encourage individuals to live healthy lifestyles with a focus on being physically active. As part of our investigations, we have explored individuals' reactions to goal-setting, specifically *goal sources* (i.e., who should set the individual's goal) and *goal timeframes* (i.e., over what time period should an individual have to achieve the goal). In this paper, we present our findings related to various approaches for implementing goal-setting in a persuasive technology to encourage physical activity.

Categories and Subject Descriptors
H.5.2. [**User Interfaces**]: User-centered design, H.1.2. [**User-Machine Systems**]: Software psychology.

General Terms
Design, Theory

Keywords
Goal-setting, goals, goal source, goal timeframe, goal strategy, behavior change, physical activity, persuasive technology

1. INTRODUCTION
Literature from psychology and health sciences has long argued that goal-setting is an effective strategy for changing behavior (e.g., [10][14]). As the field of persuasive technology is focused on developing computing systems that attempt to change attitudes and behavior [6], the aforementioned findings from the literature suggest that employing goal-setting in persuasive technologies might be an effective means of supporting behavior change.

As part of our on-going research agenda, we are developing persuasive technologies that encourage individuals to live healthy lifestyles. Specifically, we attempt to encourage participation in regular and varied physical activity. Our recent focus has been on the design and evaluation of the UbiFit system (Figure 1), which was influenced by goal-related literature, particularly Locke & Latham's *Goal-Setting Theory* [10]. Our evaluation included a field study where 28 individuals who represented our target audience used our system for three months over the winter holiday season. During that field study, we explored participants' reactions to our system's implementation of goal-setting as well as their preferences for alternative goal-setting approaches.

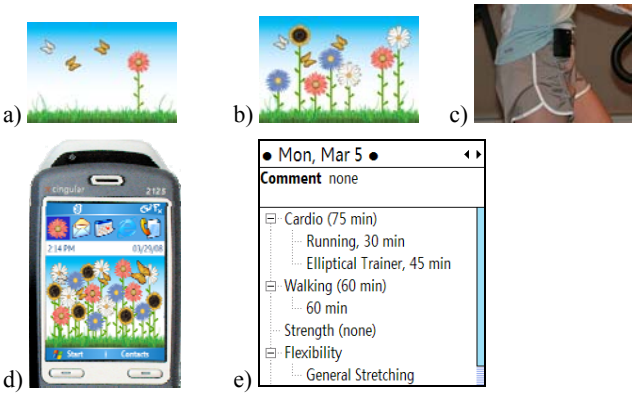

Figure 1. The UbiFit system. a) the glanceable display's garden after one cardio workout; b) a week with variety; c) the fitness device as worn during exercise; d) the garden on a mobile phone's background screen; and e) the interactive application.

This paper presents our findings related to various approaches to setting goals in a persuasive technology that encourages physical activity. We focus on *goal sources* (i.e., who should set the goal) and *goal timeframes* (i.e., over what time period an individual should have to achieve the goal). While UbiFit has been presented elsewhere, those contributions focused on participants' reactions to activity inference [5], the differences in behavior change in differing system conditions [3], and the prior work and theory that influenced our design decisions [4]. The contribution of this paper is the participants' reactions to goal-setting considerations.

This paper is organized as follows. In Section 2, we provide an overview of the persuasive technology system we developed that was used in our exploration of goal-setting considerations. We follow with a review of Goal-Setting Theory [10] in Section 3, and then discuss related work in Section 4. In Section 5, we describe our three-month field study, including the goal-setting

Persuasive'09, April 26-29, Claremont, California, USA.

choices we made for UbiFit and how we investigated alternative approaches. Section 6 covers our findings related to goal-setting, and in Section 7, we discuss the implications of those findings and opportunities for future work. Finally, in Section 8 we conclude.

2. THE UBIFIT SYSTEM

UbiFit is a mobile, persuasive technology we developed to encourage individuals to self-monitor their physical activity and incorporate regular and varied activity into everyday life. Because the underlying technology and design have been presented elsewhere [3][4][5], we offer only a brief overview here.

The UbiFit system includes a glanceable display, interactive application, and fitness device (Figure 1). The *glanceable display* uses a stylized, aesthetic image that resides on the background screen of the individual's mobile phone. Every time she uses her phone, the display presents key information about her physical activity behavior and goal-attainment status, as well as a subtle but persistent and easily accessible reminder of her commitment to physical activity and self-monitoring. The *interactive application*, which also resides on the mobile phone, includes detailed information about her physical activities and a journal in which activities can be added, edited, and deleted. Finally, the *fitness device* automatically infers and transmits information about several types of activities—walking, running, cycling, use of the elliptical trainer, and use of the stair machine—to the glanceable display and interactive application. Because UbiFit runs on the individual's mobile phone, it is available essentially whenever and wherever she may need it, in time to change her behavior to have an active week.

The glanceable display that we implemented uses the metaphor of a garden that blooms throughout the week as activities are performed. We thus call this implementation of the UbiFit system, *UbiFit Garden*. Different types of flowers represent the types of activities that the American College of Sports Medicine (ACSM) suggests are important [16]: Cardio (pink flowers), Strength (blue), Flexibility (white), and Walking (sunflowers). With UbiFit Garden's glanceable display, a healthy garden represents healthy behavior.

Since most agencies that provide physical activity guidelines (e.g., the ACSM and American Heart Association (AHA) [7][16]) use a weekly time frame, the glanceable display represents one week's worth of activities, and goals are set and attained on a per-week basis. Upon meeting a weekly goal, a large butterfly appears in the garden display. Up to three smaller butterflies represent recent goal attainments, rewarding and reminding the individual of successes over the past month. Yellow butterflies indicate that the *primary weekly goal* was met, while white butterflies indicate that the *alternate weekly goal* was met—the optional alternate goal is intended to help the individual stay active during difficult weeks. At the end of each week, the display resets to an empty garden.

3. GOAL-SETTING THEORY

The primary intent of UbiFit is to motivate individuals to participate in regular and varied physical activity—that is, UbiFit attempts to persuade individuals to change their behavior, and then sustain the changed behavior so that it becomes a regular part of their everyday lives. Although several theories from behavioral psychology focus on encouraging behavior change in one form or another, one theory that is commonly used to drive the design of healthy lifestyle interventions that specifically encourage individuals to be physically active and/or eat well is Locke and Latham's Goal Setting Theory [10]. *Goal Setting Theory* describes how individuals respond to different types of goals, and thus how to set goals to motivate behavior. Goal-Setting Theory was developed based on nearly four decades of empirical research and Ryan's [13] early work that reintroduced the notions of intentions and goals into the study of motivation and performance. Locke and Latham are industrial-organizational psychologists, and as such, focus on the relationship between conscious performance goals and level of task performance, particularly in the work setting. Goal-Setting Theory is not limited to the workplace, however.

In their empirical work, Locke and Latham found that people give the highest levels of effort and performance to the highest or most difficult goals. They also found that "*Specific, difficult goals consistently led to higher performance than urging people to do their best"* [10]. The belief is that the general "do your best" type of goal has too wide a range of acceptable levels of performance and is therefore difficult to judge if the goal has been attained. Though not all specific goals lead to high performance, they do reduce variation in performance, as there is less ambiguity about what is expected. Incidentally, physical activity recommendations, such as those provided by the ACSM, follow the model of proposing specific, unambiguous goals.[1]

Locke and Latham claim that goals most strongly influence performance when individuals are committed to their goals. The two factors that most contribute to *goal commitment* are (1) the importance of goal attainment to the individual, including the outcomes she expects to result, and (2) self-efficacy, that is, the belief that she can achieve the goal. Therefore if the individual does not consider the goal to be important or does not believe she can achieve it, she is unlikely to achieve it. Locke and Latham identify two ways to increase the *importance* of a goal for an individual: (1) have the individual make a public commitment to the goal, or (2) provide an incentive. When an incentive is used, the rate at which the incentive is provided is important. If the incentive is provided only for *achieving* the goal, performance may drop significantly. For example, if the individual realizes that she is not going to meet her goal and will, therefore, not receive the incentive, her performance and self-efficacy will drop. The drop does not tend to occur if the goal is only moderately difficult or if the individual is rewarded for performance (*i.e.,* piece rate) rather than for goal attainment only. Locke and Latham caution that conflicting goals may undermine performance if the conflicting goals motivate incompatible behaviors.

Locke and Latham stress the importance of providing feedback about the individual's progress toward her goal [10]:

> *For goals to be effective, people need summary feedback that reveals progress in relation to their goals. If they do not know how they are doing, it is difficult or impossible for them to adjust the level or direction of their effort or to adjust their performance strategies to match what the*

[1] A general weekly exercise program recommended by the ACSM is to do at least 3-5 sessions of cardio training for 20-60 minutes/session, 2-3 sessions of strength training involving 8-10 muscle groups/session, and 5-7 flexibility training sessions involving the static stretching of all major muscle groups [16].

goal requires…goals plus feedback is more effective than goals alone.

Locke and Latham identify three types of goal sources: (1) self-set, (2) assigned, and (3) participatively set. Self-set goals tend to be of personal importance to the individual. Because self-set goals relate to self-efficacy, the individual is likely to set a goal that she believes she can realistically achieve. Performance toward a goal set for the individual (assigned) tends to be comparable with performance on a goal the individual helped define (participatory) *if* the assigned goal is accompanied by the rationale for the goal. A goal that is set for the individual (assigned) without a clear rationale leads to significantly lower performance.

3.1 Implications for Design

When using *Goal-Setting Theory* to develop persuasive technologies to encourage physical activity, Locke and Latham's [10] findings suggest that the target audience should be individuals who have determined that being physically active is something that is important to them. The goal should be set by the individual or participatively with an expert, such as a personal trainer. What the individual has to do to meet her goal should be unambiguous, for example, by following the common format of guidelines set by government agencies. The goal should be a priority in her life, and it must be challenging, yet something that she believes she can realistically achieve. The individual should receive incentives as she makes noticeable progress toward her goal, in addition to when she attains her goal. Feedback should also be provided when the goal is exceeded, for example, by showing how far over the goal the individual has gone.

Next, we describe related work regarding goal-setting as used in health interventions and persuasive technologies.

4. RELATED WORK

Goal-setting has been used as a strategy in healthy lifestyle interventions as well as in recent research on persuasive technologies to encourage physical activity. In this section, we summarize recent work that has employed goal-setting.

4.1 Goal-Setting in Health Interventions

Shilts, Horowitz, and Townsend [14] provide a survey of health interventions involving goal-setting as a strategy for promoting physical activity and dietary behavior change. Because much of the traditional goal-setting literature focuses on the workplace and yet goal-setting is often used in health interventions, the survey was conducted to determine goal-setting's effectiveness when used as part of physical activity and dietary interventions. Based on their survey, Shilts, Horowitz, and Townsend propose two goal sources to add to the three originally identified by Locke and Latham—(1) self-set, (2) assigned, and (3) participatory. Shilts, Horowitz, and Townsend propose (4) guided, where an expert designs multiple goal choices and the individual chooses one, and (5) group-set, where individuals who participate together as a group design and choose a goal for the group (or an expert sets the group's goal), and goal attainment is contingent on the performance of the group.

There was not enough evidence in their literature review to support a single type of goal source as being most effective. The use of goals in the intervention studies included in Shilts, Horowitz, and Townsend's review showed a positive effect on physical activity and nutrition behavior—however, these studies did not compare interventions with and without goals or with different types of goal sources, but rather interventions with goals versus no intervention.

4.2 Goal-Setting in Persuasive Technologies

Besides our work with the UbiFit system, other recent research has developed persuasive technologies to encourage changes in diet and physical activity behavior. Some form of goal-setting was a key component in several of these projects. We briefly discuss these next.

In Consolvo et al's study of Houston [2], which was our first attempt at developing a persuasive technology to encourage physical activity, small groups of women from pre-existing social networks shared their step counts and progress toward a daily goal with each other via their mobile phones. Each participant was *assigned* a daily step count goal for the two weeks of the intervention-portion of the study. The goal was derived from each participant's daily step count during a pre-intervention baseline week. The calculation was based on a suggestion from the President's Council on Physical Fitness and Sports' *Walking Works* program [12].

In Lin et al's study of Fish'n'Steps [9], participants' ability to reach their daily step count goal was tied to the state of a virtual pet, a fish in a fish tank. Similar to the Houston study, in Lin et al's study of Fish'n'Steps, each participant was *assigned* a step count goal for each week of the study. The goal was calculated based on each participant's step count during the four weeks of a pre-intervention baseline. The weekly goals became progressively more challenging over the six weeks of the intervention-portion of the study, and were calculated using an exponential function. Lin et al limited the maximum total step count goal for each participant based on findings from the health sciences literature.

Similar to the studies of Houston and Fish'n'Steps, Gasser et al employed *assigned* goals in their study of a lifestyle coaching system [8]. However, unlike the Houston and Fish'n'Steps studies, the participants in Gasser et al's study had the same daily goal: to earn at least seven "lifestyle points" every day. Each point was earned either by doing 10 minutes of moderate or vigorous physical activity, or by consuming one serving of fruit or vegetables. To reach the daily goal, at least four points had to come from fruit or vegetables. The goal was based on the World Health Organization's recommendation that individuals should perform at least 30 minutes of moderate physical activity every day and consume at least five servings of fruit and vegetables.

Bickmore et al's work with virtual agents [1] used a different goal source strategy. In their study, the participants' daily step count goal was negotiated every day with Laura, a virtual agent running on a PC with a touch screen monitor (i.e., Bickmore et al employed *participatory* goals). The negotiation would take into account the current day's step count and the step count history, and attempt to slowly "shape" each participant to her final step count goal at the end of the two month study. This final goal was assigned to each participant based on their baseline activity level, and was either 5,000 or 10,000 steps, depending on whether the baseline step count was below or above 5,000 steps.

Finally, although they incorporate goal-setting, other recent studies do not specify *how* goals were set. In Mamykina et al's

study of a mobile system for diabetes management [11], for example, the participants had goals to make meal patterns more regular, increase their exercise level, and increase the regularity of their blood glucose level monitoring. However, it is unclear if the participants—who were participating in a diabetes education class—were assigned the same goals, or if goals were assigned by or participatively set for each participant with the educator. In Tsai et al's study of a mobile phone system for calorie tracking [15], participants could set a daily caloric intake goal that would help them lose weight, but it is not clear who set the goal (e.g., the system or the individual) or how it was determined.

Next, we describe the details of the study in which we explored goal setting considerations, including how we implemented goal-setting in UbiFit Garden.

5. METHOD

The results presented in this paper focus on participants' reactions to the goal-setting strategy used in the three-month field study of the UbiFit Garden system, and alternative goal-setting strategies that were presented to participants at the end of the study. Here, we briefly describe the study details, then discuss how goal-setting was implemented and explored in our study.

5.1 Study Details

Twenty-eight individuals who were recruited by a market research agency participated in the three-month field study of UbiFit Garden (15 female/13 male, aged 25 to 54). All were regular mobile phone users who wanted to increase their physical activity.

The participants represented a range of occupations including real estate agent, personal care assistant, public relations specialist, retail manager, psychologist, event laborer, project manager, human resources specialist, teacher, business developer, and comedian. Seventeen were employed full-time (one was also a student), eight were employed part-time (one was also self-employed), two were homemakers, and one was a full-time student. The highest level of education completed for four participants was "some college," 19 others had a Bachelor's Degree, one had course work at the Master's level, three had a Master's Degree, and one had a PhD. Twelve were classified as *normal weight*, nine as *overweight*, and seven as *obese* according to Body Mass Index (BMI) calculations performed on their height and weight measurements.

Participation involved three months of *in situ* use of UbiFit and three in-person sessions with the researchers. For the in situ portion of the study, participants placed their SIM cards into the study phones that we provided, so that the study phone served as the participants' personal phone throughout the study. During the first in-person session, participants completed several questionnaires and set a weekly physical activity goal of their own choosing. Each participant had their height and weight measurements taken, received the study equipment, and instructions on how to use the equipment. In the second and third in-person sessions (conducted approximately one and three months after the first session), participants were interviewed about their experiences in the study (interviews were audio recorded and transcribed), had their weight measurement retaken, and repeated two of the questionnaires. In the second session, participants were also able to revise their weekly goal and add the optional alternate weekly goal. In the third session, participants returned the study equipment and were compensated for their participation. Additional details are described in [3].

5.2 Goal-Setting in the Study

We used *self-set goals* in the three-month field study, that is, participants set their own goals. Goals were calculated on a seven-day timeframe, and ran for a *fixed calendar week* (i.e., Sunday to Saturday). The only other goal requirements were that:

- all participants have a weekly goal,
- the goal include at least one session of cardio (≥ 10 minutes in duration), walking (≥ 10 minutes in duration), strength training, OR flexibility training each week, and
- the goal be of the form: *<number of sessions> <activity type> <minimum session duration in minutes> per week*

We required that a minimum duration be set for cardio and walking sessions, but that was optional for strength and flexibility training sessions.[2] Examples of participants' goals included:

- Participant 18's (i.e., P18's) weekly goal:
  - 2 cardio sessions ≥ 30 minutes/session,
  - 4 walking sessions ≥ 15 minutes/session, and
  - 3 flexibility training sessions (no minimum duration)
- P24's weekly goal:
  - 4 cardio sessions ≥ 30 minutes/session,
  - 4 strength training sessions (no minimum duration), and
  - 1 flexibility session ≥ 30 minutes/session

5.3 Exploring Alternatives in the Study

Using self-set, fixed calendar week goals is not the only way that we could have implemented goal-setting in the system. For example, we could have used other types of goal sources such as those suggested by Locke and Latham [10] and Shilts, Horowitz, and Townsend [14]. Examples of those options include:

- **Self-set**: the individual sets her goal (i.e., as in our study),
- **Assigned**
  - **national recommendations**: the individual chooses from established physical activity guidelines, such as those set by the ACSM, AHA, U.S. Surgeon General, or President's Council on Physical Fitness,
  - **fitness expert**: a personal trainer sets the goal for the individual,
  - **medical expert**: the individual's medical doctor sets the goal for the individual,
- **Participatory**
  - **fitness expert**: the individual works with a personal trainer to set the goal,
  - **medical expert**: the individual works with her medical doctor to set the goal,
- **Guided**
  - **fitness expert**: a personal trainer designs multiple goal options from which the individual can choose,

[2]Our decision is consistent with ACSM and AHA recommendations which specify minimum durations for cardio and walking, but not for strength and flexibility.

- **medical expert**: the individual's medical doctor designs multiple goal options from which she can choose, or

- **Group-set**
  - **strangers**: the individual works with a group of strangers to set a goal for the group where even if she did her part, if someone else did not do his or her part, the goal might not be achieved,
  - **social network**: the individual works with a group of her friends and/or family to set a goal for the group where even if she did her part, if someone else did not do his or her part, the goal might not be achieved.

Additionally, we could have implemented the weekly goal's timeframe differently. Possible options include:

- **Rolling seven-day window**: a seven-day timeframe that shows the individual's last seven days worth of activity and whether those last seven days qualify as having met her goal (i.e., a rolling seven-day window that never resets),
- **Customizable calendar week**: a goal that resets once per week, where the individual specifies the reset day at the start of the study, or
- **Fixed calendar week**: a goal that resets once per week, where the reset day is fixed (i.e., as in our study).

During the final interview of the study, we proposed all of these alternatives to participants who then speculated about their goal source and timeframe preferences. While participants only experienced one goal setting technique during their three months with the system, our interview challenged them to systematically reflect on their experience in contrast to these other possible goal setting options. We describe our findings next.

6. RESULTS

In this section, we report results from our field study where the 28 participants speculated about their goal source and timeframe preferences. All results are from the final interview that took place at the end of the three-month field study.

6.1 Goal Sources

Of the goal source options that we proposed—Self-set, Assigned (national recommendations, fitness expert, or medical expert), Participatory (fitness or medical expert), Guided (fitness or medical expert), and Group-set (strangers or social network)—only one participant would have even considered choosing from established guidelines (i.e., Assigned: national recommendations), though it was not her top preference. She explained:

> *I like the idea of the either a personal trainer or the guidelines from like American Health* <sic> *Association or something…I think it's a good standard, but at the same time, I like being able to set my own. I mean working toward that goal, but realistic too with what my schedule is.* {P28}

Depending on their current level of fitness, the other participants thought that the 'national recommendations' option would be too easy or too difficult. Participants explained:

> *I feel like I'm in shape. I don't think that…the Surgeon General or somebody coming in saying these are what you should be doing and I think I could easily maintain those goals.* {P1}

> *My current physical condition…is going to completely inhibit me from meeting the national goals or national recommendations. That would just be dismal for me. Oh sure, you need to get out eight days a week. That would be so discouraging for me.* {P17}

> *They put out their general guidelines. They don't know specific injuries I've had or problems that I—issues that come up or whatever.* {P21}

A few participants did not completely dismiss the 'medical expert' options (Guided, Assigned, or Participatory), though they were no one's top pick. Those who found them potentially interesting had consulted with their medical doctor about exercise in the past because of its potential impact on personal health issues (e.g., obesity-related conditions, asthma, injuries, and depression). A participant explained:

> *Well, I guess my asthma would be a prime example. Having a doctor in the past that's taught me how to control it or when I have issues, how to deal with them…I would say that the activities I do are based on knowledge I've gained from a doctor in the past…but I wouldn't go to a doctor and ask for a workout routine per se.* {P7}

In general, however, the 'medical expert' options were as unpopular as the 'national recommendations' option. Participants explained:

> *I have doctors who are friends and they're overweight and you know, they know the biology of things, but I don't feel like they're necessarily fitness experts.* {P5}

> *I would never use my doctor's goals because he's probably looking at the American Heart Association goals.* {P18}

The group-set options (strangers or social network) met with mixed reviews. Initially, those options sounded appealing to many participants, with a slight preference for 'strangers.' The words "accountability" and "motivation" were often used, for example:

> *The collective* [group set] *goals…because it would hold me accountable. I would be more apt to not let others down, whereas here* [in the study], *I was just letting myself down. But if other people were involved and were counting on me, that would probably be easier for me or better for me.* {P22}

> *You can kind of get around your friends…you know…'Well you guys are going to be upset because I didn't meet my goal,' but I don't think it still carries the same clout as if you were say with a group of strangers that you all had to collectively meet a goal and you had to pull your weight. And so I think that would have been very effective…I wouldn't want to sit in a room and just be like I was the reason why somebody didn't meet their goal or our group didn't meet the goal.* {P2}

Participants often clarified that members of the group should have similar abilities and goals:

> *I would really struggle with that* [group-set goals] *unless they were a whole group of people that were in a very*

similar situation to myself, because if I'm working with the rowing team, I'm bringing down the curve. {P17}

Several participants thought that the group-set model would help them be more active during weeks when lack of activity was attributed to complaints about the weather or being tired, for example. However, when they reflected on what a group-set goal might be like during periods when they were faced with something such as an illness or deadline at work—that is, a barrier that seemed more "reasonable" than, perhaps, an inclement weather excuse—they were not as enthusiastic, for example:

I've never been one for team sports and things like that, so I wouldn't be interested in the 'everybody try to get the goal, and if you don't do it, everyone fails.' {P23}

I may have actually gotten to the point, and I sort of did, where I just like, 'Something's got to give,' and unfortunately, it's the same thing that angers me every time it gets really busy…it's just exercise was always the thing that gave...I just think there are times like now where it just doesn't matter how much accountability I have, I would be willing to take the gruff. {P2}

In the above example, P2, whose quote on the previous page illustrates that she found the idea of the group-set—strangers option appealing, explains how at certain times, exercise is not her top priority. Toward the end of the study, she had to prepare for a professional licensing exam. She explained that she would have let her goal slide (and in fact did toward the end of the study) even if doing so would upset the group in the event of a group goal.

Similarly, participants would be upset if they did their part, but missed the goal because of another group member:

I'm sure there are people who wouldn't meet it [the goal] *and then that would be demoralizing.* {P14}

Several participants explained why the group-set—social network option was not appealing, often drawing from past experiences:

I've got a lot of lazy friends and family. {P25}

I wouldn't do it with the friends and family thing…That never worked for me. 'Let's go for a walk together, come on,' and that whole thing of them trying to motivate me. It just does not work for me…[explaining from past experiences]*…It will start off, and then one will stop, either I will or they will, and then it just never resumes again. So it never worked…*[But] *this group thing* [with strangers] *would be interesting.* {P15}

The Guided and Participatory options with the 'fitness expert' were appealing to most participants (Assigned was often not appealing, similar to Locke and Latham's findings [10]); participants liked the idea of working with a personal trainer to set the goal or have the trainer design multiple goal options from which they could choose to ensure that they felt the goal was something they could accomplish. Again, words such as "accountability" and "motivation" were frequently mentioned. P22 explained why she would not want a goal that a personal trainer simply assigned to her (i.e., Assigned—fitness expert), *"Personal trainers tend to be a little…hard core*." Some wanted to be able to modify a trainer's suggestion without notifying the trainer of their changes (i.e., they wanted to edit an assigned goal without notifying the trainer of the change). P14 wanted to self-set her alternate goal and have a trainer assign her primary goal.

Participants clarified that an on-going relationship with the fitness expert would be important. They expected that the fitness expert would follow their progress and adjust their goal over time, not simply set the goal for them and be done. They also wanted to meet the fitness expert in person (partially to ensure that s/he was physically fit) and assumed that the fitness expert would get to know their current abilities, constraints (including childcare responsibilities and job schedule), and long-term objectives (e.g., run a marathon or lose 40 pounds by summer) prior to setting the goal. That is, the fitness expert options were appealing not only because of the expert's perceived knowledge and experience, but also because of the ongoing relationship that participants would expect to have with the fitness expert. For example:

If I worked with somebody that had personal experience with my activity levels, my physical condition, and then they worked to find something that was achievable for me, that's going to help me improve, that's going to allow me to see the improvement, that would be, I think, my best-case scenario. {P17}

If something wasn't working or I felt that wasn't working about it, I would call them [the trainer] *and have them kind of reassign or maybe tweak it* [the goal] *a little…with them kind of overseeing it, they can help guide you, you know, kind of get you pushed, whereas if you tweak it yourself, you might allow yourself to lax a little bit.* {P12}

However, most participants claimed that they did not currently have a personal trainer because they could not afford one; cost was a common concern. Also, some had past negative experiences with trainers, for example:

When I first moved out here and I joined a gym and they gave me like three free training sessions. And the guy [the trainer] *tried to get me to do all this stuff and just really max out after I hadn't lifted* [weights] *for a while...and I was sore for a week and a half afterwards. So, he was trying to make me feel sore so I felt like he was providing a service that I needed or something, where it just made me not ever want to see the guy again because then I took a week off right when I was excited to work out. Then I had a week when I couldn't work out 'cause my muscles were so sore.* {P7}

Self-set goals, as implemented in our three-month field study, were also popular, particularly given the cost concerns of personal trainers. For example, if participants were provided with a personal trainer by their employer, they often would have preferred one of the 'fitness expert' options. However, if they had to pay for one themselves, they often would have preferred self-set goals, particularly after considering what group-set goals would be like during weeks with illnesses or deadlines. P9 summed up his perspective on the various goal source options:

I liked setting it myself. The only one out of the others [i.e., alternate goal source options] *that I would, you know, not be annoyed by would be a personal trainer. I don't want somebody else in the group affecting it. I don't want, you know, a doctor or a President's goal. I just know there's certain ways I'm going to work out.* {P9}

6.2 Goal Timeframes

Of the three types of weekly goal timeframes that we proposed—rolling seven-day window, customizable calendar week, and fixed calendar week—the calendar week options were the most popular, with a slight preference for providing the option of the participant setting when the week begins (i.e., a customizable calendar week). Monday and Sunday were the most frequently preferred start days, with a slight preference for starting on Monday, as several participants liked to rest on Sundays and would rather end than begin their week with a rest day. Despite the background screens resetting (i.e., flowers disappearing), many participants liked the idea of a calendar week with a reset because (1) it gave them a clear deadline, (2) it provided a fresh start each week, and (3) it reminded them that being active was an ongoing process—something on which they had to stay focused. They explained:

> *I think the Sunday through Saturday's best for me. It's just easier for me to visualize or to keep track, I guess, of the exercise…it's fine that it clears out. It gets you motivated to get going again.* {P28}

> *I enjoyed the structure of the week…you know when it's going to end so you have, you have to do it within that time period. Like, you know, it gives you an endpoint so you have to, you've got to do it. You've got to move.* {P6}

> *Every week is a new week. I don't want the seven-day window because then I always have the next day, I always have the next day…*[With the calendar week] *I have a definite parameter. A boundary…I don't like the rolling window idea because then I think I would keep pushing it off and pushing it off.* {P11}

> *This* [being physically active] *is something that needs to be—it's not like a project. It needs to be ongoing, and if you're saying well, I can always do it some other time, that's not good.* {P16}

However, for some, the rolling seven-day window sounded appealing, particularly if they tended to be active toward the end of the week, since end-of-week flowers on the calendar week options do not remain on the glanceable display for very long. Those participants at least wanted to try the rolling window option and compare it to the calendar week timeframe.

> *…you do something on Saturday, it's* [the flower is] *gone. It's all gone, And so, it's kind of like, 'I finally did something and now it's gone.'…if it is a rolling seven days, it's like what you just did yesterday is still there for you…you get to kind of hold onto that success for a little longer.* {P19}

7. DISCUSSION

As part of our three-month field study of the UbiFit Garden system, 28 participants reflected on their experiences with and speculated on their preferences for goal-setting sources and timeframes. The results we presented can be used to recommend default settings for systems such as UbiFit as well as propose opportunities for future work for persuasive technologies that encourage physical activity, which we discuss in this section.

7.1 Goal Sources

Participants' reactions to different goal source options have raised opportunities for future work. Although the self-set goals employed in our field study were popular, participants found some of the other options appealing as well, particularly the 'fitness expert' and group-set options. In many cases, participants thought those goal source options could be motivating. However, cost was a common concern for the 'fitness expert' options and certain barriers—such as illness or work deadlines—as well as past experiences with friends and family were concerns for the group-set options. Exploring how persuasive technologies could leverage fitness experts while minimizing cost to the individual is a promising avenue for future work. Similarly, future work could explore how to implement group-set goals in a way that would continue to motivate the members of the group despite the changing demands of everyday life.

Unpopular options were the 'national recommendations' and 'medical expert' options. However, despite being unpopular, if self-set goals are used in a system, it might be useful to provide the national recommendations for reference—not necessarily as default goals—to remind individuals of the type of variety for which they should strive. Additionally, for individuals with health concerns that may impact their ability to perform physical activities, the medical expert options might be appropriate.

7.2 Goal Timeframes

Based on participants' experiences with and speculations about the weekly goal timeframe, the default for a system such as UbiFit should be a calendar week that begins on Monday and ends on Sunday. Individuals should be allowed to change on which day their week resets (e.g., so that their weekly goal could run from Sunday to Saturday, Wednesday to Tuesday, etc.) and potentially switch to a seven-day rolling window model where the week does not reset, but rather moves forward one day at a time.

There is an opportunity for future work to further investigate the time window based on the individual's activity level. Of the participants who were interested in the rolling seven-day window idea, most tended to be less active on average or were less consistent with their activity levels. In many cases, their reason for wanting to try the rolling seven-day window model was that their flowers would last longer. However, they might benefit from a different timeframe altogether until they are more active on a regular basis. Perhaps instead of a seven-day timeframe, a four-week timeframe might provide more motivation for them, even if their goal resets, so that the little rewards for behavior (e.g., the flowers we used in UbiFit Garden) persist longer. As the individual improves the regularity of her behavior, the time window could shorten (e.g., from four to two to one week).[3]

7.3 Making Goal Commitment Public

Finally, while we did not implement this strategy in UbiFit, nor did we investigate it as part of our three-month field study, Goal-Setting Theory suggests that having the individual make her goal public could be effective at increasing goal-commitment. The sharing aspects of some recent systems (e.g., Houston [2] and

[3]Some related work (e.g., the Houston study [2]) used a daily goal. While it was effective for some participants, most did not find it appealing as they tended to need days off or 'rest days.'

Fish'n'Steps [9]) have begun to investigate this issue, but little has been reported on its effectiveness. Future work could explore the effectiveness of this strategy in persuasive systems, including challenges such as how to so implement it without introducing undesirable effects such as shame, excessive competition, and other factors that could lead to system abandonment.

8. CONCLUSION

Employing goals in persuasive technologies may be an effective way to encourage behavior change. As part of our investigations of developing persuasive technologies to encourage individuals to be physically active, we have explored individuals' reactions to various types of goal-setting considerations, specifically *goal sources* (i.e., who should set the goal) and *goal timeframes* (i.e., over what time period should an individual have to achieve the goal). In this paper, we presented findings from a three-month field study of the UbiFit system that relate to participants' reactions to various approaches for implementing goal-setting in a persuasive technology to encourage physical activity.

Most participants would prefer to set their goal themselves (i.e., self-set) or work with a fitness expert to set a goal (i.e., guided or participatory), in which case they would expect an ongoing relationship with the expert. Established guidelines and assigned goals do not consider their individual abilities, objectives, and constraints, and most participants simply did not think of medical doctors as people from whom to seek advice about physical activity. Participants would prefer their goal to run for a calendar week that starts on Monday or Sunday, and then reset at the end of the week. They preferred the calendar week to a rolling seven-day window because it gives them a clear deadline, provides a fresh start each week, and reminds them that being active is something on which they must stay focused over time. Based on our results, we suggested opportunities for future work to continue to explore the effectiveness of goal-setting as a strategy for persuasive technologies to encourage physical activity.

9. ACKNOWLEDGMENTS

Thanks to Daniel Avrahami, Jon Froehlich, Louis LeGrand, Ryan Libby, Keith Mosher, Tammy Toscos, and many other family, friends, colleagues, study participants, and paper reviewers who have contributed to this research. Portions of this work were supported by the National Science Foundation.

10. REFERENCES

[1] Bickmore, T. Caruso, L., & Clough-Gorr, K. 2005. "Acceptance and Usability of a Relational Agent Interface by Urban Older Adults," Extended Abstracts of CHI 2005, New York: ACM Press: 1212-1215.

[2] Consolvo, S., Everitt, K., Smith, I., & Landay, J.A. 2006. "Design Requirements for Technologies that Encourage Physical Activity," In Proceedings of the Conference on Human Factors & Computing Systems (Montreal, Canada, April 22-27, 2006). CHI '06. ACM Press, New York, NY, 457-66.

[3] Consolvo, S., Klasnja, P., McDonald, D.W., Avrahami, D., Froehlich, J., LeGrand, L., Libby, R., Mosher, K., & Landay, J.A. 2008. "Flowers or a Robot Army? Encouraging Awareness and Activity with Personal, Mobile Displays," In Proceedings of the International Conference on Ubiquitous Computing (Seoul, Korea, September 21-24, 2008). UbiComp '08, 54-63.

[4] Consolvo, S., McDonald, D.W., & Landay, J.A. 2009. "Theory-Driven Design Strategies for Technologies that Support Behavior Change in Everyday Life," In Proceedings of the Conference on Human Factors & Computing Systems (Boston, MA, USA, April 4-9, 2009). CHI '09. (*To Appear*).

[5] Consolvo, S., McDonald, D.W., Toscos, T., Chen, M.Y., Froehlich, J., Harrison, B., Klasnja, P., LaMarca, A., LeGrand, L., Libby, R., Smith, I., & Landay, J.A. 2008. "Activity Sensing in the Wild: A Field Trial of UbiFit Garden," In Proceedings of the Conference on Human Factors & Computing Systems (Florence, Italy, April 5-10, 2008). CHI '08. ACM Press, New York, NY, 1797-806.

[6] Fogg, B.J. 2003. Persuasive Technology: Using Computers to Change What We Think and Do. San Francisco, CA, USA: Morgan Kaufmann Publishers.

[7] Haskell, W.L., Lee, I-M, Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., & Bauman, A. 2007. "Physical Activity and Public Health: Updated Recommendations for Adults from the ACSM and the AHA," Circulation, 116, pp.1081-93.

[8] Gasser, R., Brodbeck, D., Degen, M., Luthiger, J., Wyss, R., & Reichlin, S. 2006. "Persuasiveness of a Mobile Lifestyle Coaching Application Using Social Facilitation," Proceedings of Persuasive 2006, Eindhoven, The Netherlands, Springer Berlin / Heidelberg, pp. 27 – 38.

[9] Lin, J.L., Mamykina, L., Lindtner, S., Delajoux, G., & Stub, H.B. 2006. "Fish'n'Step: Encouraging Physical Activity with an Interactive Computer Game," Proceedings of UbiComp 2006, Berlin: Springer-Verlag, 261-278.

[10] Locke, E.A. & Latham, G.P. 2002. "Building a Practically Useful Theory of Goal Setting and Task Motivation: A 35-Year Odyssey," American Psychologist, 57(9), 705-17.

[11] Mamykina, L., Mynatt, E.D., Davidson, P.R., & Greenblatt, D. 2008. "MAHI: Investigation of Social Scaffolding for Reflective Thinking in Diabetes Management," Proceedings of CHI '08, New York: ACM Press, 477-486.

[12] President's Council on Physical Fitness and Sports. Jul 2004. *Walking Works: The Blue Program for a Healthier America*.

[13] Ryan, T.A. 1970. Intentional behavior. NY: Ronald Press.

[14] Shilts, M.K., Horowitz, M., & Townsend, M.S. 2004. "Goal Setting as a Strategy for Dietary and Physical Activity Behavior Change: A Review of the Literature," American Journal of Health Promotion, 19(2), 81-93.

[15] Tsai, C.C., Le, G., Raab, F., Norman, G.J., Sohn, T., Griswold, W.G., Patrick, K. 2007. "Usability and Feasibility of PmEB: A Mobile Phone Application for Monitoring Real Time Caloric Balance," Mobile Networks and Applications, 12, 173-184.

[16] Whaley, M.H., Brubaker, P.H., & Otto, R.M. (Eds). 2006. "General Principles of Exercise Prescription," ACSM's Guidelines for Exercise Testing and Prescription, 7th Ed, Baltimore, MD: Lippincott Williams & Wilkins.