Designing for Human Supported Evidence-Based Planning

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Abstract

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Behavior planning is a technique that can help people bridge goals with the actions that will help them accomplish those goals. Although more than half of all Americans set goals for changing behavior every year, people encounter a range of barriers: knowing what series of behaviors will help accomplish a goal, identifying opportune moments to enact behaviors, identify behaviors relevant to the goal and that are feasible in the moment. Planning can help overcome these barriers, but people either do not know how to use plans on their own, or do not have access to experts who can deliver the techniques.

Technology has made it easier to access interventions such as planning. However, technology-supported planning does not provide people with solutions that are tailored to the person's needs or that incorporate evidence-based interventions that have been shown to help people accomplish intended goals. Social computing has shown that other people can provide informational support to others about incorporating changes in one's life in contexts such as

chronic disease management, yet little is known about how people can help each other for behavior planning.

In this research, I investigate how technology can support behavior planning and how people can help each other to create more effective plans using technology. I first evaluate in what ways other people can help create behavior plans to fit with people's needs. I identify types of preferences and constraints that plans need to satisfy to be tailored to people's needs. I investigate how people without professional expertise, domain non-experts, can help others with behavior planning for physical activity and healthy eating. I identify strengths and weaknesses that different kinds of domain non-experts (friends, crowd members) have in helping others with tailored planning support. Based on this understanding, I designed, built, and deployed CrowdFit, a fully functioning system for behavior planning that support domain non-experts in creating behavior plans for physical activity that are aligned with exercising evidence-based guidelines.

My findings contribute empirical understanding, design guidelines and theoretical implications to the human computer interaction, social computing, and behavior intervention technology researchers. It expands the existing understanding of people's needs in engaging with behavior plans and of the needs and strengths of domain non-experts in providing behavior planning support. This research also expands understanding of how technology can scaffold behavioral evidence-based interventions to help domain non-experts provide high quality support to others.

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Chapter 1.

INTRODUCTION

1.1 BEHAVIOR CHANGE IS HARD

Pursuing behavior changes is a complex, difficult to maintain, and long-term process. Many people aspire and seek to change their behaviors to better themselves. However, people have a hard time accomplishing personal goals. According to Norcross et al., six months after making a New Year's resolution, only 46% of people were still on track [100], and some people set the same resolution for 5 years before they maintain it for 6 months [100]. The top New Year resolutions are related to improving health: to exercise more and eat healthier [148]. The failure to accomplish these goals puts people at health risks of chronic disease that half of all adult Americans experience [147,149]. Technology has started to play an important role in supporting people's pursuit of health goals. There has been an increase in health technologies, with over 300,000 health apps available on top app stores [146]. Technology opens opportunities to understand how to provide support for people changing behavior. Through accessing apps, or through seeking support from other people online, there are new opportunities to help people with their goal pursuit.

1.2 BARRIERS TO IMPLEMENTING GOALS

Although people often have positive intentions and set goals, just setting goals is not enough when those goals are complex [80]. People encounter a multitude of barriers to taking action towards their goals: they need to be able to identify moments that are opportunistic for enacting a behavior, to know what series of behaviors will help them accomplish their goal, to identify behaviors that are relevant to the goal, and to identify behaviors that are feasible in the moment [48]. Behavior planning bridges people's intentions with their intended behavior [125]. By planning out the actions to take towards a goal, people are more likely to perform those actions and to make progress towards their goal [48]. Yet planning is a difficult task requiring complex reasoning about future

situations, opportunistic times to act, what behaviors to enact, and how to account for complexities of everyday life [48]. These complexities are amplified by the need for domain-specific knowledge trained experts typically have. For example, when working towards an exercise goal, one should consider insights about one's current level of fitness, the difficulty of a physical activity, and principles of exercising safely [42]. In addition to domain specific knowledge, it is necessary to have an understanding of people's needs to tailor behavior support through assessing needs and incorporating them in the advice provided [42,114]. The multitude of aspects that go into successful planning show a need to better support people in taking positive action through effective behavior planning.

A typical approach for getting high-quality support for health behavior changes is through domain experts (e.g., dietitians, exercise trainers, smoking cessation counselors, mental health providers). All such behavioral support includes some form of planning, for example through exercise plans [86] or therapy homework [7,33,58]. The techniques used by professionals involve a close interaction with the client, to understand their needs, identify an appropriate approach for supporting a behavior change, and tailor the support to the client's needs and situation [42,150]. However, most domain experts are inaccessible for a lot of people. Many professional experts are prohibitively expensive for many people, with costs ranging from $70 to $225 per session [151]. In the absence of access to professionals, digital platforms are an emerging source for support, either through making it easy to connect to professionals via telehealth or by supporting providing self-management.

1.3 Technology Mediated Support For Planning

Technology has facilitated several effective behavioral strategies that help people improve behavior through planning. Numerous apps promise to make it easier for people to access support for their behavior from the convenience of their homes, however technology falls short at integrating recommendations with people's life and needs. Numerous apps support people in finding activity plans that include recommendations for what behaviors people should follow, for example what exercises to do, and how to perform them [152,153], plans to start eating healthier [154], or creating plans to manage productivity [155]. Crowdsourcing tools have made it easier for people to break down complex goals like exercising or trip planning into plans [69,140]. However,

current planning technology predominantly provides people with plans that are a one-size-fits-all and do not account for people's preferences in what activities they like performing and how that might fit with other aspects of their life.

Technology also makes it easier for people to seek support and information from others through online platforms. People can now use a variety of platforms to ask questions or find ideas on Facebook [92], Twitter [107], Instagram [28], using crowd work platforms such as Amazon Mechanical Turk (AMT) [16], or from special interest communities, such as communities for managing chronic conditions [53]. Peers share the day-to-day context of coping with health issues, or managing specific health conditions [53]. The insights in managing everyday life [53] makes peers a great source of support to others. The potential of people from a variety of context to provide planning support, combined with the experiential support of people have with managing everyday life makes technology mediated planning support a promising approach to support people in making progress towards their health goals.

More and more interventions are delivered through digital devices [89]. Health interventions have been delivered typically with the help of peers and successfully supported people in pursuing health goals such as being more physically active [6,20,26]. Technology behavioral interventions also include human support [118]. Because technology has been used to deliver evidence-based interventions, it has the potential to be an appropriate means to provide planning support to people. The potential of people to provide advice to others about how to manage change in their life through technology shows raises the question: can people without professional expertise support others in through behavioral planning advice? The intersection of these advantageous factors made it promising to study if domain non-experts can support people with planning advice that follows evidence-based guidelines using technology.

1.4 Research Overview

1.4.1 Thesis Statement

I investigated the following thesis statement:

> *Technology can be designed to support domain non-experts in creating tailored, evidence-based plans for others.*

In this research, I investigated how domain non-experts can support people in behavior planning across a range of domains: physical activity, eating healthy, and saving money. I examined the value of support from other people for behavior planning, and the needs domain non-experts have in providing planning support. I investigated the strength and weaknesses of familiar and non-familiar domain non-experts (friends and online strangers from crowd work platforms). I designed, built, and deployed a system that supports the creation of behavior plans for exercising by domain non-experts. Findings from this research show a new approach for delivering behavior planning support that helps domain non-experts provide tailored and evidence driven support to others.

In this dissertation, I use the term **domain non-experts** to refer to people who do not have any professional training in the domains that they provide support on (e.g., they have not taken certifications in exercise or fitness). I will refer to **familiar** people as those who know the person they are helping (e.g. friends and family who met the person), and **non-familiar** as people who do now know the person they are helping (e.g. online crowd workers). **Evidence-based** refers to interventions that have been shown to lead to positive behavioral outcomes. In this research, I consider types of plans that have been proven to be successful (that include what, when, where will be enacted) to be an evidence-based intervention. Exercise guidelines that have been correlated with positive health outcomes will be the other evidence-based intervention used in this research.

1.4.2 Research Questions

To examine the thesis statement above, I used a human centered design process and mixed methods. I conducted research to understand people's needs in supporting others in the creation of behavior plans for physical activity, eating healthier and saving money. Based on the needs identified, I designed, prototyped and built a system, CrowdFit, to support the creation of physical activity plans for others. Finally, I evaluate the system in a deployment.

I answer the following research questions:
RQ1: How can familiar and non-familiar domain non-experts (friends and crowd workers) support tailored, evidence-based behavior planning?
RQ2: How can design of technology support non-familiar people in tailored behavior planning?

RQ3: How can design of technology support domain non-experts in, evidence-based behavior planning?

1.4.3 Understanding Stakeholder Needs for Planning

To answer RQ1, I conducted a study to understand the feasibility of relying on domain non-experts for behavior planning support (Chapter 3). I studied how familiar and non-familiar people—friends and crowd workers—provide behavior support, to understand the strengths of these different types of domain non-experts. To understand needs in planning support across domains, I studied behavior planning across common goals set by adults in the US: exercising more, eating healthier, saving money [148]. I used a mixed methods approach, using interviews, surveys and a low fidelity prototype. This study allowed me to understand the needs that domain non-experts have in providing planning support, and the needs that people have in receiving support from domain non-experts. This study shows the opportunity of leveraging domain non-experts for providing personalized planning support to others.

1.4.4 Design, Build and Deploy a Tool for Domain Non-Expert Behavior Planning

To answer RQ2 (Chapter 4, Chapter 5), I designed, built, deployed, and evaluated a system that supports domain non-experts in providing personalized behavior planning support for physical activity goals, using evidence-based guidelines. In Chapter 4, I explain the design goals and design choices for a tool, CrowdFit, that supports domain non-experts in providing tailored behavior planning to others. I show how design can incorporate evidence-based guidelines for behavior planning, and for conducting physical activities.

In Chapter 5, I describe the deployment, and evaluation of CrowdFit through a three-week comparative study. I evaluated CrowdFit, comparing it to planning support from domain experts and to planning support from domain non-experts who did not use technology support for creating activity plans. I evaluated CrowdFit through multiple stakeholder interviews, surveys, and a diary study. I interviewed the planners to understand their experience and needs in using the system. I interviewed clients, along with surveys in a diary study to understand how they used the behavior plans they received. I evaluated the CrowdFit with expert feedback from professionals who were

certified as personal trainers. To assess the quality of plans created, I worked with an exercise scientist to adapt a scale for evaluating physical activity plans.

1.5 Summary of Key Contributions

Summary of research questions, approaches, and contributions:

Questions	**Methods**	**Contribution**
RQ1: How can familiar and non-familiar domain non-experts (friends and crowd members) support tailored, evidence-based behavior planning?	Study 1: Empirical study to understand how friends and crowd workers can provide behavior planning support (exercise, healthy eating, saving money). - Interviews, low fidelity prototype (Chapter 3)	Empirical understanding of the type of *personalized* support that domain non-experts can provide for behavior planning with regard to tailoring (preferences, constraints, routines, and goals) and novelty of recommendations, accountability and privacy concerns.
RQ2: How can we design technology to support non-familiar people in tailored behavior planning? RQ3: How can we design technology to support domain non-experts in, evidence-based behavior planning?	Study 2: Design, build, deployment and evaluation of system that supports crowd members in providing personalized behavior planning (exercise) recommendations that draw on evidence-based techniques. - System design (Chapter 4) - System evaluation through deployment, interviews, diary study (Chapter 5)	Artifact and design contribution illustrating techniques through which domain non-experts can provide *personalized* and evidence-based exercise planning support. Empirical data that shows how planners rely on information about the person they are helping with following the evidence-based guidelines.

The contributions of this work are: (1) An understanding of the strengths and needs that familiar (friends) and non-familiar (crowd members) domain non-experts offering behavior planning support have with regard to tailoring recommendations, accountability and novelty of ideas, in light of how their help is perceived by the people they are helping; (2) Design and implementation of a system artifact, CrowdFit, that shows how evidence-based planning principles can be translated into design; (3) Evidence of the effectiveness of CrowdFit in supporting non-familiar people to tailor exercise plans, and in supporting domain non-experts in incorporating evidence-based guidelines into plans; (4) Understanding of how domain non-experts use CrowdFit by prioritizing evidence-based recommendations with the needs of those they are helping and their personal background.

Chapter 2.

RELATED WORK

2.1 Behavior Planning Theory and Best Practices

The research in this dissertation is driven by theories and constructs from psychology. This section highlights aspects of behavior planning that most influenced what aspects of planning I researched, and that were the foundation of the tool I designed. Next, I provide an overview of behavioral planning. I then discuss best practices of using behavior planning in applied settings by health practitioners.

2.1.1 Overview of Planning

Research shows that a range of planning techniques are effective in helping people accomplish desired behaviors. In a systematic review of 94 studies, people who created *if-then plans* were more successful at accomplishing goals than those who did not [48]. If-then plans help people address common barriers that people encounter in getting started striving towards a goal, such as: remembering to act, using good opportunities to act, or overcoming reluctance to act. Other types of plans are also effective at supporting behavior changes. In a systematic review of 65 studies, creating plans accompanied by *coping plans* (i.e., plans that include how to cope with anticipated barriers) facilitate behavior change for health related outcomes [70]. Based on planning's effectiveness for accomplishing goals, I focused my dissertation research on understanding how to better support planning.

Research in behavioral psychology has studied what helps people make progress towards their goals. Research by Locke and Latham [80] shows that the action of setting goals promotes achieving the goals. But setting a goal, or intention, is not enough to reach that intention. Plans can help people accomplish goals, by helping people identify the steps that will take them to that goal. When people set a goal, they draw on skills they already have to accomplish the goals. If

people already know how to accomplish the goal, they automatically draw on skills they have to do so [73]. But when people do not know how to accomplish a goal, making a plan can help people identify how to use existing skills to reach a goal [80]. By making a plan, people identify a path to reach that goal, instead of just using automatic responses. When a goal is new to an individual, plans can help the person engage in deliberate actions that will help them reach their goal [122].

2.1.2 What is Planning?

Plans are discussed in behavioral literature as an approach to bridge the gap between behavioral intentions and behavior [48,123,125]. Planning is an intervention studied in the psychology literature in studies going back many decades [76]. Prior research has discussed planning as a self-regulation mechanism, that helps people to act in an intentional way. People form representations in the present of future outcomes they want to accomplish, goals, and they anticipate what set of actions can take them to a desired outcome [10,48,125]. Plans are a "self-regulatory strategy, a mental simulation of linking concrete responses to future situations" [125]. They help people respond to situations with intentional behaviors, instead of responding with potentially undesirable behaviors. Thus, planning has the potential to help people pursue desired behaviors, instead of learned, habitual, or innate responses that a person is trying to avoid [125]. Researchers also find that people get benefits from developing plans for diet and physical activity. Vet et al. find that, "to overcome or prevent self-regulatory problems, individuals need to get acquainted with how to make plans and how to adapt plans to regulate their daily behaviors" [132].

One of the well-established types of plans, and commonly used in literature, are *implementation intentions*. As defined by Gollwitzer, implementation intentions are an if-then plan specifying *"when, where and how the person will instigate responses that promote goal realization"* [46,48]. Implementation intentions are based on the premise of facilitating goal striving by bridging the behavior-intention gap. Implementation intentions are beneficial because they ease the difficulty of make conscious and effortful decisions in the moment about a behavior, and they help the individual to shift some of the control to situational cues that were planned ahead of time [46].

To create an implementation intention, one needs two critical components:

1) to identify a behavior that will promote accomplishing a goal.

2) to anticipate an occasion when a behavior will be enacted,

By specifying the behavior that one will perform, and the situation when that behavior will occur, people are more likely to accomplish their goal. Implementation intentions connect good opportunities to act with behavioral responses that are effective in accomplishing one's goal. This type of action plans use a structure of "If situation Y occurs, then I will initiate goal directed behavior X," for example, "If I get home from work at 6pm, I will go running on the trail near my house." Identifying good opportunities to act are facilitated by specifying in a plan *when* and *where* to act. Identifying a behavior to promote accomplishing the goal is facilitated through specifying in a plan *how* to act.

2.1.3 Evidence-Based Planning

2.1.3.1 Properties of Plans That Lead to Positive Behavioral Outcomes

Research on what aspects of plans make them effective in the behavior planning field is still ongoing. It is known that creating or being given plans to follow leads to more successful goal accomplishment based on systematic reviews of tens of studies [48]. The criteria for inclusion of such studies is that plans included the components of *what*, *where, when* to perform action. This implies that plans that include what, where, when components lead to successful goal accomplishment. I sought to understand how plans, or planning principles, are operationalized in these studies, or studies that cite this work, and what aspects of plans were proven to help people achieve positive outcomes. This section describes properties of plans that existing studies have found to lead to positive behavioral outcomes.

To exemplify the properties that are part of effective plans, I include in Table 1 studies that had positive outcomes from a planning intervention, and the properties of plans created as part of the intervention. The components in Table 1, such as what to do, and how, include time when to perform action, situations when to act, or are location based. These plan components sometimes co-occurred in the studies. The studies evaluate the effectiveness of the plans on behavior, but not of each individual component, so the insights from the papers are only about plan components that are effective in aggregate. Besides having limited information about what aspects of plans are effective, the details of the interventions themselves can be limited in the psychology papers. Several studies only provide generic descriptions of the planning intervention delivered. Several

studies mention that plans were either given to participants or created by the participants but do not include details of how detailed these plans were (e.g., plan for smoking cessation, or plans how to get a medical shot) [76,133]. The most detail included in these studies is in the domain of exercise. For this domain, the studies include what activities were included in plans (e.g., vigorous activities, fitness activities). The plans in the studies vary with regard to how "occasion to act" is operationalized, including time, situations or locations as a cue. Related research suggests that other properties of situations when people exercise should include mood, because it could be considered in planning as a trigger to action [57]. People encounter challenges in creating effective plans on their own, which I discuss in Section 2.1.1.4 below.

The lack of understanding of what components of plans are effective makes it difficult to know how to create plans that lead to plan enactment [40,61]. Plan enactment is correlated with positive behavioral outcomes [133]. Fleig and colleagues highlight that part of not knowing which aspects of planning are effective relates to not measuring how people engage with plans, whether they complete planned activities, or not. The outcomes that are measured in studies of planning are of the intended outcome (e.g., exercise, flossing, quit smoking, writing a task). In addition, researchers are measuring whether people complete plans can help understand the effectiveness of different components of plans. Fleig and colleagues evaluate how different aspects of plans impact plan enactment. They show that specificity (the precision with which participants specified what activity they wanted to do, and when and where they intended to be physically active) of the

Plan Components		**Example studies operationalizing different components of plans**
Actions to perform	What	Physical activities [61,87,123,125] [82] Plan for how to get a medical shot [76] Plan to quit smoking helped to quit smoking [133] Completing report for class [47] Performing surgery recovery activities [87] Plan to floss [57]
	How	How to exercise [82]
Opportunities to enact behavior	Time based	Time of day [47] When to perform surgery recovery activity [103] When and where will exercise [87]
	Situation based	Floss tooth after brushing teeth [57] (not specified what routines, but differentiated from time) [61] [40]
	Location based	Location to complete a report for class [47] Where to perform surgery recovery activity [103] Where will exercise [87]

Table 1: Plan components of plans that led to goal achievement

occasion to act, the when-cue, promotes plan enactment, but that specificity of where to act, the where-cue, does not affect plan enactment [40]. Some researchers have tried to understand if highly specific plans are more helpful, but the evidence is unclear. Keller found that plans were more likely to get enacted when they included less specific *when* cues. This indicates that highly specific cues can be difficult to detect by people and might cause them to not enact a plan (e.g., "when the clock ticks 6:30 I will stand up") [61].

The studies above highlight differences in plan effectiveness based on level of specificity of the plan. Gollwitzer proposed that plans should be specific. One aspect to make plans specific is to include appropriate opportunities to act, so that people do not have to develop a response about how to act in situ, when the opportunity to act occurs [48]. Gollwitzer also proposed that plans should be viable*:* the specified situation to act will occur, and when it does, people can perform the response they planned. For a plan to be viable the person needs to have control over the behavior, which researchers speculate would reflect in terms of physical abilities, resources and opportunities like physical environments [119]. Although such properties of plans seem promising, research is still ongoing on what characteristic of plans lead to positive outcomes [40,61].

Inclusion of a backup, or a coping plan, has also been shown to be a helpful planning strategy that leads to positive behavioral outcomes. Coping plans are developed in service of addressing barriers that prevent following through with initially developed plans. Sniehotta defines coping planning as a "barrier-focused self-regulation strategy" [125]. It represents a mental link between anticipated risk situations and suitable coping responses." The benefit of coping plans according to Sniehotta is that it leads to identifying coping strategies at a time when the individual has more resources in identifying coping strategies, compared to when the person has to make a decision on how to act in the moment.

To summarize, the constructs that are primarily measured about characteristics of plans evaluate the effectiveness of plans against a different intervention (e.g. generic or unrelated instructions). The lack of clear implications for what characteristics of plans lead to positive outcomes can be challenging in implementing planning best practices into technology. Because of this, I used the generic principles of planning to guide the design of tools for planning: (1) include actions that will promote accomplishing a goal, such as what and how to perform them, and (2) to

anticipate an occasion when a behavior will be enacted, such as time, situations, or locations to perform behavior.

2.1.3.2 Tailoring Plans to People's Needs

Prior research, described above, expands on how planning can help people accomplish desired goals. In this section, I elaborate on how people's needs are reflected in creating plans. I first describe insights about how domain experts account for people's needs in plan creation and what types of plans people prefer.

People get planning support from a range of domain experts when they are trying to manage complex issues. Domains that use planning interventions include exercise, diet, or mental health, or smoking cessation. Personal trainers help clients create exercise plans that are tailored to the level of the client's fitness level, goals, and their preferences and constraints [42]. Dietitians assess client needs to tailor interventions to the client's personal goals and unique challenges [114]. Mental health providers use goal setting and planning as a critical element of several interventions, such as Problem Solving Therapy [33] and Engage Therapy [7]. Planning is part of therapy homework [60] through which providers help clients shape action plans they can pursue outside therapy sessions to help them manage situations that occur outside of therapy. Planning is also part of behavioral counseling for smoking cessation [150], promoting physical activity [25], or obesity prevention [129].

The above treatments produce positive outcomes and are part of best practices. Planning is prevalent and is part of the best practices above. To plan, domain experts understanding the needs of the client by asking the client about their experiences with the desired behavior, provide advice on how to improve behavior, assist and agree with the client in how to create a plan that fits with their needs, and follow up [150]. Other approaches to tailor a plan to a client's needs is to assess the feasibility of different ideas to find the most suitable plan for supporting behavior change [33].

Researchers have started to also evaluate people's preferences in terms of behavior planning. Although it is not known explicitly from planning studies if incorporating people's preferences about plans would lead to positive behavioral outcomes, there are several reasons to understand them. For example, understanding people's preferences about the content of plans can be helpful in creating plans that people are more likely to follow. If people find the planned behaviors enjoyable [135], or have positive attitudes towards a behavior [57] they more likely to

repeat the planned behavior in the future. Research on people's preferences with plans is still limited. For example, research shows that people prefer to plan behaviors that are anchored in time, and they prefer leisure time activities for exercise, as opposed to behaviors that are embedded in other everyday activities, such as "taking the stairs" [40]. There is a need to understand people's experiences and preferences in using plans to understand if there might be other criteria in creating plans that people find valuable. In this regard, I also draw on Human Centered Design Principles that have at their core an understanding of people's experiences to inform design, and propose that understanding the needs of people in engaging with plans will inform how to better design plans so that they are aligned with people's needs.

2.1.4 Summary of Using Planning Theory and Best Practices

To summarize, there are two guidelines that related research has identified for effective planning and that I will use in this dissertation: (1) helpful plans follow evidence-based practices that prior research showed lead to positive behavioral outcomes by including information about the actions to be included in the plan (what, how) and the situations when the actions will be performed (when, where) to perform intended actions, (2) helpful plans are tailored by health experts to fit the needs of the person the plan is intended for.

There are several challenges that make planning difficult that I discuss in the next section: (1) people have limited skills in creating plans that match with planning principles, (2) accessing domain experts who have the expertise of providing evidence-based, tailored plans is not affordable to many people. In this research I examine alternative ways for technology to facilitate access evidence-based, tailored planning, with the help of domain non-experts. I show how plans can be tailored to people's needs and how planning can be supported by other people (Chapter 3 and Chapter 5). I show ways to translate planning principles into the design and evaluation of a system, CrowdFit (Chapter 4). I show how domain non-experts use evidence-based planning principles while balancing people's needs (Chapter 5).

2.2 Designing Technology for Behavior Planning

In many domains, such as health, creating an effective plan requires skills that many people do not have. Research shows that people created fell short at satisfying criteria for effective planning such

as: not linking a behavior with specific routine [43], not specifying exactly what needed to be done and when [43], following past strategies whether they worked or not [126]. This suggests that people need support in creating effective plans. Such skills can be accessed through experts such as personal trainer, dietitians, mental health providers and more. However, accessing such planning services can be expensive. For example, online services price nutritionists at $70-$100 [151]. There are several alternatives to increasing access to behavior support, when domain experts are not available.

An alternative to expert support is through peers, who are providing social support. Research shows that peer support can help people accomplish better health outcomes in behavior changes for weight management [131], breast-feeding [34], managing anxiety [105], or managing chronic disease management [38].

Technology can increase access to behavioral support when people do not have access to experts. There has been an increase in behavioral intervention technologies that facilitate the access to behavioral interventions delivered through technology [89,90]. In the next sections, I elaborate on how technology can support planning, and how other people might be able to facilitate support for planning.

Many people turn to the Internet to search for plans [19,77]. While programs for common behavior change goals, such as exercise or diet, are bountiful online, many have had poor quality by providing misleading and potentially dangerous information, or lacked the structure that in person programs usually provide [116]. Current apps offer limited support for people's needs. Apps might account for the current level of fitness of a person, or the type of foods they like to eat, but the extent to which plans are further customized to any other needs that people have is missing [104]. This results in plans being less effective [127] – or less likely to be tried [111]. In domains like physical activity, the apps where people get planning support but do not follow evidence-based practices for exercising [49,66,88].

There is a need to understand what is helpful to people in planning support, how to help people in engaging with effective evidence-based practices that might be used by experts, and how to provide planning support that is tailored to people's needs.

In this section, I first situate planning technologies within HCI behavior change research. I then discuss HCI research and what is known about how technology can support aspects of planning (identifying activities to plan, and occasions to enact activities). I then discuss the current

limitation in supporting the integration of these aspects of planning with people's needs. I organize the next section based on how technology can:

1) make it easier for people to identify behaviors that promote accomplishing a goal,
2) make it easier to identify occasions when behavior can get enacted to promote accomplishing a goal
3) support the creation of behavior plans

2.2.1 Planning Technology within HCI Behavior Change Research

Extensive prior research in HCI has worked to help people set and achieve physical activity goals. Systems like UbiFit [31], GoalPost [95], and Fish'N'Steps [78] enable people to set goals and track progress toward them. These systems commonly encourage people to set a goal as a daily step count (e.g., 10,000 steps per day as an ongoing goal) or a set of exercises for a week. Other systems encourage people to consider what is achievable over each day of a week. CommitToSteps prompted users to set a step goal as both a minimum number of steps and the minimum number of days per week they would achieve it (e.g., "I will walk at least 8,000 steps per day on 3 or more days this week.") [96]. Although there is a lot of research on goal setting, there is little research on an effective strategy to help people accomplish their goals: behavior planning. Studying behavior planning technologies can help people bridge goal setting, with actions that will promote achieving those goals. In this dissertation, I expand current understanding of how to support behavior planning and how to design tools that support people in creating plan that fit with people's needs and follow evidence-based practices.

2.2.2 Supporting Identifying Behavioral Actions to Plan

Many applications provide people with plans for goals such as exercising more or eating healthier. For example, diet plans might include links to recipes, or caloric estimates of a meal, or strategies for incorporating healthy eating into one's life [154]. Exercise plans include information about how to perform a certain physical activity by following along with video instructions [152,153]. Some of these plans include links to strategies for managing barriers, such as managing cravings for salty foods by replacing them with healthy foods [156]. People can even find information about activities they can perform and how through social media platforms, from information shared by

other people [28]. Online plans typically include lists of activities, how to perform the activities, or links to text summaries explaining strategies for how to improve a behavior, but they have limited tailoring.

However, technologies provide limited support for tailoring the plans to a person's needs. Research has shown some needs in this space. For example, recommender systems provide people with recommendations on what physical activities to do increase physical activity [110], or how many steps to take [75], foods with similar nutritional values to what the user is currently eating based on image analysis [139], or based on what people have access to in their pantry [24]. Systems propose intelligent systems can use data from rehabilitation programs of other people can help clinicians make decisions for new patients [81].

Another example of opportunities to tailor behavior recommendations is by providing n the moment feedback. For example, technology can make it easier for people to receive customized feedback on maintaining good form when performing physical activities by receiving feedback from tools that track body posture [37,113]. To support tailoring, few systems discuss ways of assessing information about a person in order to support tailoring of assistive technologies, for example through building a system for assessing information about the user, such as goals, preferences, abilities [79].

Although technology has explored different ways of addressing people's needs in pursuing desired behaviors (e.g., recommendations that fit with existing behavior, just-in-time feedback on behavior), systems that provide behavior recommendations that draw on people's backgrounds and on expert practices are still in a stage of being envisioned [41]. While recommender systems above show examples of providing single recommendations at a time, these often rely on having existing data about a user to calibrate recommendations. Thus, there is a need to have a way of assessing a user's preferences to provide appropriate recommendations. In addition, recommender systems predominantly support suggestions for activities, such as foods or exercises that are a good match for the user [41,110,139], rather than support for creating plans. Research is still building knowledge about how to tailor recommendations for behavior change and to support people in behavior plans that people want to follow.

2.2.3 Opportunities to Enact Planned Behaviors to Plan

An important aspect of planning is finding opportunities to perform a certain behavior. Even if a person identifies what actions to take, they still need to find opportune moments to act. Tools have improved their support for scheduling, with calendar becoming prominent in managing work and meetings. However, even calendar only offer an overview of when people are available, rather than opportunities to do a complex task.

Managing complex behaviors can require much more than when to schedule an activity, through an understanding of people's context and tailoring to it. Managing healthy goals such as exercising more or managing conditions like diabetes can require people identify a variety of contextual factors for when there are opportunistic moments to act, such as aligning behavior with their routines. People identify sweet spots or contexts [112] to act that depends on settings (e.g., Home, Work, School) or other factors such as weather, location, time, social interaction, or affect [106,112]. Even though such factors are important in identifying when people should enact behavior based on their context, it is still difficult for people to know when to perform a certain action, and it is still unclear how to design tools that incorporate these insights into systems.

Some systems try to use data to help people understand themselves and opportunities to act. Personal informatics systems help people draw insight about their lives, by surfacing insights and opportunities for change in their everyday life that are compatible with their everyday routines. Tools like Cuts, or Health Mashups help people in visualizing personal data to surface patterns, routines or anomalies to help people identify behavior they would like to continue, or that they would like to alter [12,39].

The tools and insights above help people in drawing insights about their past behavior, but do not connect the past insights with planning what, when and how they enact future behaviors. The tools that support people in taking action at opportune times are commonly in the productivity space where they are tightly connected to monitoring screen time. Some people use technology to create opportunity to enact action by suppressing distractions, for example through restricting apps [62] or by tracking productivity to increase awareness [67]. Research in managing productivity of office workers has shown that tools can help identify when there are opportune moments to encourage people to transition between tasks, by tailoring to moments that are opportune for the person, while managing interruptions and disconnect from tasks [59,136]. Such recommendations

are just in time suggestions but do not support people in planning and identifying what works for themselves.

Few tools support people in both identifying situation to enact desired behaviors and in suggesting the intended actions, by tailoring to the person's context. MyBehavior makes use of information about a person's activity patterns to make recommendations based on that. The system learns an individual's physical activity and dietary patterns to generate behavioral recommendations based on context and past behavior [110,111]. For example, MyBehavior shows opportunities for performing behaviors in situations, such as walking home after work, or walking a particular path in the city. While these tailored just in time interventions can be helpful, such tools do not support people in creating their own plans. Planned behaviors might also allow people to incorporate knowledge about preferences or cues that work for themselves [126], which a just in time intervention could miss.

The research above shows that although there is empirical evidence on what contextual factors might help people in pursuing desired behaviors, tools have not yet incorporated this type of knowledge. There are still few tools that attempt to help people take action at opportune moments. Such tools do so through just-in-time interventions but not by supporting people in creating plans. There is little knowledge in how to support people in identifying opportunities to take action when creating a plan.

2.2.4 Technologies that Support Creating Plans

A baseline technology for supporting people in creating plans are task management apps that help people to create task lists, to schedule tasks on different days or at different times. Many apps support basic creation of task lists [157]. Other apps include more advanced features, such as coordination with other team members, integration with other technologies used as part of the user's workflow, like calendars, or a variety of ways of customizing the visual organization of the tasks [155,158]. These applications make it easy to keep track of tasks, organize tasks, but do not support the process of identifying what tasks to perform. Researchers have tried to automatically identify opportune times to schedule activities [32]. But using automatic approaches has limits. An example that illustrates how challenging it is to even schedule a work meeting is Calendar.help [32]. Using an algorithmic approach, and feedback from the users scheduling a meeting, is still not enough to identify appropriate meeting times. In this case, it is necessary to have a human in the

loop to better accommodated for people's scheduling constraints. Researchers have tried to support the process of creating task lists, such as automatically suggesting tasks based on prior corpus of to-do items [45]. However, creating task lists is difficult and is impacted by different aspects of the task performed (e.g., history of interacting and engaging with task, task complexity, priority, current state), and context of the individual (e.g., location, social relationships associated with task) [11]. People still need to do the labor of identifying appropriate tasks, given their goals and personal context.

Research in social computing and crowdsourcing shows designs lower the burden of the individual in creating a plan, by outsourcing the labor of creating a plan to other people and leveraging the experience or other people in identifying an appropriate plan. Several systems show that creation of task lists does not need to fall on the user alone. Instead, tools can enlist the help of crowds to generate plans for how a person can accomplish personal goals such as doing laundry, exercising [68], or trip planning [140], or enlist members of team to create writing tasks for completing a large manuscript [128]. System designers have also proposed concepts for tools can outsource tasks to the crowd, so that the person working towards a goal need not execute every single step of their plan to reach that goal [72]. At times, such tools also make people even more likely to accomplish their goals than when they planned for themselves [68]. These technologies lower the bar to breaking down goals that might be otherwise overwhelming, making it easier for people to access any kind of plan in the first place. These tools also make it easier to get perspective from multiple people which can lead to more novel ideas and to verification of a plan quality by voting on the best plan ideas [68].

One example of how plans do not account for people's needs is that they do not provide support if the person cannot follow the plan [68]. An approach that is similar to coping plans [124] is to provide alternatives. A way to do so could be through a variety of options for what tasks to do. For example, Teevan's work on writing microtasks [128] allows the group member to pick from available tasks to perform, but it is still possible to reach a point where remaining tasks are not a fit for the member of the team.

However, it is not known what needs plans should satisfy to best support people. Planning psychology suggests specifying when and where a plan will be pursued, but these cues are often missing in the plans above. Health practice suggests that plans should be tailored, but the examples above provide limited support to tailoring. For example, some tools assume the same solution for

goals like exercising, doing laundry or writing can be enacted by anyone and are applicable to anyone [68,128]. Incorporating subjective constraints from the requester was found to be helpful in creating a plan, but was only studied in the context of trip planning, and not of behavior change [140]. This suggests there is a need to further understand how to tailor what content is part of plans to people's needs and to understand how to do that.

2.2.1 Summary of Technology to Support Planning

Technology to support planning has been evolving with the rise of social computing systems for crowdsourcing, which have made it easier to break down goals and identify task lists. However, existing planning tools assume a one size fits all and do not support creating customized plans that account for people's needs in their everyday life. Planning tools support identifying task that one could do to perform a behavior, but do not pair that up with opportunities to act. There is not much known about how to support planning for opportune moments to take action. Providing support for planning is further complicated by the fact that people might not know how to reach their goal. Trial and error is necessary for people to identify what works for them [126]. Research in self-experimentation for behavior change shows that people need to adjust plans on a weekly basis to identify what strategies work for them [74]. Crowdsourcing technologies show the potential of outsourcing planning for behavior change to other people, but there is still a need to understand how to design planning tools that account for people's needs while also incorporating planning best practices of including activities that people can do at opportune times.

2.3 How Domain Non-Experts Can Support Planning

Advances in technology reduce the barriers to soliciting help from other people: friends, strangers, or peers. This can include seeking help from friends on social network sites, from peers in online communities, or from strangers in online task markets like Amazon Mechanical Turk (AMT). In this section, I review how people can provide support that is relevant to planning techniques.

A range of tools rely on the participation of various people to support behavior. Crowdsourcing using platforms like Mechanical Turk has already been used for planning tasks, as discussed above, for trip planning or creating to-do lists [68,140]. People already seek support from others for personal tasks such as getting answers to personal questions such as health, dating

or finance [92], finding new ideas for how to work towards a goal, such as finding recipe idea [28], finding ideas to restructure thoughts in ways not previously considered [94], or ideas for how hospitalized patients can manage their hospital stay and safety [50]. This shows that people have potential to help others create simple plans identify ideas for activities they might want to pursue, and even for creating plans.

Research that discusses how people can identify opportunities to pursue desired behaviors has identified of factors that are important for scheduling activities, such as context, location, or time of day. However algorithmic approaches are still limited in making recommendations that fit the needs of people. Using a human in the loop approach has been successful in scheduling meetings so that they are more aligned with people's needs [32]. People also engage in helping others identify how to fit much more complex change into their life than a meeting. Experts, such as clinicians, dietitians, or mental health providers provide care plans that encourage incorporating behaviors into daily routines [25]. Research on managing chronic disease emphasizes how peers can help patients in managing their condition at home and at work, they offer perspectives on how to manage situations that come up, exchange information about medication, share personal stories of managing the disease [53,56,121]. For example, cancer patients saw potential in peers helping organize and schedule tasks [121]. Caregivers can provide help with creating routines, in other context, such as providing care for self-management of spinal cord injury [18].

These examples indicate that people with a range of expertise can provide support to each other, from peers, to friends, and crowd members. Peers with similarities in experiences have a unique expertise in sharing their patient experience, either through managing similar types of conditions, or through experiencing a similar situation, like being hospitalized. By using their lived experience, patients can provide others with advice that reflects the challenges of the lived experience. But platforms that are not centered on peer systems can still help people get relevant support from others. Studies involving people with no domain expertise, such as crowd workers, show people who are domain non-experts can provide useful advice to each other on managing low back pain [55], for reframing thoughts [94]., or having therapeutic conversation [101]. This indicates that people with no particular domain expertise can provide help to each other for managing a variety of goals, including health goals that traditionally require domain specific expertise.

With the rise of behavioral intervention technologies [89,90] helpers are increasingly contributing as part of tools that support delivering behavioral interventions. Helpers, in many cases lay people, provide support with the delivery of interventions through addressing key challenges that patients have: boosting engagement or providing troubleshooting [118]. Through the efficiency model of support, Schuller and colleagues identify opportunities for human supporters to address other aspects of delivering interventions: such as matching the patient with the appropriate tool to fit their needs, or to ensure that the behavioral intervention is delivered with high fidelity. This model emphasizes a need to understand what helpers do and how. Researchers have started studying the type of support that therapists offer when supporting the delivery of a digital intervention, such as deadline flexibility, task reinforcement, educational content, reminders, self-efficacy, empathetic utterances [108]. This is important for the delivery of behavioral interventions because it informs how the helper shapes the content that is being delivered. As more domain non-experts are becoming part of supporting the delivery of behavioral interventions through technology, there is a need to understand how helpers provide support, and the needs they have in being effective when helping others.

2.4 Summary of Related Work

To support people in pursuing their goals, planning is a critical step that helps people translate their intentions into actions. To plan effectively, people need to identify what actions to take and to find opportunities to enact them. Research shows that plans that are specific, feasible and instrumental can help people enact actions and make progress towards their goal. But it is still not known what features of plan are actually correlated to positive outcomes. Research shows that people do not create effective plans on their own. Typically, people might get support from experts in creating such plans, but when access to experts is limited people can use different resources to get planning support.

Technology has made it easier to get support for different aspects of planning. Technology that incorporates crowdsourcing techniques makes it easier to break down complex goals and identify activities that one might plan to reach their goal. Research provides understandings of how to better help people with scheduling activities, and understanding routines. This can help people better identify opportunities to pursue planned activities. But there are still few tools that can help

people create plans and identify opportunities to pursue the planned actions. Even when technology does support identifying tasks and scheduling them, it is not known if the plans are feasible for the individual and are helping them progress towards their goals.

Some of the challenges of creating behavior plans have the potential of getting addressed through support from other people. Online communities make it easier for people to get support in managing health goals and integrating those into their everyday life. Crowdsourcing research shows how even people who do not have shared experiences with others can provide useful ideas, strategies or even create simple plans that help others. But little is known about how other people can help create effective plans that are tailored to the needs of the people they are meant for and that follow evidence-based guidelines. In Chapter 3, (1) I identify criteria needed for tailoring behavior plan to other people's needs, and (2) I identify the strengths of familiar and non-familiar people in providing behavior planning support to others.

Social computing tools that leverage crowdsourcing show how people's help can be incorporated in tools that support behavior planning. However, such tools do not account for the specific needs of either the people creating the behavior plans and those receiving behavior plans. In Chapter 4, I show how to design technology that incorporates the needs of people creating behavior plans and of those receiving them. I show how design can incorporate techniques that scaffold planning principles, and domain specific information about physical activity so that domain non-experts can create evidence-based plans. I show how to design user profiles that scaffold information about the plan recipient to better support non-familiar people in customizing the behavior plan to the needs of the person receiving it. In Chapter 5, I show how non-familiar domain non-experts use CrowdFit to create tailored evidence-based plans. I also show what are people's perceptions and experiences in receiving the behavior plans created with CrowdFit.

Chapter 3.

FRIEND- AND CROWD- SOURCED PLANS

Information technologies have greatly reduced the barriers to seeking help from other people. This includes seeking answers from others via social network sites (e.g., Facebook and Twitter) [27,92], getting answers in online communities (e.g., Social Q&A sites) [51], or even paying for help in online marketplaces for work (e.g., upwork, Amazon Mechanical Turk). Half of respondents in one survey say they engage in information seeking on Facebook or Twitter [92]. Multiple Q&A sites also boast millions of questions and answers (e.g., StackExchange, Quora). Crowdsourcing and friendsourcing are increasingly applied to accomplish basic tasks and to answer questions Twitter [51,92,107]. Crowds and friends have also been used in some planning tasks, such as trip planning, or to do item planning [68,140]. There is an opportunity to evaluate if it is possible to leverage crowdsourcing and friendsourcing in the complex task of generating behavior change plans.

In this chapter I aim to understand whether and how friends and crowd members can help generate behavior change plans I conducted a study (Figure 1). I conducted a study with 22 clients seeking to change their behavior and 66 planners (friends of participants and crowd members) who created behavior change plans. Each client logged and shared their current physical activity, eating, or spending behavior for in a 1-week diary. The planners – friends recruited by participants and crowd members from upwork (at the time named oDesk) and Amazon Mechanical Turk. Planners used the 1-week diary to create one-week plans intended to help clients improve their behavior. I conducted interviews with the clients to evaluate the content of the plans. I surveyed and interviewer the planners, and analyzed the plans generated.

In this study we find that friend- and crowd- sourced plans provide benefits for behavior change in the domains of exercise, healthy eating, and budgeting. We identify different strengths of friends and crowd members. Friends provide more tailoring, being more available for longitudinal interactions, but clients are less willing to share information with them. Crowd members provide more novel ideas, recommend more change to the client, are easier to share information with, but provide less tailored advice than friends. This research shows that involving

domain non-experts in creating behavior plans can be a beneficial approach to help people get access to behavior plans.

This chapter addresses the research question: *RQ1: How can familiar and non-familiar domain non-experts (friends and crowd workers) support tailored, evidence-based behavior planning?* Part of the findings and discussion in this chapter were published at CSCW 2016 [2].

3.1 Related Work

3.1.1 Asking for Information from Friends

With the increase of digital connectedness, people commonly ask friends for help with answering questions online, through friendsourcing [15]. Because friends are aware of or even share the same preferences as the person requesting help [121], they are a potentially valuable avenue for behavior support. Some of their strengths are that advice from friends or family can be accompanied by emotional support and a feeling of accountability to people who matter [98]. There are, however, potential challenges and drawbacks in seeking help from friends. First, people may be reluctant to ask friends about personal topics like health, dating, religion, or finance [92]. People feel uncomfortable sharing content that they consider sensitive, such as photos of themselves trying out clothing [93]. Second, while asking friends for help is usually free financially, it does incur social capital costs [115]. People might prefer not to make repeated requests to friends [93,121], and sometimes choose to pay for receiving an answer rather than use social capital [115]. Asking for help from friends can have certain downsides, such as reduced diversity of ideas compared to asking strangers [85], a focus only on positive feedback rather than critique [93]. These challenges limit the number of requests that people might make from friends, and the type of content they would receive from friends regarding diversity and types of responses received. Finally, while similarity among friends help individuals in getting advice that might be more applicable, it may also reduce the diversity of suggestions [85]. Friends' replies tend to be consistent with each other and to agree with previous responses. Together, these challenges limit both the number of requests people make of their friends and the diversity and types of responses received. Despite these challenges, friends are able to provide help with small tasks such as information requests, opinions,

or social coordination [35]. In the current research, we assess whether and how friends can help with creating behavior plans.

3.1.2 Asking for Information from Crowd Members

Online technologies have made it easier for people to connect to others whom they can ask for help from. People have been using online communities to seek support for behavior like healthy eating of physical activity from people that they do not know in person [28]. Further, innovations in social computing technologies for crowdsourcing have made it possible for people to ask for help on a variety of personal support.

People were able to successfully get support to complete everyday tasks such as: recognizing labels for people who are blind [16], getting fashion advice [93], helping plan a trip [140], managing email [69]. Crowdsourcing technology has more recently been used to provide informational or emotional support for health improvement, such as support for mental health reframing of thoughts [94,101], for informational support to manage autism [17], or for providing estimates of nutritional information [21]. Crowd members have previously helped create step-by-step plans, including collaboratively generated travel itineraries and creating instructions for completing a to-do task (e.g., doing laundry) [68,140]. An evaluation of such a system, TaskGenies, found that people who receive actionable plans from the crowd were more likely to achieve their plans than people who were asked to create their own plans or who did not create plans at all [68]. The plans generated by crowd members offered steps to help people remember the actions they need to take, practice viewing and not ignoring tasks, and break the cycle of habituated inaction.

Crowd members offer several benefits. First, crowds provide fast responses, being available even in real time on platforms like Mechanical Turk [13,16]. Second, crowd members may offer a diversity of backgrounds to which the requester might not otherwise have access. Crowds may also contain peers – others who have first-hand experience with similar goals and experiences and who can provide experience-based advice [54,121] – even when one's social network does not. Third, crowdsourcing need not be costly. People answer millions of questions on social Q&A at no cost. Many of these sites provide valuable answers and insights to behavior change (e.g. the subreddits r/Fitness, r/LoseIt, or the Physical Fitness Stack Exchange).

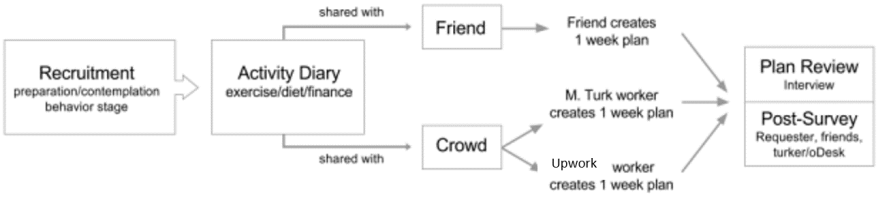


Figure 1. Study Design

However, crowd members could also have drawbacks: they may not know requester tastes and preferences [93], they can make negative comments that can be uncomfortable [93], and they might not have the expertise to answer questions for specialized topics [121]. Given these potential strengths and tradeoffs, in this research I investigate the potential for asking crowd members for help in creating behavior plans.

3.2 METHODS

I and the research team designed a study to assess the benefits and costs of creating behavior change plans with the help of friends or crowdworkers (Figure 1). Friends selected by participants and crowd members from oDesk and Mechanical Turk created one-week long behavior change plans.

3.2.1 Study design

To compare friendsourcing and crowdsourcing across different behavior change domains, this study focused on three different everyday behaviors: increasing exercise, eating healthy, and saving money. These are common behaviors that people seek to improve and people commonly set them as New Year's resolutions [142,148].

To provide planners with baseline data about participant behaviors, I asked participants to first track their chosen behavior for a week in as much detail as possible using an online document, an activity diary. Depending on which activity they were tracking, people logged the following information for: exercise – time of any physical activity and length in time, diet – time of any food consumed and what was consumed, finance – the amount of money spent and what was bought (Figure 3). Clients were encouraged to write any relevant notes about their behavior that would help others create a plan for them. Before their activity diary was shared with other people,

participants had the opportunity to revise what they chose to share with their friend and with a stranger.

As part of the information shared with the planners, clients included their age and gender. They also describe their goal, for example: "*My goal is to eat healthier. In particular I would like to increase my fruit and vegetable intake and try to consume fewer processed foods*" (P1) or "*I want to spend less than 150 a week*!" (P3). Clients were provided instructions to describe any constraints and preferences they had related to the activity, e.g., "*to avoid take out food and pack a lunch if I am away from home all day*" (P6) or "*I prefer running and live by a trail. I get bored doing the same thing two days in a row. I prefer going to the gym with a partner for motivation*" (P12). A complete list of goals and preferences can be found in Appendix A.

Clients were instructed to recruit a friend to create a plan for them after they completed logging their activity (Figure 1). The research team recruited crowdworkers by posting job announcements on upwork and tasks on Mechanical Turk. In the rest of this paper, I refer to these friends and crowdworkers as *planners*. I refer to participants who are recipients of the plans as *clients.*

Each planner created one plan for one client. Planners were given the client's description, goal, and activity log and asked to create a one-week plan to help the person exercise more, eat healthier, or save more money. The planners had three days to create the plan. Workers on Mechanical Turk and oDesk were limited to working at most two hours on the plan. The planners were provided with a similar structure as the activity diary (Figure 2) in which they could create their plan. Other than that, we provided no other constraints so planners may flexibility structure and present their plans. A sample of an activity log and instructions provided to the planner are available in the Appendix B.

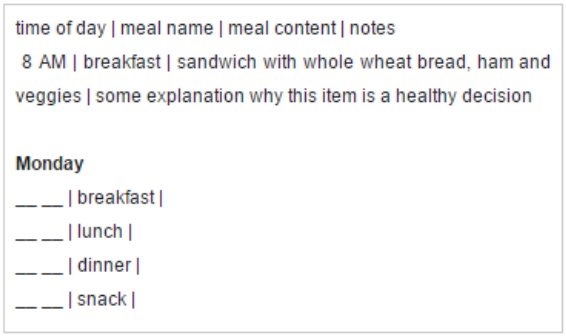
3.2.2 Recruitment and Participants

3.2.2.1 Clients

Through Craigslist and a university mailing list, I recruited clients interested in increasing their physical activity, eating healthier, or saving money. Clients were screened using a survey to include only participants who were (1) not actively working towards their chosen behavior and (2) were considering or planning to change their behaviors (in the contemplative or planning stage of

the transtheoretical model for behavior change [109]. Further, participants had to be willing to contact up to three friends to help them create a one-week long behavior change plan.

79 people completed the screener survey. Of these, I enrolled 63 participants in the study. 41 participants did not complete the study, either by not filling in their activity diary or not contacting a friend. 22 participants completed all the steps of the study. Out of the 22 participants, 8 had exercise goals, 8 had diet goals, and 6 had financial goals. Their ages ranged from 19 to 45 (mean=28 years), 17 were female and 5 male (Appendix A. Summary of Client Data).


time of day | meal name | meal content | notes
8 AM | breakfast | sandwich with whole wheat bread, ham and veggies | some explanation why this item is a healthy decision

Monday
__ __ | breakfast |
__ __ | lunch |
__ __ | dinner |
__ __ | snack |

Figure 2. Example Template that participants used for creating a food plan

Clients prepared a week-long activity diary, recruited a friend, received plans prepared by three people (the recruited friend and two crowdworkers, discussed below), and completed a post-study survey and interview. They were compensated with Amazon gift cards: $20 for logging activity for a week and contacting a friend and $40 for the final interview.

3.2.2.2 Planners

I recruited 66 planners to create plans for the 22 clients recruited, including friends and workers on Mechanical Turk and oDesk. 60 of these planners completed a follow up survey (discussed in the next sections). Out of those, 19 were male, 40 female, and one identified differently. There were more females than males among upwork planners: two male and 19 females. Upwork planners were recruited from the Personal Assistants role on upwork. We chose this category because it included some upwork workers with expertise in exercise, finance, or nutrition. However, these categories were not clearly delimited, so we recruited Personal Assistants more broadly.

The clients recruited a friend planner each. Friends had known the participants for an average of 13 years, with a range of 1 to 35 years. Most friend planners were close to the participants: family members, spouses, siblings, other close friends. Only one friend planner was recruited from the broader network of Facebook friends of the participant. Each planner reported talking with the participants at least a couple of times per week. Friends were compensated by

entering a lottery for one $25 Amazon gift card per every 10 participants. Planners on Mechanical Turk were compensated with $5 per task. Workers from oDesk bid for the task, varying between $3 and $33. The workers who received the lowest hourly wages had no reputation and said they wanted to perform work at low-cost while building their reputation. All crowdworkers were selected from the US.

3.2.3 Approach to Evaluation

3.2.3.1 Planner and Participant Surveys and Interviews

I evaluated the clients' assessment of plan quality through a survey, which included quantitative measure of likelihood to follow plan, perceived improvement in behavior and perceived fit with the person.

I interviewed clients about the quality of the plans and their current and previous behavior in relation to the activity they wanted to improve, and how friends and crowd workers contributed to the plan. The plans were presented to the participants in a random order and without revealing which plans were created by the friends or by crowd members, until after the plans were evaluated. Planners completed a survey at the end of their task. The survey included questions about demographics and their experience creating the plan. For example, what information did they use to create the plan? What other information would have helped them create the plan? We interviewed some planners to understand more about their process of creating the plans.

3.2.3.2 Expert Evaluation of Plans

To evaluate the quality of the plans, the research team hired experts to qualitatively rate each plan: a registered dietitian, a high school teacher who taught personal finance classes for several years, and an accredited Aerobics and Fitness Association of America instructor. The research team chose these people because they were accredited to have expertise in the same domains as the plans, and were teaching or counseling people in behavior improvement. The experts analyzed the information in the plans and rated how much of an improvement the plan would be for the person, if followed. They noted which items and strategies supported or did not support the participant's goal in each plan.

Participant	Activity Log	Plan (partitioned from full plan)
P10 **Diet**	**Sunday** __8AM__ | breakfast | nothing __12PM__ | lunch | nothing __6PM__ | dinner | steak and salmon with rice __1AM__ | snack | creamcheese fruit tart	**Sunday** _7_ _30_ | breakfast | Special K Cereal with Low fat Milk _12_ _00_ | lunch | Salad with Mixed Greens and either Chicken or Lean beef for protein. Add in Olives, Avocado and Nuts for additional Healthy Fats. Balsamic and EVOO for dressing.
P2 **Exercise**	**Tuesday** 6PM | 1 hr | Life | Moving from old apartment to new, heavy lifting, stairs	**Tuesday** 8:00 AM | HIIT | 30 second walk (brisk), 30 second sprint. 8 minutes total workout
P7 **Finances**	**Thursday** __ | 3.32 | fast food __ | 8.51 | Netflix __ | 6.34 | Drink and pretzels for snacks for class	**Thursday** $0 | You've already spent money on groceries, bring a lunch you made at home to work and eat dinner at home. $0 | Evening Entertainment: Read a book, watch TV, or play a video game. Maybe have a friend come over.

Figure 3. Example activity logs and plans for three participants. Plans illustrate justifications for the recommendations along with explanations on how to execute steps (e.g. food recipe)

3.2.3.3 Descriptive Analysis of Plans

The research team conducted an exploratory analysis of the plans received to see if there are any major differences across type and source of the plan. This included: the presence of justifications for the steps, links to external resources, or recipes. We also measured the word counts for each plan and compared them based on the type (exercise, diet, or finances) and source of the plan (friends, crowdworkers). Special characters were removed during the text processing, but no other words were omitted from the text.

3.3 RESULTS

I describe the plans and activity diaries produced by the clients and the planners. The results include the evaluation of clients, planners, and domain experts. I will discuss what clients identified as the most important aspects of behavior plans and how friends and crowd members contributed to creating the useful plans.

3.3.1 Overview of Plans

I describe the plans and activity diaries produced by the clients and the planners, and how the plans were evaluated by the clients and the domain experts through surveys. I will discuss what clients

found as the most important aspects of the behavior plans and how the friends and crowd members contributed to this.

Planners generated plans that ranged in levels of detail (Figure 3). Some were had minimal modification from the original activity logs: two to three meals and one or two snacks a day for diet plans, and a few or no entries a day for exercise and financial plans. Some plans were more elaborate and included additional information that was not requested in the instructions to participants. For example, diet plans included links to, or details of recipes, portion sizes and calories per meal; exercise plans included full descriptions of how to perform physical activity exercises; finance plans included links to money-saving applications or budget websites. Some planners also included information about why a recommendation would be beneficial: "sp*ending a little more at the grocery store will save you money later by not going out to eat*" (P16). Some plans included introductory paragraphs that explained what the goal of the plan is: "*Before starting any work-out it is very important to warm up first. The effectiveness of your warm up will prevent the likelihood of injury*" (P9). 46 of the 66 plans included specific details on how to execute a routine, prepare a food or general strategies that went beyond the exact step that was prescribed. 27 of the plans included justifications for why to follow a particular recommendation. Justifications were more common in stranger plans (4 were in friend plans, and 23 in stranger plans).

To examine how plan length varied between plan sources and across topics, a mixed effects regression model was used, where participants who received multiple plans was treated as a random effects variable. I and the research team found that crowd member plans (M=544 words) were in general longer than friend plans (M=313 words; $t(43)=1.98$, $p=0.05$). I attribute the longer length of crowd member plans to them adding more justifications and explanations on why to follow a particular recommendation. This was uncommon in the friend plans.

In addition, the analysis shows that plan length varied by domain. Food plans were almost twice as long as exercise or finance plans (Table 2). Compared to exercise as the baseline, food plans were significantly longer ($t(19)=2.40$, $p=0.03$), while finance plans were not significantly different from the exercise plans. Additional analyses show that activity logs which seeded the plans had the same

Domain	Plan Length mean (std dev)	Activity Log Length mean (std dev)
Exercise	293.1(493.0)	122.1 (46.2)
Diet	622.1 (464.4)	432.3 (291.8)
Finances	300.1 (212.1)	206.1 (130.2)

Table 2. Plan length in words varies across domains, food plans being longest and financial ones shortest

property, which can explain the difference in plan length across domains. Food plans included several items for each meal of the day, along with occasional notes for each item. In contrast, the other domains had at most one or two recommendations per day and did not require the same level of granularity needed to describe each meal.

3.3.2 Quality of Plans

To understand the potential of friend and crowd members in creating behavior plans, we evaluated plans based on the perspectives of clients, planners, and domain experts.

3.3.2.1 Client Evaluation of Plans

Clients found plans to be helpful and felt they were likely to follow the plans. Clients rated 74% of the plans as likely or very likely to make an improvement to their current behavior. Clients rated 50% of the plans as either good or very good fit with their life. Clients stated they were likely or very likely to follow 56% of the plans. Fewer plans were rated negatively, with only 13% perceived as not offering improvement, 24% as not being a good fit, and 30% as not likely to follow the plans.

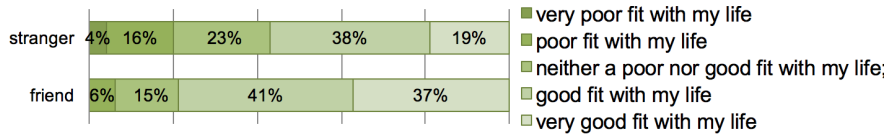


Figure 4. Client rating of how crowd member and friend plans fit with their lifestyle

To understand how the client perceptions differed across plan source, we conducted multiple ordinal mixed effects regression analysis, modeling the plan source (friend or crowd member) and topic as primary independent variables. We found that friend plans were rated higher than crowd member plans in terms of fit with lifestyle (1.95 times more likely to be rated at a higher level, p=0.03, Figure 4). As we will discuss later, this is most likely due to the additional information that friends had about the participants that crowd members did not. There were no significant differences across source in terms of perceived improvement and likelihood to follow. The domain of the plan (physical activity, eating healthy, saving money) was also not a significant factor in these models.

The rating of clients might have been influenced of their perception about the identity of who created the plan (a friend or a crowd member). When asked to make their assessments, the

source of the plan creator was not revealed to the client, to minimize the potential bias (e.g. more positive ratings towards friend' plans because the participant knew them). Some participants tried to guess which plan was generated by a friend or a crowd member, but they were not certain. In the pre-interview survey, when asked to identify the source of each plan, only 11 of 22 clients correctly guessed which one was from the friend.

3.3.2.2 Domain Expert Evaluation of Plans

The domain expert rated the plans based on how much the plans provided behavioral improvements to the client's current behavior. Domain experts rated 79% of the plans as likely of very likely to improve the client's behavior.

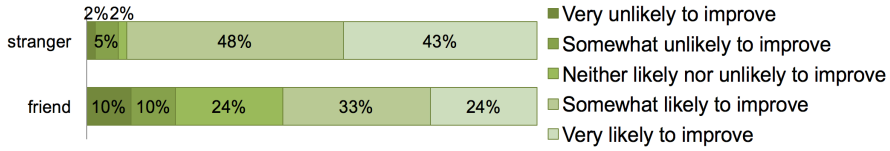


Figure 5. Expert Improvement Assessment of crowd member and friend plans

To understand if the quality of plans was influenced by the source or domain of the plans, we conducted an ordinal mixed effects regression analysis on the ratings by the domain experts. Domain experts rated crowd member plans as providing greater improvement than friend plans (2.04 times more likely to be rated at a higher level, p=0.01, Figure 5).

3.3.3 Information Needs in Creating Plans that Are Aligned with Client Needs

Through the analysis of survey and interview data, we gained an understanding about the benefits and challenges in creating behavior plans with the help of other people. I discuss the differences between the friend and crowd member created plans next.

Clients reported they were more likely to follow plans that fit with their lives. They found that the plans which reflected knowledge about their lifestyle were the ones that fit best. We identified four types of information that the clients found important to have in the plans. This information was important in helping create plans that were aligned with the client needs: preferences, routines, goals and constraints.

3.3.3.1 Identifying Activities that Fit with Client Preferences

Clients valued when plans were tailored to their preferences: food and exercises they enjoy, things they like to buy for themselves, at which stores to shop, when they usually shopped, and things that the client wanted to keep in their life or was reluctant to give up.

Several clients (P8, P9, P11, P13, P14, P20*)* recognized the value of a friend knowing them well, and that it reflected in the plans that friends created:

> *"I do like the treadmill elliptical [...] that's something my friend knows about me" (P13)*

> *"I know that [my friend] did Plan C because he knows my attention span. [...] Because exercising is really boring for me." (P8)*

The physical activity expert also emphasized the importance of creating plans aligned with client preference. They were critical of the plans that were not responsive to the client's preferences: *"If followed the plan would increase physical activity, but it may be difficult to follow since it doesn't take into account the user's preferences."*

The finance expert was positive about plans that offered strategies responsive to a client's needs and resources, rather than substituting activities or generic advice: *"I like the idea of shopping ahead of time and making meals for the week. However, this felt like a cut and paste plan instead of an honest approach to the person's particular spending needs"*. The finance expert was also critical of plans that suggested substitute activities that did not meet a participant's reason for spending, e.g., *"The suggestion to stay at home and read books doesn't address this person's needs."*

Clients noticed when something did not fit with their preferences when planners suggested cutting out items or activities that the clients found important to them:

> *"this does not seem very foodie. I like my food yummy" (P10 about crowd member plan)*

> *"The Birch Box [a monthly subscription to grooming supplies] […] I don't know if I want to cancel it […] I know that it does add up, but I really like it. It's given me a lot of happiness. It's one of my vices" (P16 about crowd member plan)*

3.3.3.2 Identifying Activities that Fit with Client Goals

Clients found that many plans would not help them make progress towards their goals, e.g., the plan did not include enough food (P11, P14), or too little exercise (P5, P8, P9, P13). This reflected in finding some to not be ambitious enough:

> *"I somewhat expected to be given more than I actually do. I expected more, but this is not as much as I expected." (P13 about friend and crowd member plans)*

Some clients thought that a friend knew their goals better than crowd members did, creating more tailored plans, e.g., P2 found the friend plan, tailored to muscle building more of a fit with their goal:

> *"So I'd see a lot of walking, gym, elliptical, stuff like that whereas … my friend knows me a little better. He knew that that wasn't probably what I really wanted to do and he made something completely different" (P2 about friend plan)*

Planners valued clear descriptions of client goals and mentioned it as part of the most relevant information in creating the plans for 12 of the clients.

3.3.3.3 Identifying Activities that Fit with Client Constraints

Clients had various constraints, such as dietary of physical activity limitations. Three participants had medical conditions they did share with the planner but that were relevant to creating a diet or exercise plan (P1, P5, P15). One client highlighted how their friend knew their restrictions better:

> *"She knows that I love to play basketball but that I had surgery on my ankle and I have a steel plate in there. That definitely limits me" (P5 about friend)*

Similarly, plans including suggestions that required resources or opportunities to which clients do not have access, were frustrating, as clients could not follow them:

> *"I don't have access to a bicycle or a swimming pool right now and I don't have a yard or a mom [to visit], there's just not enough here that applies to my life" (P5 about crowd member plan)*

Other mismatches with client constraints involved whether the client cooked (P11), or making recommendations that do not apply to the client, such as a breakfast menu (P6, P10, P15) for participants who do not eat, or want to eat, breakfast.

3.3.3.4 Identifying Opportunities to Enact Activities that Fit with Client Routines

Clients found it important for the plans to accommodate their routines. Clients valued when the plans fit with their schedules, when they exercised, ate or shopped. Sometimes that was better reflected in plans created by friends:

> *"knowing my schedule, knowing how I work … knowing how unproductive I get … I think it just comes from knowing somebody for so long so well" (P8 about friend plan)*

Clients identified several ways in which plans did not fit with their routines, such as: schedules for eating and exercising (P2, P13, P15), or how often they visit the stores where they spend money (P3). Each such conflict elicited negative reactions from the clients.

3.3.4 Impact of Planner Knowledge on Plan Creation: A Client's Diary vs Years of Familiarity

Friends knew more about the clients than crowd members did. Many clients intentionally chose friends who knew them very well (P7, P8, P9, P11, P14, P15, P20):

> *"we know each other pretty well and we grew up together so we know how easy it is to gain weight, or if it's harder to lose weight, so we can relate to each other. It's kind of more personal information, where she already has all the background. So I don't have to explain" (P14 about friend plan)*

Of the 17 friend-planners who responded to the survey, 11 had known the client for more than five years and were very close to the client (closer friends, family members, significant others). When plans included information that was tailored to them, clients noticed it quickly and would often realize the plan came from their friends - *"[doing] something crazy [like a group activity of capture the flag] sounded like something my friend would say"* (P12). Friend advice did not always match the routine of client, but only rarely were the recommendations a poor fit with their routines.

Although friends knew more about the clients, they did not always have detailed information about their friend's activities Consequently, they still benefitted from having the activity log while generating plans:

> *"I noticed there was a powerless feeling … so she'd have some herbal tea … some kind of pick-me-up in the afternoon … so that was something that stood out to me … So, when I made my plan, I tried to maintain that for her so that*

she could still have a cup of tea or something later in the day" (friend planner about P1)

In contrast, crowd members had to rely on only the information from the client diary to infer people's preferences and constraints. Crowd members did not have insights about the client beyond their diary. Crowd members mentioned they tried to tailor plans to the client needs based on what they interred the client liked based on their activity diary:

"Looking at his taste in food … I know he likes breakfast … He seems to have a lot of time in the morning, so I went off that and gave him a healthy breakfast … I can tell he likes meat from his diet" (crowd member planner about P22)

The valued the tailoring, and on some occasions, the crowd members were perceived as having in dept knowledge about the client (P3, P10, P15):

"even the people who weren't my friends [...] would fill out the plan more tailored to what I had put [in the diary]" (P2 about crowd member planners)

"I feel like this person knew me. They knew I liked to shop they knew I like to go buy Scratch tickets. I feel like they knew everything that was important" (P3 about crowd member planner)

3.3.4.1 Asking for Help from Similar Friends

Clients used knowledge about their friends' habits, routines, and expertise in choosing which friend to get help from on generating the plan (P1, P4, P13, P15, P16, P17). Some clients selected the particular friend they asked because the friend was good at the behavior the participant wanted to change (P2, P5, P9, P13, P16): *"she's on a health kick and exercising and eating right" (P9 about friend)*. Clients also mentioned picking friends who are similar to themselves and who have similar habits (P1, P2, P14) – and because they used their knowledge about friends to tailor the plans:

"she and I both want to be a little bit better and so because we have... we know each other, we have similar personalities, we have similar goals when it comes to diet, in terms of eating and exercise" (P1 about friend)

Both friend and stranger planners recommended changes that they had tried or were trying themselves: food they liked, ways in which they saved money. Clients were better able to see this in plans produced by their friends – because they often knew about their friends' efforts and successes but had no way of knowing about similar efforts by crowd member planners.

3.3.5 Balancing Novelty with Tailoring

Clients had mixed reactions to the diversity of ideas in the plans. They wanted plans that contained novel suggestions, but as discussed above, they also wanted plans that fit with their existing routines, goals, constraints and preferences. These desires were often at odds. Clients liked the simplicity of plans, but that came in tensions with plans becoming boring.

3.3.5.1 Trying New Activities: Exciting vs Disengaging

Clients found that the crowd-generated plans were more likely to contain novel ideas. Almost every crowd-generated plan contained one or more suggestions the participant had not previously considered adding to their behavior. Clients perceived this both negatively and positively. When ideas in the plan resonated with them, they were enthusiastic to try new ways of changing behavior. This included trying new foods (P15), new exercises (P2, P5), and new strategies for improving behavior, such ideas for how to eat less of something unhealthy (P11), how to balance foods better (P1), and how to budget better (P16):

> *"I would usually [use] those things if I had them, but I probably wouldn't think to get them at the grocery store" (P14 about stranger plan)*

> *"They mentioned sprouted grain bread, which I didn't really know about. ... I had never heard of it before, so I looked it up and it seems good. That was a food that I learned about" (P15 about stranger plan)*

For these new ideas, participants wanted references to more details: links to how to cook a recipe or apps for budgeting (P3, P4, P16).

On the other hand, many of the novel ideas were not well received because they were inconsistent with participant preferences, constraints, and routines. In these instances, participants were not enthusiastic to try them.

3.3.5.2 Too Much Similarity: Convenience vs Boredom

Plans that were close to the current participant of the client were perceived as easier and less risky to follow. The small changes were perceived as easier to implement. This was a characteristic of both friend plans (P11, P13, P20) and crowd member plans (P1, P3, P4, P8, P9). Participants liked when plans were similar to what they were already doing (P1, P3, P4, P9, P11, P20). They also valued a level of repetition, such as cooking the same meal or shopping for groceries fewer times

a week (P1, P11, P15), could easily fit into their schedule (P5, P9). P10 valued a plan that used resources she already had on hand, and P15 expresses the preference to be repetitive:

> *"many of these things I already have in my cabinet and fridge so that was nic*e. I didn't have to go out and buy anything, and a lot of the stuff I like to eat." (P10 about friend and stranger plans)

> *"I like that it's really repetitive because I like the idea of eating different things but in reality I tend to be the kind of person where I'll just eat the same thing every day for weeks." (P15)*

On the other hand, plans similar to one's current activity were also seen as not being beneficial: participants noted they seemed boring (P10, P12). They also found that plans were not providing as much change as they had hoped (P5, P8, P9, P13, P14). Some participants (P10, P12, P13, P14, P20) had hoped that the plans would contain more new ideas that deviated from their routines. Participants were also skeptical that plans similar to their current behavior would offer them much improvement:

> *"It just looks like something I would write because I think my plan was similar to this. [...] It's a little boring. There's no variety. You're doing the same exercise." (P12 about friend plan)*

> *"it's very similar to what I was eating before … I don't think it will change my eating habit … it's going to be much harder to think that I'm changing my eating habits and so I will want to go back to what I'm used to eating" (P20 about stranger plan)*

3.3.6 Longitudinal Planning Support

Clients showed interest in following different parts of the plans in the company of others who could keep them accountable and provide support. When discussing plans from their friends, participants looked forward to having the friend participate in the plan's activities. Clients perceived plans generated by friends to have additional social benefits. Some clients commented that the behavior they sought to improve was something they have done in the past with the selected friend, such as exercising (P2), eating or dieting together (P1, P10, P13, P15, P16). They also anticipated that asking friends to craft the plan might encourage them to further support each other, e.g., *"we could look for foods together and support each other"* (P15). Some saw potential for doing planned activities together: *"we could ride bicycles together and then walk together"* (P5), or *"we need to eat better together"* (P11).

Friends thought they could benefit from exchanging plans, because even the friends felt like they could learn from the clients: *"Another thing that was good for me was that it was mutually beneficial in the sense that I think I could get ideas from her"* (friend about P1). Some participants noted that the planning process created a possible accountability mechanism with the selected friend (P4, P15): *"It would be nice for us to be accountable to each other"* (P4).

3.3.7 Social Cost of Help from Other People

3.3.7.1 Managing Relationships

Clients were sensitive about whom they wanted to ask for help. All clients contacted people they knew well. They did not want to impose on other people by making a request that seemed somewhat demanding. Some clients had a hard time contacting people to request their time for creating the plan (P1, P6, P15, P16):

> *"I didn't want to place too much burden on my other close friend so I thought of my sisters first and then I thought of my husband" (P1 about friend)*

Consequently, clients chose planners primarily based on how close they were to them and how willing they would be to help, while concerns like expertise or experience with the target behavior were secondary.

Clients were also concerned about what the request would signal to their friends, or that it would violate norms of what they talk about. P6 was worried his friends would think something was wrong with him, P13 thought other people would think it was inappropriate to talk about healthy eating where she lived. P10 said that her friends do not discuss healthy eating because it is associated with weight loss.

One client was concerned that asking a friend to create a plan could lead to potential conflicts, such as more accountability than they wanted or hurt feelings about not following her friend's advice:

> *"my boyfriend can give me a plan, but he's with me when I'm doing all this stuff. [...] this person told me to do X, Y, Z, that doesn't mean that I can be like oh I'm not listening to your suggestions." (P3 about friend plan)*

3.3.7.2 Negative or Inappropriate Feedback

Clients had difficulties receiving negative feedback from friends. When friends offered participants feedback perceived as offensive, clients felt it would affect their relationship (P7, P16):

> *"I'm kind of wondering about how it's going to be to see her the next time I see her. If we're going to talk about it and I don't particularly want to and just kind of wishing that she was more practical and understood my needs a little bit more." (P7, about friend plan)*

The financial expert also felt that the diary that clients kept served as a form of critique from the planners, instead of offering strategies and meeting participant needs, he pointed this in both stranger and friend plans "*It's an assessment of the spending from the previous week. These are judgments, not recommendations for better spending.*"

Friend-planners described not wanting to make strong statements about their friend's behavior, as this was not the sort of advice typically offered in the context of their friendship:

> *"It would be kind of mean because maybe it's something that he knows he spends too much on. I don't know, I think it would be a little insulting if I just saw overall the things he spends too much on and told him about it" (friend about P18)*

Clients found that some suggestions that crowd members made, such as avoiding a hypothetical DUI [driving under the influence of alcohol] citation by drinking at home rather than the bar, were judgmental or inappropriate:

> *"to get a DUI [driving under the influence of alcohol] on your travel home […] that's kind of a little condescending." (P16)*

Crowd members mentioned feeling comfortable providing criticism, as they did not have an ongoing social relationship to protect with the participant. This helped them suggest greater changes from the client's behavior:

> *"I didn't find that it was too difficult [to cut items from the plan]. That was easy just because I had seen some frivolous things that they were buying" (stranger planner about P3).*

3.3.7.3 Sharing Personal Data

Clients had limits in how much, and what, they wanted to share with others. Clients were more comfortable sharing with crowd members and more concerned about judgment from friends.

Some clients did not describe privacy concerns about sharing their activity diary with their selected friends and some participants said they would not mind sharing everything in their diary with others (P1, P6, P16, P17). Clients noted that they chose a certain friend because they already knew about their behavior or because privacy would not be a concern with them, even if it would be with others.

Other clients preferred to not share information from their activity diaries with others because they felt the topic was inappropriate to discuss or share information about (P1, P13, P16, P17). For example, P17 had health constraints that she did not want to share with others, and so she was reluctant to contact people other than her partner and parents. P1 was concerned about how others would perceive her eating habits:

> *"I would feel embarrassed for them to know how infrequently I actually am sitting down to a meal" (P1).*

All interviewed friends felt they were familiar with the overall aspects of the participant's activity diary, but that they were not necessarily familiar with the details in it: *"I wouldn't have been able […] to recreate all the details but it's, let's say, it wasn't surprising"* (P14).

Participants were not reluctant to share information with crowdworkers and several felt more comfortable sharing with crowdworkers than friends as they would not feel judged by these strangers:

> *"They don't know me. They can't really judge me, and even if they do, it's not like I will really know about it. I don't know, it's just easier" (P3).*

Although participants were comfortable sharing their activity plans with crowd members, some participants said they had limits, such as sharing their income or where they live (P4, P16).

3.3.8 Domain Specific Expertise for Behavior Plans

The domain experts pointed out a variety of ways in which the plans did not follow best practices, which made plans unhelpful or posed risks to the clients.

The physical activity expert pointed out that some plans suggested potentially risky increases in physical activity, or increases that were too insignificant to the client's goal and current activity level.

In some cases, planners and clients favored strategies of which domain experts disapproved. For example, some planners included "cheat days". Clients particularly appreciated "cheat days" – opportunities on which the participant could eat what they wanted – but the dietician did not agree with this practice. Sometimes, planners also tried to accommodate participant preferences that domain experts thought were not helpful. For example, food plans might include favorite desserts (P10). One plan allowed a participant to skip breakfast, which the planner stated they did to fit with the habits of the client: *"There is no scientific proof that breakfast eaters are healthier than non breakfast eaters. Thus I don't see a reason to change your habit of skipping breakfast"* (crowd planner for P15). However, the domain expert evaluator of the plans, a dietician, disagreed with this opinion: *"Plan does not incorporate breakfast, which is a missed opportunity for improvement"* (dietitian evaluating crowd plan for P15). The financial expert favored strategies that helped save money, like do it yourself projects, setting a cap on money to spend when shopping, or long-term plans for saving money.

Not knowing about the crowd member expertise or experiences made participants reluctant to trust the crowd members (P1, P17): "*the fact that they're not nutritionists I guess would make me trust them less*" (P17).

3.4 DISCUSSION

In the current work I demonstrate that people, like friends and crowd workers can create behavior plans for others that are tailored, actionable and help people make progress towards their goal. To do so, I identify criteria how criteria for tailoring behavior plans, such as preferences, constraints, goals and routines, are important for creating effective plans. When plans do not satisfy alignment with these criteria, people have negative attitudes to the plan, or might not be able to execute the plan, which can lead to not making progress towards a desired goal. In this research I also identify benefits in using others' help, and tradeoffs in using different type of planners – friends and crowd members – and different ways in which different types of planners can contribute to planning through tailoring recommendations, accountability, and novel ideas. Our results can inform the

design of systems that support behavior planning, including exercise, dieting, and budgeting tools. Several aspects of behavior change plans are important to participants. Friends and crowd workers recruited from crowds differ in which aspects they best support. I discuss how the design of systems that enlist the help of others to create behavior change plans should consider tailoring to people's needs, different strengths of friends and crowd members, facilitating longitudinal interactions, and how to combine support from friends and crowd members.

3.4.1 Implications for Planning Support

This research shows that there are several types of criteria that a plan needs to be aligned with to fit with people's needs. We find that clients found it important to receive plans that are aligned with their preferences and goals, constraints, and routines. When plans did not satisfy these criteria, clients did not feel like they could implement their plan, or to make progress towards their goal. This shows what type of information should inform the creation of plans to promote plan enactment by clients.

3.4.1.1 Aligning Plans with Preferred to Promote Plan Enactment

Clients felt like they cannot pursue plans that did not fit with their preferences, constraints, and routines, making them not as *feasible* for them.

Preferred Activities: When a plan included suggestion that did not fit with the preferences of the client, they were less likely to be interested in the plan. Such plans would interfere or prevent the client from doing things that were important to them, such as doing specific types of activities (e.g. eating favorite foods, buying favorite items), interfering with how they liked to live aspects of their life (e.g. being a foodie).

Preferred Approach to Progress towards Goal: Some plans included recommendations that were not aligned with the client's goals. This indicates that clients find it important that plans are aligned with their preferences with regard to how to progress towards a goal (e.g. how much food to eat, how much exercise to do). When the recommendations did not feel like they are aligned with the goal or did not push the client enough towards their goals, clients received that with dissatisfaction. Prior research has identified that it is important for plans to be aligned with the goals of the individual, by being instrumental [40,48]. This research shows that individuals have

preferences towards how such instrumentality of plans should be expressed in plan design so that they are interested in pursuing the plan.

Preferred Approach between Novelty and Boredom: Clients encountered tensions in how they balanced different criteria of plan feasibility. Some plans were too similar to what the person was doing already, which made them perceive plans as boring. However, when plans included more diverse ideas, they were perceived as more engaging, but sometimes they were not feasible. The criteria of novelty in the plan should be carefully considered in planning support, so that behavior plans are engaging through new ideas, but also feasible by keeping novel ideas tailored.

3.4.1.2 Aligning Plans with Constraints to Promote Plan Enactment

Plans were perceived as not feasible when they did not fit with the client constraints, such as physical injuries (e.g. sprained ankle) or access to necessary equipment (e.g. pool). Poor integration with people's routines also made plans feel not feasible because it interfered with when and how often people performed the targeted activities (exercise, eat, shop). Plans needed to account for things that people were or were not willing to give up, physical abilities, or access to resources.

Clients found that sometimes plans were not specific enough for their needs. This was salient when plans included recommendations for new activities (e.g. types of food that the client is not familiar with). This indicates that when novel recommendations are made to a client, they should include more details, such as recipes for how to cook a food.

3.4.1.3 Alignment with Best Practices to Promote Creating Plans Aligned with Domain Specific Best Practices

While plans were rated as helping the clients make progress towards their goal, not all the recommendations were helpful. The domain expert evaluation indicates that friends and crowd workers held misperceptions about what might be an appropriate behavior. For example, some planners made recommendations that involved unhealthy foods. This was not specific to any of the groups, and it indicates that domain non-experts need support in making sure their suggestions are aligned with best practices.

3.4.1.4 Implications for Creating Plans

Based on the assessment of the plans by clients and domain experts, we find that alignment with people's needs is important for creating plans that are people are interested in engaging with. This shows the importance of tailoring in creating behavior plans with respect to preferences, and constraints. The criteria for preferences that emerge from this study are to account for activities that people like to perform, to account for the approach they want to take towards reaching their goal and to consider novelty of ideas as a potential way to engage interest of people in engaging with plans. To address barriers that might come in the way of enacting plans, plan designers should consider people's access to resources, abilities and other physical constraints.

3.4.2 Implications for Social Computing

3.4.2.1 Supporting People in Creating Behavior Plans for Others

This research identifies criteria for tailoring behavior plans that are important for creating effective plans, through aligning plans with the preferences, constraints, routines and goals of the client. Knowledge about the participant allowed planners to create plans that varied in how well they were aligned with these different criteria for tailoring. This indicates a need to evaluate plans against domain specific criteria.

Perhaps not surprising, friends had overall more knowledge about the participant, which made their plans better tailored, more appealing and more likely to be followed to the clients. These findings are similar to findings in prior work in friendsourcing [93] and social support [121]. While friends knew more information about their friends, this was not enough. Even friends needed to know more detailed information about their friend routine to give good advice, which shows that even friends need informational support to tailor recommendations to their friend's needs. While crowd members did not know anything about their friends providing them with a client diary helped them tailor recommendations to the client's needs.

To better support other people in advising others, systems should provide information about the client relevant for behavioral support. A client profile could include information about their preferences, constraints, routines and goals to support better tailoring of advice. To help others provide advice that is tailored to the client's current physical activity level, systems can collect information about the client's activity, similar to an activity diary. This information can

help planners have a baseline understanding of the client's current level of activity. By providing the relevant information to planners, it can equalize the amount of tailoring that a crowd member can do, even if they do not know the client otherwise.

Our research shows that there are differences in what data clients were willing to share. Consistent with prior work, people were reluctant to share certain types of information with their friends. Prior work identified that people are reluctant to ask questions on sensitive topics such as health, or finance [92], or to share photos of themselves trying out clothes [93]. In this study we find that the type of information some people feel uncomfortable sharing with friends includes sharing routines such as eating the same thing regularly. Although this might be common for a lot of people, this indicates that people's everyday routines can be sensitive information. In sharing information with a planner, systems should allow clients to filter what information they would want to share with a friend or a crowd member. While this has positive implications for not disclosing sensitive information, it comes in conflict with providing the necessary information for creating a good plan.

The findings in this study can also apply more broadly to the design of general online Q&A and peer support communities. Including contextual information about the person who is asking for help could provide the helpers in an online community. By having information that would help them better understand the questions being asked, helpers can better understand the question askers and provide more personalized feedback. These communities may make these types of information required when submitting a question or allow users to share these types of personal information through rich profiles.

3.4.2.2 Facilitating Longitudinal Interactions

Clients felt supported when receiving plans from friends, and they felt their friends could continue to offer social support as they worked to follow the plans. They also though friends could serve as accountability partners or sources, including through participating in activities together. This shows the value in having planners continuously engage with participants over time, aside from just the planning stage.

Longitudinal support is an important area of design for behavior change plan creation systems. How might we enable longitudinal interactions, especially for planners who are strangers, to build on these potential benefits? Crowdsourcing systems have previously attempted developing

relationships between a user and several crowd workers posing as one conversational assistant [71], however for only a short period of time. Through such longitudinal interactions, crowd members could learn about requester's context over time, making them more effective planners. Systems can also consider pairing up crowd members and clients in similar geographic areas, which could lead to opportunities to do things together, similarly to how running groups of meetups leverage on location.

Longitudinal support can extend to general crowdsourcing systems. Previous work in crowdsourcing for fashion advice for blind [22] people has shown that such sensitive tasks can be suited for strangers and discusses strategies to pair up with trusted others. But aside from just task-based needs, these systems may also enable interactions that can satisfy social support needs.

3.4.2.3 Combining Planning Support from Friends and Crowd Workers

Many of current crowdsourcing systems rely on members who do not know each other, and do not differentiate between the different people using a system and their skills [14,16,140]. Our findings point out the potential for using a hybrid group of people to serve different roles to generate behavior change plans.

In general, our findings support prior research that has found that asking other people for help incurs a variety of costs, such as inconvenience to others and concerned about being perceived as less competent [115], or social capital costs [93,115]. But our research further highlights some critical differences between friends and crowd members in terms of tailoring, the types of information people are comfortable sharing, the different strengths in diversity of ideas provided by friends and crowd members.

For example, clients reported being concerned about sharing personal information with friends, or worried about offending friends if they do not end up following their advice. On the other hand, crowd members provided more novel ideas that clients were interested in following. This suggest that assigning different roles in the planning process could mediate some concerns: clients could share more data with crowd members who could be involved in the ideation stage of planning.

On the other, we found a clear benefit of having friend-planners who have contextual knowledge of participants. These friends may be best used to give critical insights of the participants and overlook the plans being generated by crowds. In prior crowdsourcing systems,

workflows were used to ensure quality while dividing the task needed solving, such as the Find-Fix-Verify process for copy-editing [14]. An implication of this could be to rely on crowd members for finding appropriate ideas, vote for best ideas and fix anything that might not be a good fit in the plan. Such a workflow could reserve friend help to verify the tasks and add the final personalized touch. This type of hybrid workflows can aim at minimizing the costs, such as reducing the costs involved with asking friends for help, while maximizing the benefits, such as receiving diverse yet tailored recommendations.

3.5 SUMMARY OF CONTRIBUTION

In this chapter, I answer the research question: How can people support others in the behavior planning process? This research provides empirical evidence of how friends and crowd member can provide planning support and how they differ in the help they provide. This research shows criteria for tailoring plans to people's needs, specifically through tailoring to preferences, constraints, routines and goals. For people to help others with behavior planning, they need informational support on these four criteria to be able to tailor their recommendations accordingly. By understanding the needs of friends and crowd members in providing behavior support, I identify that these two group differ in how well they can tailor their support. While friends can tailor informational support more, and provide longitudinal accountability, crowd members provide more novel and engaging recommendations, and people are more comfortable sharing information with them.

Chapter 4.

DESIGN OF CROWDFIT, A TOOL FOR TAILORED, EVIDENCE-BASED PLANNING

Six in ten adult Americans experience one or more chronic disease cause by lack of physical activity, poor nutrition, tobacco use and excessive alcohol use [159]. The U.S. Department of Health and Human Services has created a set of national physical activity recommendations to maintain good health and prevent chronic disease [147]. Despite that recommendations exist, only 26% of Americans follow the aerobic and muscle strengthening national guidelines [147], and less than 23% of the world population meets recommended guidelines [145]. To meet the recommended levels of physical activity, people must change their daily practices to incorporate more exercise.

A critical barrier to changing behavior is getting started and fitting the behavior into their life [48] - what can a person do now? How can they adjust their lifestyle to accommodate for exercise in their life? For physical activity, people can turn to exercise experts, such as personal trainers, to create plans for them which meet national guidelines. Personal trainers are educated to tailor these guidelines to abilities and goals of the person [23]. However, personal trainers can be prohibitively costly. On average, in the U.S. one hour with a personal trainer can cost $50 an hour [143].

Because experts are expensive, some people turn to cheap or free mobile apps which provide exercise plans that people can follow weekly, like the 7-minute workout, or couch to 5K. Though these apps can help people make progress on exercise, the apps still offer limited ability to tailor the plans. Some apps allow customization of exercise plans based on goals, age, weight, and gender, but struggle to account for people's schedules, or personal preferences for exercise. Furthermore, the plans included in exercise apps fall short of national physical activity recommendations [49,66,88].

Previous HCI research shows that, with adequate support, crowd workers can help complete tasks normally performed by experts, such as providing mental health support with expert strategies [94] or providing surgery feedback [44]. Based on the results in Chapter 3,

describing the strengths of domain non-experts in creating behavior plans, in this research I investigate how to design tools that support domain non-experts in creating exercise plans.

To conduct the work in Chapter 4 and Chapter 5, I speculated that crowd workers can create quality exercise plans if they are provided with means to help them follow expert guidelines. I created a system, CrowdFit, that helps the crowd members (i.e., *crowd planner*) make plans *compatible* with the recipient (i.e., *client*) by providing an exercise profile of the client. CrowdFit guides the planner towards making recommendations that satisfy national guidelines, with respect to *how much* and *what types* of physical activity is recommended. CrowdFit does so through providing quantitative feedback during plan creation on calories progress and strength-cardio balance, and by providing a database of activities with exercise properties. In this Chapter I present the design of CrowdFit and how I translated planning and physical activity guidelines into design.

This chapter addresses the research questions by showing how the CrowdFit system is designed (with the evaluation of the system continuing in Chapter 5): *RQ2: How can we design technology to support non-familiar people in tailored behavior planning? RQ3: How can design technology to support domain non-experts in, evidence-based behavior planning?* Part of the findings and discussion in this chapter were published at CHI 2018 [1].

4.1 Related Work

Many people want to improve exercise activity, but fail to achieve this goal because they do not know what to do, do not have the skills to exercise, are concerned about injury or cannot make the time to exercise [141]. Further, while many behavior change plans exist in books or online, these are rarely tailored to people's preferences and constraints, making the plans less effective [111]. To receive tailored advice, people turn to personal trainers. Face-to-face coaching helps reduce exercise barriers and better facilitates exercise than individual efforts [91]. When personal trainers create exercise plans they use *tailoring* to help people pursue the plans [86,91] and *exercise science guidelines* to help provide the best health benefits [42].

4.1.1 Physical Activity Guidelines

The U.S. Department of Health and Human Services and the American College of Sports Medicine (ACSM) have identified a set of guidelines for effective exercising based on evidence

from physical activity studies to date [42,147]. Both organizations are consistent in their recommendations, but ACSM targets exercise experts and thus contains more guidelines for creating effective exercise recommendations. We selected five exercise guidelines that incorporate the main recommendations in the current National Exercise Guidelines [144,147] and ACSM recommendations [42]. Several other ACSM guidelines exist. Here I focus on the primary principles articulated by both institutions. In this work, I and the research team define the guidelines as follows:

Amount (*how much* activity to perform): People should perform 75 minutes of vigorous or 150 of moderate physical activity weekly [144], or a range of calories [42] (e.g., a person of 170lb and 5.6ft should burn at least 1270 calories).

Progression (*how much* to increase activity): Based on the client's level of activity, the plan should start with a few days of activity a week and increase gradually. To be realistic, recommendations should consider the person's level of activity, and ability, and increase exercise duration, frequency and intensity gradually [42].

Balance (*what types* of activity to perform): The plan should have a similar amount of strength and aerobic activity. Healthy adults should perform both types of exercise [42], because of the different physiological benefits they provide.

Pattern (*when* to perform activity): The plan should include rest days. If consecutive days contain physical activity, they should include different types of activities to allow muscle recovery time and prevent injury [42].

Compatibility (*what activities* to perform**)**: the plan should match the client's lifestyle, schedule, preferences, constraints, goals, and experiences, to increase likelihood it is followed.
We focus on how these guidelines can be represented in an exercise planning tool to help people create quality plans.

In this chapter I focus on how these guidelines can be represented in an exercise planning tool to help people create quality plans.

4.1.2 Technologies for Supporting Crowd Members in Planning

Technology interventions have explored techniques for developing behavior plans and found benefits like increased following of user personalized step plans over system personalized ones [75], or effectiveness of tutorials to create sleep plans [74]. Crowd workers can contribute to

planning [2,68,140]. For example, crowds can create tailored behavior change plans for others [2]. In another study of various types of goals, people who received plans from the crowd were more likely to achieve plans than those who did not receive crowd plans [68]. In this research, we use inspiration from action planning to crowdsource exercise plans.

Crowdsourcing systems enable crowd worker to accomplish expert tasks by breaking down the complex tasks. Some systems decompose tasks to a level anyone can do: writing articles [64], local news reporting [3]. Other systems assign tasks either to crowds or to experts depending on system complexity, e.g. meeting scheduling [32]. Sometimes crowds exhibit strengths over experts. For example design feedback from the crowd can be perceived as more helpful than expert feedback [83]. Crowds can provide feedback on topics traditionally done by experts, e.g. providing feedback on surgery technique [44]. Crowds can also provide feedback that produces similar benefits as expert feedback, e.g. nutrition information [21,84]. This indicates crowds can provide feedback with similar or higher benefits than experts.

Crowd members can offer specific benefits for providing personal support: they can create tailored behavior plans when provided enough information about a person [2], create effective motivational exercise messages for exercise [134], effective smoking cessation messages [30], provide support to people with autism [54] . But none of this work has tried to improve the crowd capabilities so they provide higher quality support. Technologies that support mental health show that expert principles of cognitive behavioral therapy principles can guide the crowd members R. R. Morris and Picard 2014; R. R. Morris, Schueller, and Picard 2015) and peers [101,102] to provide useful mental health support to others. This work is just emerging and there is a need to better understand how to design tools that support domain non-experts in providing expert quality health support, and the extent to which that is possible.

In the CrowdFit system design, I seek inspiration in crowdsourcing to break down the task of exercise planning into tasks that are achievable by crowd members, and to guide them through the planning task.

4.2 System Design

In this research, I seek to demonstrate techniques to help non-experts create exercise plans for others which are as good or better than expert-generated plans. In service of that, I designed

CrowdFit, a system that scaffolds principles of exercise science to support non-experts in creating actionable exercise plans. First, CrowdFit solicits information from clients to build a client profile for planners. CrowdFit scaffolds weekly exercise planning: the planner does tasks of scheduling and exercise selection, while CrowdFit provides feedback on progress, and global constraints based on national guidelines and client needs. Clients receive the plans created and can adjust the time of the activities.

4.2.1 Information Clients Contribute to CrowdFit

To create actionable and personalized plans towards behavior change, we need to include client's needs and goals [2,86]. CrowdFit collected: short- and long-term goals, constraints and access, physical activity preferences (likes, dislikes, interests and reasons for their activity preferences), schedule, gender, age, weight and occupation. This information helps create plans that align with the client's goals and connect with the client's experience.

4.2.2 Scaffolding the Exercise Planning for Crowd Workers

Once CrowdFit received the client's information, the client is assigned a planner. CrowdFit scaffolds the plan creation process in smaller steps (Figure 6). First, CrowdFit provides an overview of the five dimensions of exercise science (amount, progression, balance, compatibility, and pattern). Then, CrowdFit walks the planner through a tutorial which maps the principles of actionable planning and exercise science onto CrowdFit's features (Figure 7). After the tutorial is completed, planners are presented with the client's profile and are given tools to create plans.

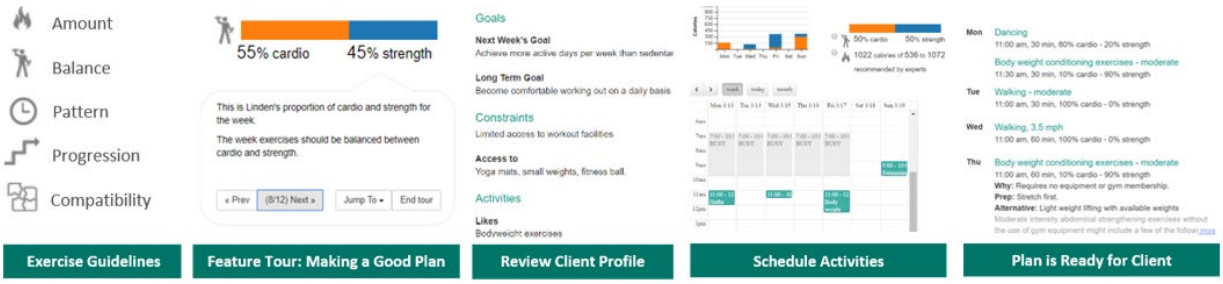


Figure 6. In CrowdFit, planners schedule exercise activities following expert guidelines. Planners are first given a tour of the interactive system and presented with the guidelines, then review the client's profile, and schedule activities which fit within the client's schedule and match their preferences.

4.2.3 Creating Plans through CrowdFit

Error! Reference source not found. shows how planners create the plans. The right panel shows the client's profile (e.g., preferences and goals). The left panel contains the principles of exercise science to match (top-left, Figure 8..B-D) and a calendar for scheduling activity (Figure 8.E). The calendar helps planners meet the *when* component of actionable planning by including times the client has other responsibilities or events to schedule exercise around. The planner schedules physical activities directly onto the calendar. When a time slot is selected on the calendar, a pop up allows the planner to choose *what* activity to recommend to the client.

4.2.3.1 Planning Principles

To facilitate planning, the system provides the planner with a list of 112 common exercise activities curated by an exercise expert. The physical activities are activities that are leisure time activities (e.g. walking, running, sports, fitness), rather than lifestyle integrated activities (e.g. active

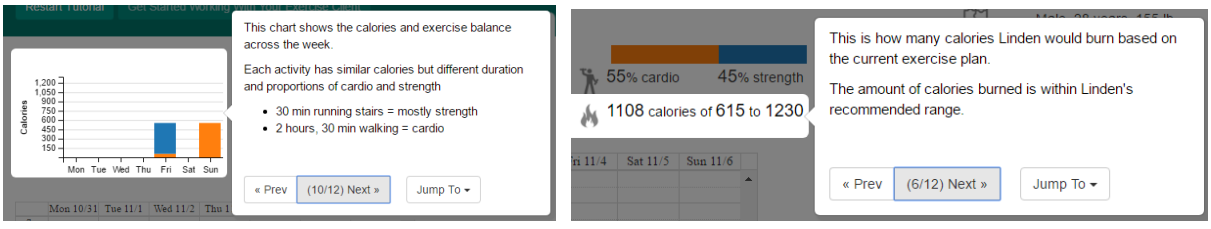


Figure 7. Example tutorial provided as part of the features overview of CrowdFit, shows description of pattern of activities across the week and amount of exercise

Plan features intended to support client	How Planner can Use CrowdFit
Know how to execute behavior	Database of physical activities, includes instructions on how to perform physical activity, links to videos
Know what preparation to conduct for performing behavior	Open ended response from planner on how to prepare for behavior
Know when to perform planned behavior	Includes time to perform behavior and duration
Client has access to resources and constraints are satisfied so they can execute behavior	Client's access to resources and other constraints
Behavior is planned at a time when the client is available	Calendar with client's schedule
The client is willing to try and enjoys doing behavior	Client preferences (what they like, what they are interested in doing, what they tried in the past and did not like)
Behavior aligns with client goals	Client's short- and long-term goals
What the client has been doing towards the goal	Client's last week's plan, and whether it was accomplished
Coping plan: The person has another plan that they can enact if the original planned behavior cannot occur.	Alternative to current activity
(exercise specific) The behavior is a gradual progression based on what the client was able to do in the past, so that they can follow the current plan	What the client planned last week, what they accomplished, and why
(exercise specific) Client gets cardiovascular health benefits	Feedback on amount of exercise recommended for the client
(exercise specific) Client strengthens their body	Feedback on balance of exercise recommended to client
(exercise specific) Client can exercise safely, to reduce risk of injury	Visual representation of how exercises are spread across the week

Table 3. Planning Features that are Represented in CrowdFit

commuting). Because past research showed that people prefer to create plans that include leisure time activities [40], in this study we only focus on such activities.

The list contains information relevant to the exercise guidelines emphasized by the system: number of calories burned per minute, distribution of strength and cardio, and a description of the activity. The description includes exercise routines or links to videos when appropriate (e.g. several circuit training routines). Once an activity is selected, the planner is given text fields to provide clients with a justification of *why* the activity is a good fit for them and suggestions of *what* they can do to ensure they perform the activity (Figure 10). The justifications aim to motivate clients to follow the plan by helping understand why this exercise was recommended to them. To

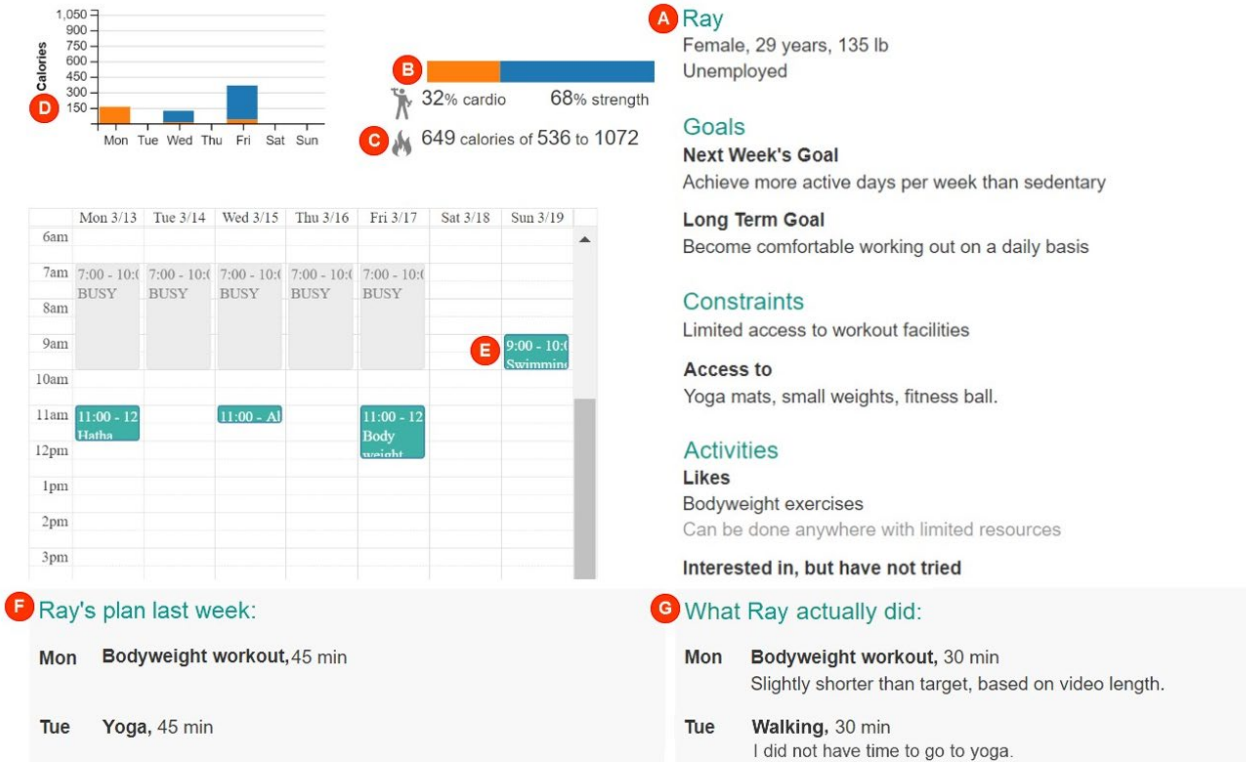


Figure 8. (A) profile of client, (B) distribution of cardio and strength over the week, (C) calories burnt if following the plan on the calendar, (D) distribution of calories and strength-cardio per day, (E) client calendar with scheduled physical activities in green, (F) overview of last week's plan and (G) plysical activity the client performed.

help clients overcome barriers to completing the plan, CrowdFit also has planners suggest exercise alternatives (Figure 9, Figure 10, Figure 11) [70,125].

4.2.3.2 Exercise Guidelines

As exercises are added to the calendar, the weekly calorie breakdown (Figure 8.C) and balance (Figure 8.B) update in real time. The calorie breakdown translates the **Amount** guideline of exercise science. The balance chart visualizes how the activities recommended are **Balanced** with respect to cardio and strength. The **Pattern** is integrated through the calendar view (Figure 8.E) and the spread of activities across the week (Figure 8.D). Providing the planner with a client's preferences encourages **Compatibility** (Figure 8.A). **Progression** is represented by providing information on what plan the client received last week (Figure 8.F), what the client did, and why (Figure 8.G). After the planner finishes scheduling physical activities, they get an overview of the plan and can provide holistic comments to the client.

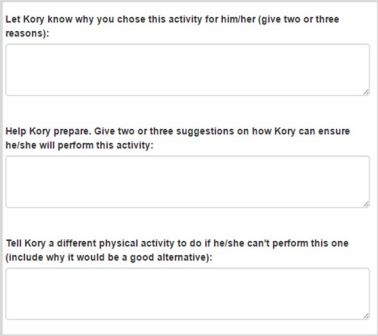


Figure 11. CrowdFit prompts the planner to say why they picked the activity, how the person should prepare for doing the activity, and alternative

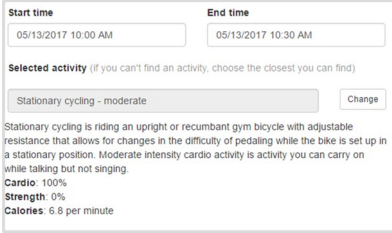


Figure 11. When a planner selects a physical activity, CrowdFit provides information about what the activity is and how to perform it

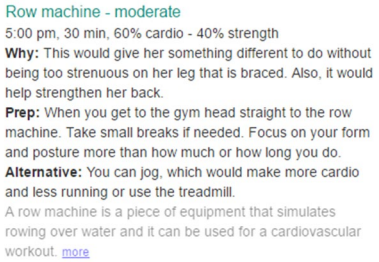


Figure 11 Example of activity in an

4.2.4 Clients receive plans created through CrowdFit

Once planners create a week-long plan through CrowdFit, the link to the plan is sent to the client. The client's view also centers around a calendar which includes their schedule for the week, and the planner created exercise plan. The clients' calendar is the same as planners' calendar view in Figure 8.

The calendar view helped integrate actionable planning principles. Aside from showing *when* and how *long* the activity should be performed, the plan also included a list of activities, each with (Figure 11): (1) a description of the activity, created by an exercise expert, (2) an explanation of why the activity is a good match for the person created by the planner, (3) a description of how to prepare for the activity also created by the planner.

4.3 CONCLUSION

In this research, I demonstrate techniques for supporting crowd workers in the creation of physical activity plans that balance client preferences and needs with nationally recommended physical activity guidelines. These techniques include feedback on satisfying the guidelines, a rich client profile including historical information about client's exercise, and a collection of physical activities with metadata relevant to guidelines.

Chapter 5. DEPLOYMENT AND EVALUATION OF CROWDFIT

To evaluate how domain non-experts can use a tool that supports creating tailored, evidence-based plans, I evaluated CrowdFit in a field deployment. To evaluate CrowdFit I conducted a field deployment with three conditions, comparing plans created by (1) crowd workers using CrowdFit, (2) crowd workers without CrowdFit but with links to exercise information, and (3) personal trainers. I recruited 46 participants who wanted to exercise (i.e., *clients*), 122 crowd workers (i.e., *crowd planners*), and 21 personal trainers (i.e., *expert planners*). To create plans, regardless of which study condition, planners used information shared by clients. Clients were randomly assigned a condition, following the generated exercise plans for two weeks.

This study provides empirical evidence that crowd plans can be a viable alternative to expert-generated exercise plans. CrowdFit plans were more actionable than plans created by experts or crowd workers not using the system. Compared to experts, crowd planners created plans that are not significantly different with respect to tailoring, strength and aerobic principles.

This chapter completes answering the research questions through a deployment and evaluation of CrowdFit: *RQ2: How can design of technology support non-familiar people in tailored behavior planning? RQ3: How can design of technology support domain non-experts in, evidence-based behavior planning?* Part of the findings and discussion in this chapter were published at CHI 2018[1].

5.1 METHOD

I conducted a study to assess if CrowdFit helps crowd members create quality exercise plans. I ran a between subject experiment with three conditions: baseline (crowd using Google docs), expert (using Google docs), and CrowdFit (crowd using CrowdFit). The baseline condition allowed me to examine the benefits of using CrowdFit for crowd workers. The expert condition allowed me to examine whether the system can result in plans comparable to those generated by experts.

Planners in the baseline and the expert condition used a Google doc. I used Google docs as to provide a basic means of communicating and sharing a plan. The Google doc included instructions to create an exercise plan and the client's profile (Appendix E. Example Task). To give the planner flexibility to decide how to structure the plans they create, the instructions for plan

creation were open ended in both the baseline and expert condition. In the baseline condition, planners were also provided with links to common and popular websites containing exercise guidelines (e.g., WebMD, Reddit), to simulate resources people can commonly access online. At recruitment, *crowd planners* are assigned randomly to either the baseline or the CrowdFit condition. *Expert planners* are always assigned to the expert condition.

Clients were assigned at recruitment to one of the three conditions. They were asked to fill in a survey that populated their user profile and received plans created according to their study condition each week, for two weeks. Clients were asked to complete a post survey at the end of the two weeks. Aside from feedback about the plans they received, the research team also shared with them all the generated plans (from the other two conditions), in a random order. Based on all the three plans, we captured clients' perceptions of each of the four plans (one created for each week of the study, plus the other two conditions), and discuss them in a follow up interview. A total of 184 plans were created in the study.

5.1.1 Clients

Forty-six clients (32 female, 12 male, and 2 self-identified as other) participated in the study. I recruited clients through email lists and neighborhood social media groups. All participating clients were randomly assigned to the three conditions: baseline crowd (15), CrowdFit (15), expert (16). The inclusion criteria were that clients needed to: (1) be between 18 and 35 years old, a commonly used bracket in exercise for young adults (M=28); (2) self-identify as not regular exercisers (e.g., exercised regularly less than two weeks in the last month); and (3) be motivated to exercise regularly for the next 30 days. For our analysis, we excluded 9 additional clients that dropped out during the first week of the study, three from each condition.

Clients had diverse occupations: half were students, others worked in medical or media fields (Appendix D. Client Demographics). Clients were interested in healthy goals and good exercise habits. Half of clients mentioned barriers of time, school work, long work hours, travel,

Measures of plan quality based on ACSM principles	
Amount	Match with recommended amount of exercise
Progression	Match with recommended progression of exercise
Pattern	Match with recommended pattern of exercise
Balance	Match with recommended balance of exercise
Compatibility	match with client's preferences, constraints, schedule, goals, balance preferences, exercise level
Aerobic	occurrence of variety of exercises, appropriateness of intensity and duration of exercise
Resistance training	occurrence of variety of exercises, intensity of exercises, appropriateness of repetitions and sets, progression through single and multi-joint exercises, rest periods, rest time between days of exercise
Transition exercises	occurrence of warmup and cooldown
Flexibility	occurrence of flexibility exercises
Accuracy	mistakes and irrelevant information
Measures related to supporting planning	
Specificity	explicit exercise names, how to exercise, reasoning for recommendations
Alternatives	single item concepts
Encouragement	how encouraging the tone of the plan is
Vocabulary	understandability of vocabulary

Table 4. Criteria used for expert evaluation

taking care of family, or balancing work and social life. Eleven clients (1 in baseline, 5 in CrowdFit, 5 in expert condition) listed in their constraints a range of physical limitations, including having a cold, being postpartum, or having a sore back. Injuries were not assessed during the study. Two participants did not have access to a gym. Clients were compensated $50 for participating in the two-week study, and $15 for an end of study interview.

5.1.2 Planners

I recruited 122 non-expert crowd planners by posting HITs on Mechanical Turk. Half (61) of the non-experts were randomly assigned to the baseline condition and the other half (61) were randomly assigned to the CrowdFit condition. Crowd planners were only allowed to participate

once and thus, only created one plan for the study. Crowd planners were given two hours to complete a plan. An additional 16 crowd planners submitted tasks but were rejected due to incomplete submissions. Crowd planners were compensated $7 for creating the plan. We added $2 if the researchers considered the plan above average. Crowd planners that were interviewed were given an additional $15. Two crowd planners reported having an exercise degree. Of the non-expert planners, only 10 had taken some exercise class before, although the majority (112) exercised or read about exercise regularly.

I recruited 21 expert planners through snowball recruitment from a local exercise sciences program, local gyms, and Craigslist. To qualify, experts needed to have a national personal trainer certification or a degree in exercise science (one expert had a course in exercise physiology). Each expert created up to 4 plans throughout the study, for different clients. Experts were compensated $15 per plan.

5.1.3 Client and Planner Surveys and Interviews

Whenever a client received a plan, they were asked to complete a short survey (week 1 plan, week 2 plan, at the end of study for the 2 plans from the conditions the planner was not assigned to). A total of 184 plans were evaluated by clients (4 plans each for the 46 clients). This survey allowed us to gather clients' perceptions of the plan. The survey included client's self-reported likelihood to follow the plan and how the plan fits with their life. Clients estimated their level of physical activity prior to the study by describing the exercise they had done the week before. During the study, clients reported daily activity and the intensity of exercise.

I and the research team interviewed 17 clients across all conditions: baseline (5), CrowdFit (7), expert (5), until we reached data saturation. Clients reported on their experience following the plans for two weeks and their impression of the two plans they were given at the end of the study. At the end of creating the plan, planners provided feedback on their experience creating the plan. We interviewed 13 crowd planners across conditions (Appendix E. Planner Demographics): baseline crowd (5), CrowdFit (8) until we reached data saturation. We interviewed non-experts because we wanted to understand their process for creating plans on their own (e.g., baseline) or through CrowdFit.

I and the research team adopted a mix of inductive and deductive approaches to analyze the data. First, four researchers each open coded a different transcript and discussed the emergent codes, organizing the codes via affinity diagramming and creating a code book based on our

original research questions. We then re-coded the same transcript using the code book, augmenting with codes that emerged through the process. After discussion, the code book was updated with the emerging codes and used to code the remaining transcripts.

5.1.4 Expert Evaluation of the Plans

I and the research team recruited a team of expert judges to evaluate the quality of the generated plans. The expert judges consisted of: a co-author (professor in exercise science) and two personal trainers with national certifications. One trainer created 4 plans in our study, but did not rate any of their own plans in the evaluation.

To evaluate the plans against the ACSM principles (Table 4), expert judges adapted an ACSM evaluation rubric (Appendix G. Expert Evaluation Rubric for Exercise Plans) [49] to capture the national guidelines and aerobic, resistance, flexibility and transition exercise principles. The plans were evaluated on: (1) how well they matched ACSM exercise principles, including exercise principles incorporated in the system, (2) how actionable the plans were, and (3) how well they were tailored to the client's needs. Table 1 contains the evaluation metrics. To ensure expert judges evaluated all plans the same way, they started by coding the same 9 plans individually, after which they added items, changed items, and resolved differences in interpretation of the items. They then rated the rest of the plans.

5.2 Results: Plan Evaluation

5.2.1 Overview of Plans Created

The plans created by crowd workers and experts varied by structure and information included in them. The plans created with CrowdFit were structured based on the system workflow: schedule, justifications of the recommendation, preparation and alternatives. Crowd planners using Google docs had no special support on how to structure the plan: they often followed a bullet point structure or open paragraphs, whereas expert planners often incorporated tables in their documents and were more likely to use photos and provide explanations on how to perform exercises. Clients valued the structured plans and images. Plans across conditions included reasoning of decisions made in the plan: *"I have provided a plan each day to ensure we achieve your goal 3 times per*

week" (PCF41). Some plans included words of encouragement for the client: *"Halfway through the week! You can do this!"* (PB01). Many plans created with Google docs contained days of the week when exercise should be performed, but few contained times to schedule the exercise.

5.2.2 Quality of plans created

We report on the quality of the plans based on the criteria used by the expert judges (Table 1), and the client's perception of the plans. We build several linear mixed effect models to understand how plan quality was different in the expert analysis. For these models, the evaluation criteria are used as the dependent variables. The analysis models the plan type (CrowdFit, baseline, expert), and the week in the study (week 1, week 2) as fixed effects. Participant id is used as the random effect. Figure 12 shows expert ratings analysis.

5.2.2.1 Client evaluation of plans

We find that across conditions, there is no statistical difference between conditions in how good of a fit the plans were, or how likely the clients were to follow them. Clients reported they were likely to follow the plan with minor modifications (M=4.05, sd=0.14 on a 5-point scale), and that the fit of the plan with their lifestyle was positive (M=3.6, sd=0.2). Among the 46 clients, 14 were already satisfying the exercise amount guidelines before the study. During the study, 28 of 46 clients reported satisfying the amount of exercise required nationally, and 33 participants reported an increase in physical activity during the study than before.

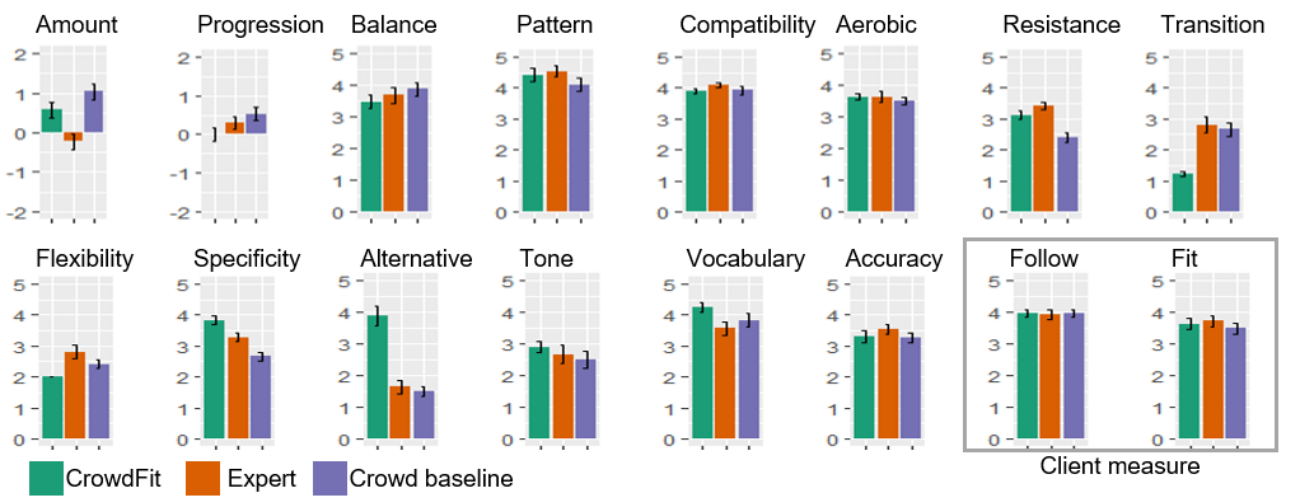


Figure 12. Expert evaluation of plans based on ACSM and actionability criteria from Table 1. Follow and Fit are client measures of quality of plans. Measurements are from 0 (lowest quality) to 5 (highest quality). Amount and progression are measured from (-2 too little exercise) to 2 (too much exercise)

5.2.2.2 Similar capabilities of crowds and experts

We find that there is no statistical difference between crowd workers and experts in terms of incorporating exercise principles of pattern (M=4.35, sd=1.01), compatibility (M=3.96, sd=0.54), balance (M=3.67, sd=1.24), and aerobic (M=3.58, sd=0.67). Both pattern and compatibility were rated as good across conditions (average above 4 on a 5-point scale), whereas balance and aerobic were positive-leaning (average around 3.5 out of 5).

These results indicate crowd workers might be familiar with these principles and can apply them even without any technology support. While not trained, these concepts may be fairly easy to grasp and implement given the information provided: *"I gave her cardio, strength"* (P_B39) or *"I tried to stagger them out as far apart from each other, so it wasn't too intense so her muscles had time to rest"* (P_{CF}57).

5.2.2.3 When crowds are better than experts

Plans created with CrowdFit were significantly more understandable (M=4.25, sd=0.08) than expert plans (M=3.56, sd=1.24, $p<0.01$), with no significant difference between CrowdFit and baseline plans. I attribute this to the experts using more specialized language than crowds. *"I didn't do clean and jerk, because I still have no idea what those are. I looked it up and I tried to do it and I'm like, 'I'm just not going to bother'"* (C38).

5.2.2.4 CrowdFit improves quality of plans

Plans created with CrowdFit were reviewed more positively compared to the baseline along several criteria: progression, resistance training, specific details of activities, alternatives, and trends in improving amount of exercise. Some of these criteria even received comparable ratings to expert-created plans. The design of CrowdFit successfully supported these exercise principles.

The amount of exercise in all crowd plans was more than the minimum recommended amount of exercise in the national guidelines. The planned amount was the most in the baseline condition (M=1.03, sd=1.09), which was marginally higher than the planned amount in CrowdFit plans (M=0.5, sd=1.1). Experts' planned amount was generally less than the recommended amount (M=-0.22, sd=1.1). When we analyze the 61 CrowdFit created plans, 59% of the plans (36) were within the range of recommended calories, and 38% (23) were above, while only 3% (2) were below the recommended minimum range. This suggests that crowds generally over-prescribe, but

CrowdFit was able to compensate slightly by getting planners to prescribe less exercise, perhaps because of the real-time calories feedback.

Both CrowdFit plans and expert plans received great ratings for the progression metric (M=0.0 and 0.29 respectively). CrowdFit plans were rated better than baseline (M=0.5, sd=0.8, p=0.05) (Figure 12). While CrowdFit had more exercise amount than recommended, the progression was optimal.

The resistance training was rated significantly better for CrowdFit plans (M=3.12, sd=06) than baseline plans (M=2.4, sd=0.84, p<0.01). The specificity level of the CrowdFit plans (M=3.82, sd=0.73), was rated significantly higher than baseline plans (M=2.65, sd=0.69, p<0.01), as well as expert plans (M=3.28, sd=0.86, p=0.01).

Alternatives were also more frequently occurring in the CrowdFit plans (M=3.88, sd=1.47) than in the expert plans (M=1.16, sd=1.12, p<0.01) or baseline plans (M=1.48, sd=0.82, p<0.01). We believe that CrowdFit supported planners along these criteria through including the database of exercises with detailed descriptions and requiring alternatives for all activities. Even so, the database we used could be improved. We found through interviews that clients much preferred detailed routines that included names for all the exercises than a generic routine titled "strengthening exercises" (C19, C28).

5.2.2.5 When CrowdFit does not improve quality

Compared to expert plans, CrowdFit plans included lower amount of flexibility (M=2.0, sd=0.0) exercises than expert plans (M=2.8, sd-0.86, p=0.02). CrowdFit plans also included lower amounts of transition exercises (M=1.2, sd=0.4) than baseline plans (M=2.6, sd=1.2, p<0.01). This is likely due to our database not including this information. The design of CrowdFit did not explicitly encourage this type of exercise even though these exercises should accompany each activity.

5.3 RESULTS: PLAN CREATION

5.3.1 Tailoring the Plan to Client Needs

Planners found the client profile was useful to tailor the plan for their client. However, planners still needed more detailed information. Here I discuss what was useful and what was needed in creating a plan tailored to the client's needs. information.

5.3.1.1 Identifying Activities that Fit with the Client's Physical Constraints

Planners needed to know the level of physical ability of the client to decide how much exercise to recommend "*I don't know enough to know how much time to schedule each activity. I'm not really sure what her fitness level is"* ($P_{CF}71$). Although planners were given a diary of the client's last week of physical activity, that was not enough to know the abilities of the client.

Many planners also strived to ensure that their activities aligned with clients' physical abilities or fitness levels (P_B35, P_B39, $P_{CF}64$, $P_{CF}71$). A quarter of the clients experienced some form of physical limitation, which lead some planners to assign less strenuous activities to the injured area (P_B35, $P_{CF}39$, P_B49, $P_{CF}49$). Planners wanted to know the seriousness of the injury (P_B39, $P_{CF}49$) to create planners around all client restrictions.

Physical constraints were a concern for the clients as well. Clients commented that they were able to follow many of the recommendations in the plans (C10, C36, C72), but avoided activities that posed risks: *"I was avoiding crunches just since I'm recovering postpartum and I didn't want to stress the potential ab separations"* (C35).

5.3.1.2 Identifying Activities that Fit with the Client's Resource Constraints

Planners wanted to recommend activities for which the client had the necessary resources, equipment and access to gym, and showed concerns when they did not have enough information ($P_{CF}57$, $P_{CF}80$, $P_{B2}67$): *"I don't know what machines are there, or what free weights, other than the treadmill and elliptical stuff"* ($P_{CF}80$). Poor information about access sometimes lead to recommendations that were not actionable for the client: *"Pure Barre and Aerial Soap class, I am an immigrant rights attorney, I work at a non profit, a lot of student loans … bar classes … are incredibly expensive"* (C41).

5.3.1.3 Identifying Opportunistic Moments to Enact Plan: Scheduling

Planners used the schedule of the client when they had it available. Planners wanted to know more details about time-based routines: *is the client a morning or evening person* ($P_{CF}49$), or transit duration between appointments or locations ($P_{CF}76$), to decide when in the day and during the week to schedule physical activity.

To create a good schedule, planners also found it useful to have time-based goals from the client. That helped decide how many times a week and for what duration to schedule exercise (P_B39), and it was detrimental when missing: *"I would like to know how long she wants to workout everyday ... I had no idea"* ($P_{CF}71$).

When information was missing, planners made potentially poor decisions about scheduling. Sometimes, planners used their own preferences, to substitute the missing information from the client: *"To me it seems like working out at 8 o'clock in the evening—it's something I wouldn't want to do"* ($P_{CF}49$). Sometimes planners did not know what to do when someone's schedule was already full. This led a planner to schedule activities even though they knew the client would have a hard time doing them, thus making the plan harder to follow: *"her daytime schedule [is] kinda tight the weekdays... Probably, if she's really dedicated, [it will] fit in between 5 and 6:30"* ($P_{CF}80$).

5.3.2 Incorporating Domain Specific Expertise into Plans

5.3.2.1 Making it Easier to Create Complex Plans

Planners who created plans through CrowdFit reported that the system made it easier to create the plans: *"An exercise plan can be quite involved. The moment I actually started using the tool, it got a lot easier"* ($P_{CF}49$). Planners found it useful to receive feedback on different aspects of the plan, like having indicators for scheduling activities and receiving feedback on quantitative measures of exercise:

> *"I liked that it has different aspects, tells you how many calories you're gonna be burning, it gives you a nice little bar graph, with the two colors that shows you the balance, the schedule is very useful because it's everything right there in front of me." (PCF71).*

5.3.2.2 Usefulness of Feedback About Domain Specific Information: Amount and Balance

More than half of the planners reported the calories bar and balance as the most helpful system features in creating plans. Planners found it easy to assess their progress towards these metrics: *"figure out whether or not I was getting close to my target, and if I was creating a somewhat appropriate exercise plan"* ($P_{CF}57$). Planners found the balance distribution bar helpful to inform whether to add strength and cardio activities to add to the plan:

> *"I like those icons because I could add an activity and then just really quickly look up there at top and see how I was doing in terms of getting a good balance and helping the person meet their objectives" ($P_{CF}41$).*

Planners adjusted the plan based on the calories feedback, as they were constructing it to try to fit within the recommended range: *"I just basically used it [the calorie counter] to gauge how close I was to my objective"* ($P_{CF}57$). The calories feedback triggered reflection on how to break down the amount of exercise across activities ($P_{CF}39$, $P_{CF}49$, $P_{CF}57$, $P_{CF}64$, $P_{CF}76$). $P_{CF}76$ reflected on how many sessions of exercise would reach the recommended amount, although they never used calories: *"Yeah ... that makes sense actually. If you do a bunch of cardio, you're gonna get the total of your calories in three days of working out really easily"* ($P_{CF}76$).

Planners did not always know what was good enough for the balance of the plan. Several planners aimed for an equal distribution of cardio and strength ($P_{B}39$, $P_{CF}49$, $P_{CF}64$, $P_{CF}76$, $P_{CF}80$). Even so, planners did not always know exactly how balanced a plan should be *"I assume based on what I know, that 30% cardio, 70% strength is okay, but 20% cardio, 80% strength would not be"* ($P_{CF}71$).

5.3.2.3 Usefulness of Domain Specific Information: Database of Activities

Planners found it useful to have a database of activities available. $P_{CF}76$ felt like having information about how to exercise included in the database was helpful when they might not know the necessary details themselves: *"how many sets and how many reps"*. This allowed him to focus on other details *"it's easier for me to say, 'Make sure you know how to do the exercises before you go, because that's important to watch the video to make sure you're doing it right'"*.

5.3.3 Tensions Between Tailoring to Client Needs and to Exercise Guidelines

The exercise guidelines came at odds with the client profile and made planners lean towards satisfying the client needs or personal knowledge over the national guidelines.

To align to client goals, some planners choose to make the plan intentionally less balanced: *"If you want to run a marathon, which in this case, she said she did, I was like, okay, I'll give her more cardio training, so she has more endurance"* ($P_{CF}49$). Other planners leaned towards their personal preferences and did not find it necessary to create a balance: *"I was trying to balance it 50/50 as best I could, but I think I was pretty happy to skew up with a little more cardio if necessary because I think, I mean, you do build some muscle doing cardio too"* ($P_{CF}76$). Other planners used their personal experiences when they did not have enough information about the client: *"not knowing what her general fitness level was … I'm thinking of my own experience of going back to the gym… and being… crippled for two days afterwards from pain from having gone at it too hard… I… wanted to produce a day of cardio that would, as far as possible and as far as I knew, avoided that outcome."* ($P_{B}49$).

CrowdFit's structured features may have also prevented planners from creating plans more customized in format, detail, and other activity suggestions. Planners wanted to be able to customize CrowdFit default activities: *"There's weight lifting, but you can't really fine tune it and pick out specifics for each."* ($P_{CF}39$).

At times, planners also identified creative solutions to maintain an equilibrium between satisfying client needs and the exercise guidelines. The planners used the database of exercises to search for ideas. They used the information about what was the distribution of cardio and strength, sometimes to find creative ideas of how to satisfy strength requirements: *"bowling is something a lot of people do just for fun and relaxation. So I thought that might be a nice way to add a little bit of strength to her exercise plan in a way that wouldn't make her necessarily feel like she was doing strength training"* ($P_{CF}64$).

5.4 RESULTS: PLAN ENACTMENT

5.4.1 Match with Preferences

Clients found it motivating to receive plans tailored that acknowledged the effort in tailoring the plan to their needs: *"I wanted to compliment the fact that this person took the time [to say] 'I've reviewed your schedule, and because of your specific needs I've put into this workout things that reflect your needs"* ($C_{CF}39$). Clients mentioned enjoying doing activities they were already familiar with and that matched their lifestyle. However, clients did not want to do recommended activities that were not of interest: *"I used to swim competitively, and I don't like swimming at all anymore"* ($C_{CF}02$).

5.4.1.1 Evolving Preferences

Although planners tried to incorporate client preferences, when it came to clients following the plans, some clients realized that their original preferences were not aligning with their experience following the plan. Some clients realized that they had different preferred schedules or activities: "*I said in my initial survey that I wanted to work on my flexibility and I thought that I would want to do yoga, but it turns out I really don't like yoga*" ($C_{CF}2$).

5.4.2 Match with Multifaceted Constraints

Plans needed to account for a variety of constraints or priorities in the participant's life, such as life events like: having an infant - *I have a nursing 6mo. that hasn't been sleeping well and is sucking every ounce of energy out of me. Literally"* ($C_{CF}70$), prioritizing course work as a student – *"I am taking 18 credits classes and have a job so I have limited time availability"* ($C_{E}20$), or managing other deadlines and goals - *"I have a large deadline at the beginning of next month that I'm working toward, so always trying to balance working, teaching, sleeping, making healthy meals, downtime, exercising, and socializing."* ($C_{B}28$).

5.4.2.1 Taking Ownership in Adjusting Activities or Plan

Some plans included activities at odds with a current injury or condition. A client was managing being postpartum and adjust the plan to avoid activities that were not adequate: *"I was avoiding*

crunches just since I'm recovering postpartum and I didn't want to stress the potential ab separations that I would have gotten" (CE35). One client pointed out the need for the plan to integrate better with her profession. Her job kept her physically active all day by lifting heavy objects. This client took ownership over integrating this activity into the plan. She accounted her heavy lifting to replace a strength training activity*: "a lot of my job is getting in and out of the truck. It was kind of the heavy lifting part was doing the activities already because just a lot of moving up and down while holding heavy boxes of fruit"* (CE72).

In an effort to follow the plan, other clients performed exercise to a level that might have been unsafe to them: *"I could feel the muscles in my legs, mid and lower back, getting cramped up"* (CCF39). Clients did not necessarily know how to modify a plan that was too difficult and wanted to have access to someone who could tell them *"here's how you can modify these workouts"* (CE72).

5.4.2.2 Access to Resources

Clients also found it hard to perform activities that required access to resources they did not have, specifically: access to strengthening equipment or a gym, access to classes, or were not willing to pay for expensive fitness experiences: *"Pure Bar and Aerial Soap class, I am an immigrant rights attorney, I work at a non profit, a lot of student loans … bar classes … are incredibly expensive"* (CE41). Clients made suggestions on how they could have communicated their constraints better: *"I said I had an access to a small gym, and I didn't really elaborate on what I meant by small gym. I was trying to say that our gym didn't have that many equipment"* (CB10)

5.4.2.3 Alignment with Client Abilities

Clients found it difficult to follow plans that required a higher level of physical activity than they were able to perform, or a commitment of time much larger than the client was physically able to do. Ten of the clients interviewed stated that some activities were too advanced for their current abilities. Some exercises were recommended for a duration longer than the client could do, or the recommendation had too many sets or repetitions: *"do three sets of 20 pushups, I'm like, 'I can't do one pushup'"* (CB28).

Although an abrupt progression of exercise was perceived negatively by clients, on some occasions they found it to be motivating to push themselves to doing more exercise.

5.4.3 Alignment with Routines

Clients had trouble doing activities that were not conveniently located to their home, required social coordination with others. Clients also felt difficulties in accommodating too much exercise into their schedule: *"All of a sudden, I had an hour and a half to two hours a day that it was suggesting that I was supposed to be exercising. That was a big jump for me I don't know how I'm supposed to fit that into my schedule"* (C_B28). However, when clients were able to get started on a routine they found it motivating to continue.

5.4.4 Specificity of Plans Impacted if Clients Followed Them

Activities recommended in plans had to contain enough detail on how to perform the activity, or the clients did not know how to execute on them: *"if I didn't know what it meant, then I just didn't do it"* (C_E72). This applied specifically to strength activities and being explicit about numbers of sets, repetitions, amount of weights, duration of activity, or proper form. Several clients defaulted to only doing the activities they knew from plans.

Clients also wanted to know the expected duration of activities to know how long to spend on them *"So that you kind of have an idea of how much time you are supposed to be spending on this"* (C_B24), and to budget time for the activity in advance.

When activities were accompanied by alternatives, these served as a potential substitute. Clients found that useful, particularly when they did not know how to do an activity, did not like it, or did not have access to the needed equipment.

Clients wanted to have the right level of detail regarding activities at different times. A planner familiarized with the activity before going to the gym, but felt the need to have the support of executing the activity at the gym as well: *"I watched it before, and then in the gym I was kind of trying to remember the steps, and follow it"* ($C_{CF}12$).

5.4.5 Alignment of Plans with Goals

Some clients found that some of the plans were not aligned with their goals based on the calories counter presented with the plan. The calories were perceived by some clients as a weight loss goals, which they were not interested in: *"I'm not in a losing weight mode, I'm in a let's get in*

better shape and be more all-around fit" (CCF41). Clients felt like a different metric might be more appropriate for their goals. Some were more interested in the balance of cardio and strength, in keeping track of how they felt after working out, whether they had an intense workout, or just in having fun.

5.5 DISCUSSION

In this research, I demonstrate how a system can help crowd members in generating exercise plans that are tailored and follow expert guidelines with respect to strength, and aerobic principles. Crowd members benefit from feedback about expert guidelines, but they struggle when trying to satisfy conflicting constraints – within guidelines, within client's needs, or between guidelines and needs. Here I summarize key findings and discuss challenges and opportunities for future work.

5.5.1 Creating of Actionable Plans Consistent with Exercise Guidelines

Results showed that CrowdFit was able to support non-expert planners with several key aspects of plan generation. Planners used the calories feedback, and the balance of cardio and strength to reflect on their choices of exercise that would satisfy the exercise guidelines and to recommend appropriate amounts of exercise. The database of physical activities enabled planners to include information in plans that they otherwise would not know about, such as strengthening routines that combined several exercises, details on how to perform exercises, sets, reps, and durations. The client profile helped planners weigh how to adapt recommendations to fit the many constraints of the clients.

Planners do not have the complex knowledge an expert has about the science behind exercise metrics, but our results show that with sufficient support, they can utilize these metrics to help them produce quality results. Previous systems have escalated parts of tasks that crowds could not accomplish to experts [32]. We instead propose bringing expert-level domain knowledge to crowds, in the interfaces they use to complete the task, and providing guidance about how experts try to satisfy constraints. Doing so, can support crowd workers in accomplishing tasks that they would not be able to perform otherwise.

5.5.2 Creating Plans That Satisfy Competing Constraints

Planners had to satisfy many competing constraints when creating exercise plans: national exercise guideline requirements, client goals, client resources and abilities, and client preferences. These constraints can be at odds. In our study, it proved challenging for planners to support personal constraints and preferences, and to meet objective guidelines. Intelligent systems show potential in automating recommendations based on user preferences [36], objective expert metrics (e.g. amount of exercise), or successful progressions of exercise based on clients' experiences. Even so, planner's insights to interpret the client constraints and profile might still be needed.

Although crowd workers can make recommendations that satisfy other people's personal constraints [140], requesters and crowd workers needed to communicate to resolve and interpret constraints. More work may be needed to understand how to help clients consider and communicate the relative priority of different constraints. Expert guidelines could also incorporate a set of heuristics for how to adjust or relax guidelines to fit client lives.

5.5.3 Facilitating Longitudinal Interactions with Clients

The profiles of clients who are new to developing a routine for a behavior might evolve quickly, as their abilities progress, as they find new activities they enjoy, and as their access to resources changes. Previous work discusses that creating behavior change plans requires iteration and involves reflection on strategies used [74]. Designs of exercise planning systems need to better support the iterative and co-design process between planners and clients (e.g. communication channel for client and planner). Future work could explore mechanisms for interaction and maintaining continuity [71] between different planners to maintain a longitudinal relationship with the client and coherent planning strategies over time.

5.5.4 Activities That Account for Varied Abilities and Interests

Clients had various levels of exercise ability. Over a quarter of participants had existent injuries, muscle or joint pain (unrelated to the exercise plan), menstrual pain, or became sick when starting or while enrolled in the study. To support client needs, planners needed to know how to address physical limitations that clients experience. Client profiles should include the physical limitations

that a person experiences and their severity. Temporary limitations should be updated as the client abilities change. To help the planner choose appropriate activities, planning apps should incorporate common physical limitations and the physical activities associated with improving or worsening the physical limitation. For people with disabilities, planning tools should use the ACSM guidelines for individuals with disabilities. For example, future databases may include what physical limitations restrict which activities, and how they can be modified to accommodate varied difficulty (e.g., intensity, duration, sets or reps).

The physical activity database was helpful to planners for recommending exercise to others. However, this list did not support the needs of participants who performed physical activity through their job, like being a market manager. The national guidelines encourage people to perform any activity that keeps them active. More occupational and home activities, like "cooking" are becoming available in exercise databases [5]. To give planners a way to account for the physical activity people do in their daily lives, exercise plans can better complement the exercise people already perform, by integrating occupational and everyday activities, and their benefits.

5.6 CONCLUSION

In this chapter I answer the question: How can design support domain non-experts in providing tailored, evidence driven behavior planning support for physical activity planning? Results demonstrate that crowd workers can create exercise plans that did not significantly differ in quality from expert plans on criteria of tailoring, balance, strength and aerobic guidelines. A rich user profile, quantitative interface feedback, and exercise databases can facilitate tailoring plans to the needs of clients and requirements of national guidelines. The crowd workers reconciled competing constraints, such as following national recommendations while also satisfying various personal needs that clients have. Techniques used in CrowdFit can successfully enable non-experts to take on tasks that otherwise performed by professional coaches.

Chapter 6.

DISCUSSION

Technology to support people's goals, from productivity to health, has increased tremendously over the years, yet people still struggle to accomplish their goals. Behavioral and health related interventions are increasingly becoming present in technology. Evidence-based interventions are helping people in using effective interventions that make them more likely to reach their goals and have positive outcomes in their lives. Technology makes it easier for people to seek the behavioral help they need by more easily connecting with other people, not just through apps. We can expect more technology to continue to incorporate both evidence-based interventions and to connect people with others. Building on empirical data and design from this dissertation, there are important directions for how technology, design, and theory, can better support people in accomplishing personal goals and in supporting each other.

Past work in behavior planning shows how technology supports creation of simple plans, but it is limited in supporting planning that accounts for people's needs. In this dissertation, I expand understanding of how to tailor behavior plans, and how technology can support people to help others with tailored, evidence-based planning advice. In this section I summarize the research questions and findings, discuss the implications of this dissertation, outline limitations and future work.

6.1 Fulfillment of Research Questions and Thesis Statement

In my dissertation research, I showed that technology can be designed to support domain non-experts in creating tailored, evidence-based plans for others. I do so by answering the following research questions. Answering these research questions makes different types of contributions to the HCI field [137]: empirical contribution that tells us about people, artifact, and empirical study of how people use a system.

RQ1: How can domain non-experts (friends and crowd workers) support people in the behavior planning process?

I evaluated the quality of 1-week behavior plans created by 66 domain non-experts for 22 people who wanted to improve behavior such as physical activity, eating healthy, spending behavior (Chapter 3). This study provides empirical contribution on how plans created by domain non-experts can help people improve behavior, if followed. I show that friends and crowd members have different strengths. Friends provide more tailored recommendations and more available for long term accountability. Crowd members provide more novel ideas and are easier to disclose information with about everyday behaviors. Across the different groups, there were misconception that did not align with domain specific best practices. I identify types of personal knowledge that helpers need to know to provide tailored recommendations to others: preferences, constraints, routines, and goals. The insights about the strengths of different types of people in planning support inform how tools should incorporate the help of each of them, by prioritizing different people for tailoring, novelty of ideas, ease of disclosure or accountability. The results also inform what informational support domain non-experts need for providing tailored recommendations. These findings have implications for planning technologies and social computing systems to design tools that are aligned with people's strengths or are designed to address people's challenges, as described in the discussion below.

RQ2: How can design of technology support non-familiar people in tailored behavior planning?
I contribute the design and implementation of a system, CrowdFit, that helps crowd workers in creating exercise plans that are tailored to a person's need and that draw on evidence-based guidelines (Chapter 4). I show how techniques incorporated into CrowdFit support non-familiar people, crowd members, in the creation of physical activity plans that incorporate client preferences. The design of CrowdFit draws on insights from Chapter 3 about criteria for tailoring behavior plans to incorporate client preferences about what activities to do, that activities fit in with existing routines, and that activities help progress the person towards a goal at a rate that is aligned with their preferences. Chapter 5 provides further insights into tailoring criteria, showing that some people's preferences in planned activities changed from week to week, and that a significant number of participants experienced temporary physical limitations that came in the way of exercise. These results inform how planning technologies should account for people's needs. These findings have implications for designing planning technology that is aligned with people's needs.

RQ3: How can design of technology support domain non-experts in, evidence-based behavior planning?

I show how techniques incorporated into CrowdFit support crowd members in the creation of physical activity plans that balance client preferences and needs with nationally recommended physical activity guidelines. These techniques include feedback on satisfying the guidelines, a rich client profile including historical information about client's exercise, and a collection of physical activities with metadata relevant to guidelines. This study provides empirical evidence that crowd plans can be a viable alternative to expert-generated exercise plans (Chapter 5). These findings have implications for designing technology for delivering evidence-based interventions as described in the discussion below.

6.2 Implications for Tailoring in Behavioral Tools

6.2.1 User Profiles in Tailoring for Behavior Change

Prior work suggests that information about the user is important in tailoring planning in health domains [33,42,114]. Past systems have also incorporated criteria for tailoring in other domains, for example systems that use preferences and goals for tailoring assistive technologies [79], or preferences and constraints about travel plans to tailor trip planning [140]. Unlike previous planning tools [68], the system designed in this dissertation shows how user profiles can be used to support tailoring for recommendations from other people for a variety of people's preferences and constraints. While the tailoring criteria has similarities to prior work (preference and constraints) [79], this research extends these recommendations to involve domain-specific information of particular relevance to behavior change: preferred activities (e.g., likes and dislikes), preferred routines (e.g., times of day or of week to perform activities), goals and preferred approach to make progress towards a goal (e.g., gradual slow progress, or progress involving larger changes in behavior), and constraints.

This dissertation shows that user profiles are effective for tailoring behavior change in recommendations from others in the context of exercise (Chapter 5). This research also shows that the same tailoring needs were surfaced in other domains of healthy eating, or saving money

(Chapter 3) through tailoring to preferences, short and long term goals, constraints and access to resources, and preferences. This suggests that technologies could use behavior change user profiles including such types of information to tailor behavior change across a wide range of domains. However, there is still a need to understand how characteristics of the application domain might influence sub-categories of such a user profile. For example, access to equipment is an important constraint in physical activity. In a domain like healthy eating, however, access to resources might be complemented by information about allergies or other food constraints.

This dissertation shows the potential of using online profiles for elevating the support people provide in online communities. Prior work has identified that user profiles can help people decide if they would reach out to an online cancer community member [52]. If online profiles were to additionally contain behavior change information, people would not need to draw only from personal experiences in helping others [53,56,121]. If people have different personal experiences than those of the people they are helping, drawing from personal background can lead to mismatching advice. People could instead tailor advice to specific preferences and constraints of the person they are helping. Behavior change profiles could be used to match people with others who might have similar types of profiles and who might encounter similar challenges in changing behavior. Preferences and constraints (e.g., likes, dislikes, behaviors the person tried in the past, access to equipment) might not be apparent when people seek support in online communities. By making information about a person's behavioral change profile more transparent, it can help others provide more tailored support to others.

6.2.2 Incorporating Qualitative Information into Behavioral Technology

Findings in Chapter 5 surface additional qualitative tailoring criteria such as profession, life events, or injuries. To account for such information, tools would have to translate activities such as "working a job where I lift heavy boxes" into physical activities that are accounted for in weekly physical activity and plans. Although prior research suggests that people preferred to create plans that involve leisure time activities, as opposed to behaviors that are embedded in other everyday activities, such as "taking the stairs" [40], this dissertation shows people do integrate plans around physical activity with their profession. To account for this, technology should account for the physical strain that one experiences at work. One approach to do this can be through creating exercise databases that incorporate activities done at work into a physical activity plan.

Research in behavior change has discussed how people's goals are expressed through a mix of qualitative and quantifiable goals [99], but it is still not known how to incorporate qualitative aspects of a person's life into technology. My dissertation shows that the translation of exercise guidelines into technology can support goals such as "staying healthy" which are qualitative in nature and can be hard to implement into technology. Following exercise guidelines has been shown to correlate with better health outcomes [42]. The translation of these guidelines into a planning tool through features that provide in the moment feedback on plans (e.g., amount of exercise, balance of exercise) shows a pathway to accomplishing qualitative goals, by following exercise plans that align with exercise guidelines. There are other types of subjective information that technology needs to support. Some of the qualitative aspects might be attitudinal, like preferred activities. Other aspects of a person's life are more contextual, such as family context.

Qualitative information is still challenging to include in intelligent systems that rely on quantifiable preferences, correlations with past activities of other people, or the person themselves [110,139]. For such tools to tailor recommendations to people's qualitative preferences, future work needs to examine how to incorporate qualitative preferences and constraints into planning tools automatically. For example, preferences and constraints such as "a crying baby" or "moving heavy boxes today" need to be translated into metrics that could be incorporated into technology to align recommendations to the person's needs.

6.2.3 Support for Evolving Preferences and Constraints

This dissertation shows that some people's activity preferences changed as they tried new things (Chapter 5), and their physical abilities varied due to typical interruptions such as colds or other physical pains. Although their goal stayed the same, people's interest in implementing actions towards their goals changed due to these additional constraints. This suggests that technology for behavior change should account for an evolving state of the user. Past research shows that people learn about what strategies work for them and might change them over time [74,126]. Similar aspects were found about people's tracking goals [117] or people's behavior goals evolving over time [29,99]. The current work implies that people's preferences or constraints can also change over time, often week-to-week in the early stage of changing a behavior. Current technologies primarily account for people's preferences and constraints at onboarding, but to better support

tailoring, tools should re-assess people's preferences over time. Future work is still needed to understand how frequently and what types of preferences need to be assessed regularly.

6.3 Implications for Incorporating Evidence-Based Interventions in Behavioral Tools

6.3.1 Scaffolding Evidence-Based Practice to Strengthen Support from Others

Through Chapter 4 and 5 this dissertation shows that technology can support domain non-experts in providing advice that is aligned with evidence-based recommendations that experts use. This can be done through in the moment feedback on domain specific metrics, in this case exercise guidelines. By identifying guidelines of value in the exercising domain, this dissertation shows that guidelines such as amount of exercise of balance of exercise can be translated into quantitative metrics that provide the user with feedback so that people can adjust the help they are providing.

In doing so, this research expands prior literature that shows how technology can help domain non-experts in providing support that follows cognitive behavioral therapy (CBT) principles [94,101]. I expand on this prior research by showing how to scaffold expert guidelines in a new field, of physical activity, through a database of physical activities and instructions, and in the moment feedback on the appropriateness exercise through metrics such as amount or balance of activities. In Chapter 5, I show that technology can help crowd members perform similarly to domain experts (fitness experts) in several exercise guidelines at creating behavior plans. Although prior work showed that qualitative guidelines can help people incorporate CBT principles in their advice, the current dissertation expands this knowledge by showing that domain specific guidelines can be used for in the moment support and can be tailored to the needs of the person receiving help.

There is a need for future work to translate domain-specific guidelines outside of exercise into interactions that technology can leverage. Technology designers can draw from techniques used in this dissertation to scaffold expertise such as: identifying domain-specific databases of healthy behaviors (e.g., a parallel to physical activities can be healthy foods), identifying quantitative metrics that can provide in-the-moment feedback to the planner about the quality of the plan (e.g., instead of amount of exercise, in a food domain the metrics might measure nutrients

in food recommended), or visualizations of the recommendations made on metrics that are relevant over time (e.g., instead of pattern of physical activities over the week, tracking portions of vegetables and fruits over the week might be more relevant).

6.3.2 Implications for Behavioral Intervention Technologies

This research expands our understanding about how people provide support that promotes evidence-based interventions by translating exercise guidelines into technology features. This research also provides understanding into planner needs when promoting evidence-based interventions, such as knowing information about the client, or how to prioritize between guidelines. This research addresses the challenge that Schueller et al. pose to researchers developing behavioral intervention technologies [89,90] to better understand what people do when they deliver behavioral interventions and the needs they have in this process [118].

In Chapter 3 and 5, I identify information needs that people have in providing planning support to others, such as preferences and constraints of the client. To understand the needs of people providing support, it is necessary to understand the needs of the people receiving help. In this dissertation I leverage multi-stakeholder understanding of the quality of human support. By drawing understanding from the needs of the help recipients, and evaluating the output of planners from expert perspectives, this research identifies insights that complement each other to better inform how to support the people that provide help. Future research that leverage human support for behavioral interventions should draw on the needs of multiple stakeholders to design tools.

In Chapter 5, I find that planner need support in prioritizing between evidence-based recommendations and the needs of the person they are helping. By understanding that these needs exist, the designers of behavior intervention technologies can provide more guideline to people who support the delivery of an evidence-based intervention on how to prioritize information. Chapter 5 also reveals that people providing support might consistently provide poor advice in certain dimensions, such as overestimating how much exercise one should perform. This surfaces a need to understand the nature of the advice people provide and in what ways it falls short. Designers of technology can first understand where people fail to provide adequate support, to design ways in which technology can better mediate the quality of support that people provide.

6.4 Implications for Incorporating Support from People with Different Expertise into Technology

This dissertation expands understanding about the role that people can play in social systems for supporting health. This has implications for the design of both human computation tools and online communities.

With the emergence of crowdsourcing and human computation, systems are increasingly designed with the purpose of drawing on people's expertise to accomplish complex goals. In many such systems workers have been assumed to have the same types of expertise and complete the same types of tasks. Although early human computation systems primarily involved people in doing tasks that that were difficult for algorithmic approaches [4], the role that people can play in human computation systems has advanced. Research has proposed that crowd participants perform jobs based on their skills and performance [63,97]. In contrast, studies of online communities outline alternative roles people can participate in: people get accountability towards goals from others [28], get advice on managing chronic conditions [53], or take roles based on engaging in different ways in the community (seeking or proving support, promote knowledge, etc.)[138].

In this dissertation, I expand the knowledge about the roles that people might play in social computing systems and human computation tools for behavior change to better design and incorporate help from different people based on their strengths. In Chapter 3, I show how familiar (friends) and non-familiar people (crowd members) have different strengths in providing support for others in terms of informational support, accountability, longitudinal availability, how willing people are to share data with them, and concerns about being judged based on how people are represented through the data. These findings are directly relevant to care management systems that have proposed integrating the expertise of different care providers such as doctors, residents, medical students, or crowd workers with no medical training [8,9]. This dissertation suggests typically overlooked criteria that a human computation system should consider when integrating support from others: information exchanged, longitudinal interactions, data sharing, presentation of self to others. Designers of human computation systems looking to better integrate support from others can first understand the strengths of different potential members of the system before designing human computation tasks. Through this research, I show how familiar and non-familiar

people can provide support, but there is still a need to understand how to integrate support across different stakeholders with different strengths.

6.5 LIMITATIONS

The participants who sought to change behavior in these studies were based in the Seattle area and represented a somewhat homogenous demographic and geographic population. The participants were all healthy young adults. The preferences and constraints encountered by these participants might differ from those of other demographics. For example, people managing a chronic condition might have both preferences and constraints impacted by their condition in a different way than healthy people.

Non-familiar planners were recruited via Mechanical Turk and had no formal expertise with the domain for which they were providing behavior support. However, non-familiar people recruited through other mechanisms might have different levels of expertise with behavior change, and their information needs in supporting others might therefore differ. For example, online peers might have expertise with behavior change, and that expertise can affect their recommendations perhaps making them even more tailored than other domain non-experts. Self-selection bias might be present in the clients and planners who participated in the interviews and might reflect perspectives of people who were more actively engaged in the studies (Chapter 3, 5).

For the CrowdFit study (Chapter 5), the client population evaluated and tried exercise plans for two weeks. While these participants engaged with the exercise plans, some of that engagement might be due to a novelty effect and accountability towards the research team. Further, the needs surfaced by clients throughout the first weeks of starting to exercise might differ from the needs they might have long-term. The needs surfaced by planners (Chapter 3, 5) relied on providing support to someone in the early stages of behavior change (first or second week of trying to change behavior). The information needs that planners had in supporting the planner might change over time. For example, the planners were provided with a 1-week diary of the client (Chapter 3, 5), or a summary of the client's challenges with the past week's plan (Chapter 5). However, if they supported the client over longer periods, their information needs might need to span more than a 1-week summary of activity of the client. Other information needs might surface when longitudinally supporting people. The differences in the needs of familiar and non-familiar

planners might also vary during longitudinal support, as it might place different social strains on the relationships between client and planner.

6.6 FUTURE WORK

The findings in this dissertation reveal several new avenues for future research in behavior change planning using technology that address the needs of a diverse group of people to maintain behavior long term:

Behavior planning for a diverse population: This dissertation surfaced how to tailor behavior planning for healthy adults in an affluent urban area. Future work should expand this knowledge to a wider range of participants. To broaden the population of participants, researchers should seek to understand the needs of participants in a diverse socioeconomic position. According to reports in health disparities [120,130], future work should engage marginalized populations with respect to social class, gender, race and ethnicity, LGBT identity, disability, and place of residence. Working with marginalized populations will undoubtably surface additional and important challenges to supporting behavior planning not explored in this dissertation

Longitudinal support: Behavior is a complex, difficult, long-term process. While this dissertation shows that short-term support from other people for behavior planning was perceived positively and well-tailored to people's needs, there is still a need to understand how to support this longitudinally. While this need not be a study of a couple of years to understand the efficacy of technology [65], the longitudinal nature of behavior change might surface different needs and support that clients have as they work towards maintaining behavior [109]. How to design for longitudinal interactions with a person providing help [71] remains an open question.

Support from a variety of people: People receive behavioral help from a variety of sources such as clinicians, friends, family, caregivers, peers, or people online. Technology is an increasing part of health interactions, pointing to a need to support the person's holistic experiences across different platforms and stakeholders that a person interacts with and who have different expertise. Technology would need to broker what support should be requested from each person based on their strengths and what information might get share with each of them. Future work should explore how to integrate the support of people with different expertise to offer continuous and longitudinal support to the individual.

Integrating domain non-expert platforms into professional care: CrowdFit was designed for domain non-experts. However, the features of this tool might be useful to professional trainers or primary care providers who are attending to a person's physical health. It would be valuable for future work to investigate how a tool like CrowdFit can fit into professional practice. Some opportunities for exploration are to understand how the tailoring features and the feedback on exercise guidelines can help a professional. Another opportunity is to understand how such a tool can be integrated with professional support during the off-time, when the client is not able to see the domain-expert professional but still needs support.

Support development of behavioral skills: Providing people with ideas and solutions for addressing behavior challenges can come at the cost of helping them build autonomy in making decisions on their own. As technology increasingly provides automated insights and recommendations, it can offer people solutions without teaching the skills they need to support themselves independently. CrowdFit provided feedback to planners that increased the quality of their recommendations. But it is unclear if planners learned from this process. Similarly, it is unclear if people receiving plans would be dependent on CrowdFit to be physically active or if they would develop skills to self-regulate and pursue exercise on their own. To design tools that help people acquire skills for better self-management, future work should examine how technology can support learning as part of behavior planning.

6.7 CONCLUSION

Technology makes it easier for people to connect with each other. A lot of people using social technologies have probably offered support to a person who needed it, through technology. While it is natural for many people to help others, it does not necessarily mean that the advice they provide to others is helpful. While online communities and communication platforms facilitate interactions, they do not necessarily ensure high quality support as part of those interactions. As part of this dissertation I show how people can help each other with behavior change through behavior planning using technology. By understanding the needs of people who want to change behavior and of those who offered help, I designed and built a tool through which people can help others with behavior planning. I show that when people are assisted by feedback from technology,

they can provide support to others that is in line with recommendations provided by domain experts, or that is elevated to a higher quality than the support they would provide otherwise.

With the increase of technology to support health, it is important to design tools that provide solutions that people want to use. Many apps that provide behavioral recommendations through behavior plans (e.g., fitness, diet) do so by employing limited tailoring criteria that are easily quantifiable (e.g., gender, age, frequency of exercise per week). My research shows that technology can move beyond quantifiable assessments of the user. By constructing rich, subjective, behavioral user profiles I show that people can tailor their recommendations to others based on a person's preferences, constraints, goals, and routines. While access to health professionals is still limited to many people by cost or access barriers, technology is becoming a prominent solution to addressing people's health needs. Behavior planning is critical in managing health goals. By incorporating evidence-based guidelines in a way that people can use, technology can make it easier for people to get access to services that might be unavailable otherwise. My research shows how evidence-based guidelines for physical activity can be translated into technology through a mix of integrating exercise databases with exercise metadata, in-the-moment feedback on alignment with physical activity guidelines, and visual representations of alignment with guidelines. Thus, by integrating evidence-based guidelines in interface features, people can provide better advice to others.

My findings show that researchers, designers, and practitioners can and should use techniques for tailoring and for incorporating evidence-based practice into technology to ensure that people follow through with their health goals. I presented techniques for how to better tailor advice that people provide to each other for behavior planning, and to better incorporate evidence-based guidelines. Behavioral technologies and communication technologies will continue to increase and facilitate support from others. Thus, this dissertation can contribute to research on technologies for planning HCI and CSCW communities and beyond by providing insights for designing tools for planning that can improve the quality of support provided by others with considerations of tailoring and evidence-based practice. This work demonstrates techniques through which technology can help people be better supported by the people they connect with so that they in live healthier lives.

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APPENDIX A. SUMMARY OF CLIENT DATA

This data was collected for participants in the study in Chapter 3

ID	Domain	Gender	Age	Goals	Preferences/Constraints
p1	food	Female	35	My goal is to eat healthier. In particular I would like to increase my fruit and vegetable intake and try to consume fewer processed foods	Restricting (but not eliminating) dairy and wheat.
p2	exercise	Male	26	Go to the gym more, routine exercises. More walking, gradually turning into jogging.	Simple, common lifting exercises. Gym facility doesn't have a lot of equipment.
p3	money	Female	27	I want to spend less than 150 a week!	N/A
p4	money	Female	33	I'd like to reduce eating out costs to $40 max, and grocery costs to $75 max, both per week	N/A
p5	exercise	Male	N/A	N/A	Sports/No Constraints
p6	food	Male	45	I might be joining a weight loss group next week or so, if my schedule allows.	My preference is to avoid take out food and pack a lunch if I am away from home all day. I do not have any constraints
p7	money	Female	27	less spending on costumes, online shopping, and going out to eat	I want one night a week I can go out and have fun, but know my spending was out of control
p8	exercise	Female	23	My goal is to exercise at least one hour 5 days per week	I have a rotator cuff injury and prefer cardio.
p9	exercise	Female	23	I want to work out more.	N/A
p10	food	Female	19	N/A	N/A
p11	food	Female	25	My activity should increase my activity by walking. Also to have one serving instead of two or three.	I like to walk but I am always sitting at work
p12	exercise	Female	31	Be active/exercise every day of the week for at least 15 minutes.	I prefer running and live by a trail. I get bored doing the same thing two days in a row. I prefer going to the gym with a partner for motivation.
p13	exercise	Female	35	variety of exercises	none
p14	food	Female	27	Eat more fruits and vegetables; I am not sure how to get 5 fruits/vegetables a day (let alone the 7-9 my doctor recommended) without going way over my budget or having to shop again midweek.	I tend to go to the store once per week, and try to stick to Trader Joe's. Every other week I will go to another store with a wider selection of produce.
p15	food	Female	27	eat more regularly and eat healthier, hopefully lower carb, foods	nothing you don't know about... all the usual migraine triggers
p16	money	Female	26	i would like to spend less on eating out, and not purchase decorative items	i will be purchasing some things still for my wedding, but i hope that the bulk of the spending for this is done. I know i need to book another hotel soon though.
p17	food	Male	28	I want to eat better	I want to still be able to eat meat
p18	money	Male	26	Would like to spend less on online shopping & gas.	none
p19	exercise	Female	25	Yoga once a week, walking around Greenlake 3x a week	N/A
p20	food	Female	18	Usually I just wait until I feel hungry before I eat anything and I think that is one of the reasons my eating habits aren't very good. I am hoping I could incorporate more fruit into my everyday life. I usually don't crave fruits so I tend not to eat them that much.	No beans, nuts, pineapples, strawberries, an additional 20 dollars can be spent outside my normal weekly food budget
p21	exercise	Female	35	3 trips to the gym of at least 1 hour each	N/A
p22	money	Female	54	(1) Save money by managing my time better--ensuring I have food at home and eat before I go out so to avoid having to spend money on food and drinks. (2) Attempt to quit smoking again by resuming my e-cigarette. (3) Attempt to make Michael more responsible for his own debts.	Ref (1) above: Shop for groceries at Fred Meyers not farmers market unless I'm sure farmers market prices are competitive to Fred Meyers. Ref (2) above: Will require initial out lay of money to replace tank and juice 25$? Quit using e cigarettes before because I got a sinus and ear infection I attribute to using the e cigarettes. resuming will require me to monitor ear and sinus health--see if I can quit both faster. Ref (3). Encourage Michael to a get job and slow down and relax a little, think safety on the road. Constraint: Michael rarely at home and available to speak to except odd hours or when he needs help.

APPENDIX B. SAMPLE OF ACTIVITY DIARY

This is an example of a diary kept by client in the study in Chapter 3

Age: 35

Gender: female

Goal (how my activity should improve in the next week): My goal is to eat healthier. In particular I would like to increase my fruit and vegetable intake and try to consume fewer processed foods

Preferences/Constraints: Restricting (but not eliminating) dairy and wheat.

Your activity log:

Saturday
9 AM | breakfast | honeydew melon, pecan & almond KIND bar
12 PM | lunch| lentil snaps, kombucha, EPIC turkey bar
4 PM | lunch | sliced tomato with mayo on sourdough toast
5:30 PM | snack | black tea, dark chocolate
7 PM | dinner | veggie burger (seven grain roll), carrots, salad greens, glass of red wine | restaurant
10 PM | snack | lemon sorbet | out with friends

Sunday
9 AM | breakfast | banana, vanilla chia pod
11 AM | snack | oatmeal raisin WHENEVER bar | black tea
2 PM | lunch | slice of cheese pizza, chipotle/tomato soup
6 PM | dinner | salad (spring mix, tomato, mozzarella, cucumer, carrot), blue corn chips and guacamole (avocado + salsa)
8 PM | snack | veggie straws | my toddler was eating them
10 PM | snack | cereal and milk | feeling stressed / emotional eating

Monday
9 AM | breakfast | buckwheat waffles
11 AM | snack | trail mix (cashews, pretzels, pepitas) & dried apples with toffee dip
2 PM | lunch | hummus, carrots, cheddar crackers
4 PM | snack | black tea, figs
6:30 PM | snack | provalone, crackers, salami
8:45 PM | dinner | beans, rice, chicken, peas, carrots, tomatoes, sour cream & flour tortilla

Tuesday
9 AM | breakfast | hot quinoa rice cereal with peanut butter, raisin & maple syrup mixed in
11 AM | snack | chai + whole milk
1 PM | lunch | salad of mixed greens, tomato, avocado, hemp seeds, tahini dressing
1:45 PM | snack | cheddar crackers
4:00 PM | snack | iced tea, orange
5:00 PM | dinner | leftover beans, rice, chicken from yesterday
8:00 PM | snack | 1/2 shrimp roll

9:15 PM | snack | raspberries, dark chocolate
11:00 PM | snack | sriracha popcorn | stayed up late watching tv

Wednesday
9 AM | breakfast | almond & sea salt KIND bar, ALOHA green drink mix
11 AM | snack | 2-ingredient pancake (banana + egg), sliced strawberries
1:30 PM | snack | 1/2 mango chia pod, veggie pirate booty | my daughter's snack leftovers
3:30 PM | lunch | chicken vegetable soup, sour dough bread, provalone cheese
4:30 PM | snack | iced green tea, dark chocolate
6:30 PM | snack | random candy a co-worker brought back from China | I didn't bring food to work and ate this out of desperation
8:30 | dinner | olive, spinach, goat cheese pizza and mixed green salad with tomato, carrot, and onion + ranch dressing

Thursday
8:30 AM | snack | 3-ingredient "cookies" - baked banana with oats and raisins
10:00 AM | breakfast | spinach & potato pancake, orange
12:00 PM | snack | peach yogurt, veggie pirate booty
2:00 PM | lunch | egg & green chile burrito on flour tortilla, avocado, salsa
4:45 PM | snack | corn chips, string cheese, iced green tea with honey
7:00 | snack | cold cereal
9:00 | "dinner" | peanut butter and jelly on sourdough | tired, hungry & not making good decisions
10:30 | snack | sriracha popcorn

Friday
8:30 AM | snack | THUNDERBIRD bar (dates, buckwheat, walnuts, cherries, sweet potato)
10:30 AM | breakfast | buckwheat cereal with peanut butter and raisins mixed in, peach
1:00 PM | lunch | spanikopita
3:30 PM | snack | iced green tea, orange
7:00 PM | dinner | ham sandwich with tomato, cheese, avocado, lettuce, mayo & mustard, fruit salad, potato chips, lemonade | picnic with family
10:00 PM | snack | apple sauce, WHENEVER oatmeal cranberry bar

APPENDIX C. STUDY TASK INSTRUCTIONS

Content Provided in the Instructions to Planners in Chapter 3 Study

Please write a plan to help a person to start eating healthier. Using the 7 day activity log you were provided, create a 7 day plan of steps this person can take to start eating healthier.

Your plan should be as detailed as possible. For each day of the week you should list the steps the person should to take in detail. Your plan should be something the person can achieve in the next week and that they will want to do. Please customize the plan based on your best judgment. You can consult any external resources as you work.

Activity log: <url >

If you need any additional information, that could help you in creating this plan, please list that in this document.

Sample method to fill in the plan (recommended format, but adapt as needed for your plan)**:**
time of day | meal name | meal content | notes
8 AM | breakfast | sandwich with whole wheat bread, ham and veggies | some explanation why this item is a healthy decision

Your plan:

Monday
| breakfast |
__ __ | lunch |
__ __ | dinner |
__ __ | snack |

Tuesday
__ __ | breakfast |
__ __ | lunch |
__ __ | dinner |
__ __ | snack |

Wednesday
__ __ | breakfast |
__ __ | lunch |
__ __ | dinner |
__ __ | snack |

Thursday
__ __ | breakfast |
__ __ | lunch |
__ __ | dinner |

__ __ | snack |

Friday
__ __ | breakfast |
__ __ | lunch |
__ __ | dinner |
__ __ | snack |

Saturday
__ __ | breakfast |
__ __ | lunch |
__ __ | dinner |
__ __ | snack |

Sunday
__ __ | breakfast |
__ __ | lunch |
__ __ | dinner |
__ __ | snack |

Content Provided in the Instructions to Friend Planners in Chapter 3 Study

Your friend _____ has asked for your help on eating healthier.

We ask that you make recommendations to help your friend improve their behavior. You should use the following document for making your recommendations: _____. This document contains instructions, but please ask me if you have any questions. To help you provide recommendations, we ask that you do the following in the document we shared with you:

1. mark the food items that your friend should improve to eat healthier.
2. for each food item you marked for improvement, provide as many alternative food items that would help your friend eat healthier. Add notes to your recommendations whenever you see fit.

Thank you,

APPENDIX D. CLIENT DEMOGRAPHICS

This is the demographic information of clients in the Chapter 5 study

Id	Condition	Age	Gender	Occupation	Long Term Goals
p001	expert	30	Male	Student	Lose 10 pounds in six months.
p002	CrowdFit	29	Female	Unemployed	Work out daily
p003	baseline	25	Male	Student	1. to gain more flexibility. 2. Run 4 miles at a stretch without exhaustion. 3. Engage in a sports activity on a semi regular basis.
p004	baseline	29	Male	Graduate Student	Healthy cardiovascular system
p005	expert	28	Female	Student	Be able to run a 10k race or do a bike race
p007	baseline	18	Female	Student	Lose fat and tone muscle
p009	CrowdFit	35	Male	Student	Keep weight and stay fit
p010	baseline	28	Female	Grad student	Habit of working out regularly
p012	CrowdFit	26	Female	Student	Lose weight and build muscles
p014	expert	32	Female	Student	Exercise at least 3 times a week
p015	CrowdFit	28	Male	PhD Student	Lose weight, gain strength, enjoy many outdoor sports/activities
p018	CrowdFit	20	Female	Student	Be able to run 1 mile.
p019	baseline	28	Male	Grad student	Create a habit out of exercising
p020	expert	22	Male	Student	Lose 10 pounds
p023	expert	20	Male	Student	Get healthier- lower my heart rate & add muscle tone.
p024	baseline	29	Female	Academic Advisor	Get in better shape and be healthier and stronger
p026	expert	29	Male	N/A	Run a half marathon with lighter weight or bike more
p028	baseline	24	Female	Student	Integrate workouts into weekly schedule. Better physical appearance, increased strength and endurance, perhaps increased enjoyment out of working out, and reducing stress
p030	CrowdFit	26	Female	Student	Tone muscles, and build up on agility and endurance.
p031	CrowdFit	33	Female	Registered Dietitian	Consistently walk for 4-5mi/day, go from lifting 5lb weights to lifting 10lb weights and firm up abs and comfortably jump on mini-trampoline for 10min or more per day
p034	expert	30	Female	Environmental & Agricultural Specialist	Build up consistency so that it is a habit and no longer a chore
p035	baseline	30	Female	Homemaker	Endurance and strength, overall health
p036	CrowdFit	26	Male	Research Scientist	Undertake a more a regular physical activity regiment complimented with a healthier diet. A better understanding of simple exercises that you don't always have to go to the gym or another work-out facility to accomplish.
p039	CrowdFit	26	Female	Public Relations	Regularly do cardio workouts with mixed in weights. Build up ability and tolerance so that 5 minute runs turn into hour runs, and weights lifted are also heavier.
p040	baseline	35	Male	Business Operations Coordinator	Lose 5-10 pounds. Get outside more for physical fitness. Engage in a routine at least 3-4 times a week.
p041	expert	29	Female	Attorney	Keep exercising or being active consistently

p042	CrowdFit	28	Female	Operations Assistant at a Non-profit	Get in a steady habit of working out at least four times a week to become more fit.
p043	baseline	35	Female	Homemaker	Have a steady plan of cardio a few times a week and lower impact activities the remaining days.
p045	CrowdFit	26	Other	Receptionist	Lose 15 - 20 pounds
p047	expert	32	Female	Medical Social Worker	Better endurance and more strength. Have a good idea of what a sustainable fitness routine would look like.
p052	baseline	28	Male	Student	Lose 40 pounds. Increase physical strength and stamina.
p059	expert	23	Female	Sales Manager	Regular schedule of when to exercise and a plan for how to exercise
p060	CrowdFit	32	Female	Personal Assistant	Raise energy, lose weight, create healthy habits
p063	baseline	35	Female	Producer	Consistent moderate exercise
p064	baseline	25	Female	Program Coordinator	Maintain a regular cardio schedule, add strength training that is manageable to do at home.
p065	expert	25	Female	Graduate Student	Lose 5 lbs and strengthen back and shoulders.
p067	expert	24	Female	Program Assistant	Train for upcoming backpacking trips / summits.
p068	expert	28	Female	Research Coordinator	Start incorporating more regular physical activity into everyday life.
p070	CrowdFit	32	Female	Nanny	Work out up to 5 times per week and be able to go for a hike.
p071	baseline	29	Female	Youth Counselor	More endurance and physical strength for self-confidence
p072	expert	26	Female	Farmer's Market Manager	Lose about 30lbs.
p073	expert	27	Female	Non-profit Program Supervisor	Get consistent about exercising. Feel stronger and be able to climb more difficult routes at the climbing gym. Look and feel more fit, but not lose weight.
p074	CrowdFit	33	Female	Counselor	Lose 10 lbs and be healthier and more physically active overall
p077	expert	29	Other	Student	Build up stamina, more toned, lose weight
p078	CrowdFit	28	Female	Grad student	Increased stamina, better cardiovascular health.
p080	baseline	23	Female	Research Study Assistant	Lose weight and build strength and endurance.

APPENDIX E. PLANNER DEMOGRAPHICS

This is the demographic information of planners in the Chapter 5 study

Planner Participants in Interview

Id	Condition	Age	Gender	Occupation
P_B39	baseline	46	Male	Professor
P_B35	baseline	27	Female	Fitness Trainer
P_B52	baseline	37	Female	Full-Time on Amazon Mechanical Turker
$P_{CF}39$	CrowdFit	25	Male	Film
$P_{CF}57$	CrowdFit	48	Female	Business Development Manager
$P_{CF}49$	CrowdFit	31	Male	n/a
$P_{CF}41$	CrowdFit	33	Male	ER Products Coordinator
$P_{CF}80$	CrowdFit	58	Male	Technical Support Lead
$P_{CF}76$	CrowdFit	33	Female	Stay-at-home parent
$P_{CF}64$	CrowdFit	n/a	Female	n/a
$P_{CF}71$	CrowdFit	n/a	Other	n/a
P_B67wk2	baseline	n/a	Male	n/a
P_B80	baseline	n/a	Other	n/a

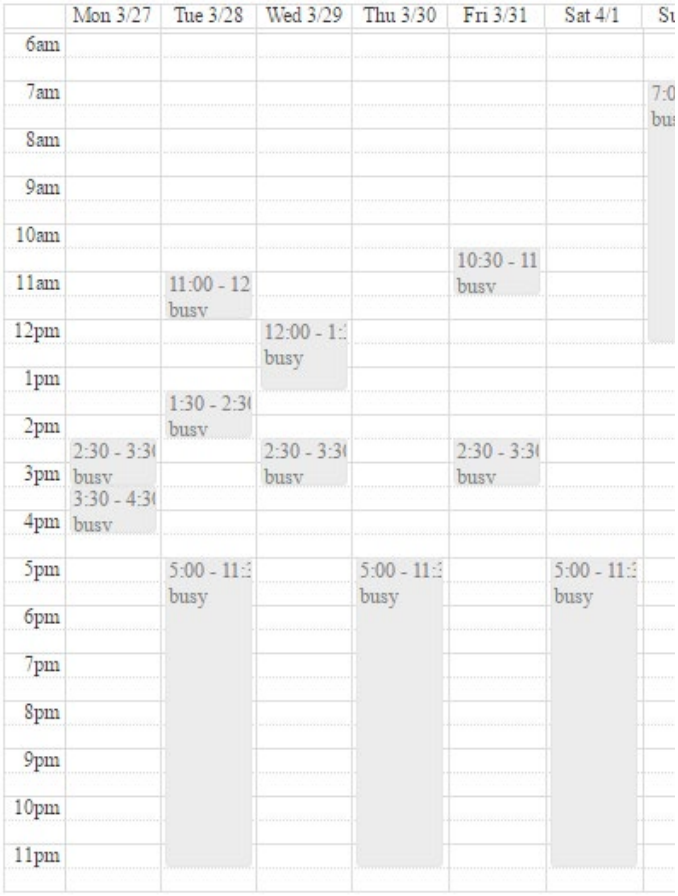
APPENDIX E. EXAMPLE TASK FOR CROWDFIT STUDY

Appendix E. Appendix 2A: Example Task for Crowd Baseline Task

Task:

1. Create a **1-week exercise plan (Monday-Sunday)** that the person described below **can follow next week**. They are a beginner at exercising.
   - Your plan should have the **appropriate level of detail**. Include physical activities and any details the person might need to follow the plan.
   - The plan should be something the person **can achieve** in the next week, and that they will **want to follow**.
   - If you need to use other tools to create the plan, you can do so, but copy paste or take a snapshot of the content you create and add it here. Format your plan **the way that you would want the recipient to see it**.
   - All that you include **will be shared with the person** you are creating the plan for
2. If you need help to learn more about exercise, here are some resources:
   - https://www.reddit.com/r/productivity/comments/439v2n/the_smart_method_of_goalsetting/
   - https://www.reddit.com/r/loseit/wiki/index#wiki_exercise
   - http://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/fitness-training/art-20044792?pg=1
   - http://www.webmd.com/fitness-exercise/features/find-the-best-workout-for-you#1
   - https://www.reddit.com/r/Fitness/wiki/resources
3. Complete the third step in the Mechanical Turk task (the survey) **after** creating the plan.

Client Profile for P19



robotuw

Male, 28 years, 135 lb
Graduate Student

Goals

Next Week's Goal
At least 3 instances of at least 30 minutes of continuous exercise.

Long Term Goal
I'd like to create a habit out of exercising, something I've never been able to do in the past.

Constraints

Time constraints mostly, and just general laziness.

Access to
I am a UW student, so I have access to the IMA. I also personally have a small set of hand weights.

Activities

Likes
Running, aerobics, dancing, strength training
I like activities with constant motion, and I'm most interested in cardio exercise. Something I can listen to podcasts while doing is also appealing.

Interested in, but have not tried
More structured strength training activities
I rarely go to a gym with access to strength training equipment. I also don't know how to use most of that equipment.

Tried, but did not enjoy
Yoga
While I see the benefits of it, it did not feel like I was improving my body while doing it.

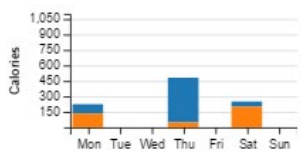
Other preferences
I'd prefer to exercise in the morning.

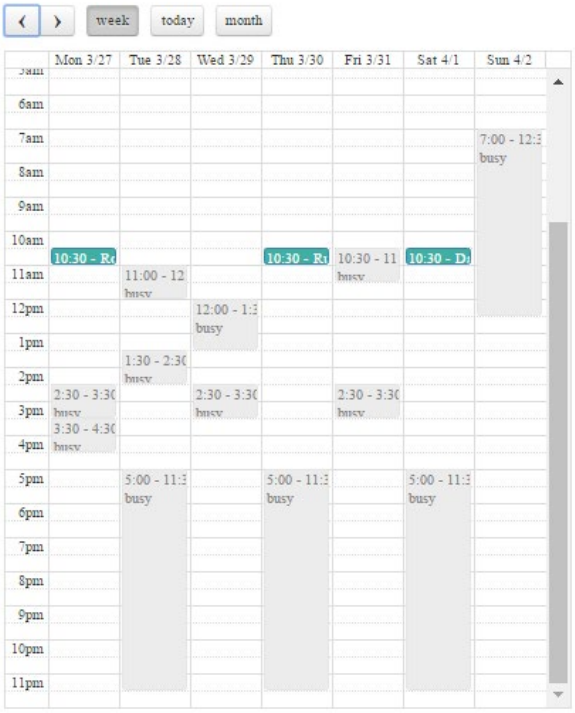
robotuw exercised this much in the past week:

Experience in the past week
Last week I was on vacation, so it was a special case, but I did about 30 minutes of swimming on Saturday, 1 hour of hiking yesterday, and several hours of walking spread throughout the last week.

APPENDIX F. PLANS CREATED BY PARTICIPANTS IN CROWDFIT STUDY

CrowdFit System Plan Created for P19





Mon

Row machine - moderate

10:30 am, 30 min, 60% cardio - 40% strength
Why: a balance of cardio and strength trainingcan listen to podcasts
Prep: Take a picture of the row machine and post it on social media. Sharing with friends might encourage you to stay on schedule. Probably can log how many reps you do on the row machine. Try to improve and challenge yourself each week.
Alternative: Try rollerblading. Easy to listen to podcasts and constant motion.
A row machine is a piece of equipment that simulates rowing over water and it can be used for a cardiovascular workout. more

Tue

Wed

Thu

Running stairs

10:30 am, 30 min, 10% cardio - 90% strength
Why: strength trainingcan listen to podcasts while exercisingexercise that requires constant motion
Prep: Download an interesting podcast. Don't allow yourself to listen to it until you're actually running up and down stairs. Make it a goal to listen to podcasts only when you're achieving a solid exercise rate.
Alternative: you could try an upper body workout. It would still be strength training and could listen to podcasts.
Running stairs is much more challenging than running over the ground. The height of the stairs also makes the activity m more

Fri

Sat

Dancing

10:30 am, 30 min, 80% cardio - 20% strength
Why: You enjoy dancingcan listen to podcastsRequires constant motion
Prep: Can sign up for classes with a friend. Friend will provide support for exercising, and a regular class schedule will encourage you to attend.
Alternative: try hiking. Good cardio exercise. Can still listen to podcasts.
Dancing can take many different forms, but generally involves moving rhythmically to music. This activity can be a fun a more

Sun

Additional comments

Scheduled at 10:30am each exercise day because you wanted mornings, and it'll be easier to make it a habit.

Baseline Crowd Plan for P19

Week 1-

Each routine should begin with a 2 minute stretch/warmup session. Stretch your arms above your head, bending at the elbows. Stretch your legs and flex your toes. Get your heart pumping with a couple standard jumps or jumping jacks. Be sure to collect a full water bottle to keep yourself hydrated.

Monday- 30 minutes of Dance (Your choice of video program or in-person class)
30 minutes of running (Outside or treadmill)

Tuesday- 30 minutes of Cardio (Your choice of video program)
5 reps each: 10 squats, 10 lunges, 10 pushups

Wednesday- 30 minutes of Dance(Your choice of video program or in-person class)
30 minutes of running (Outside or treadmill)

Thursday- 30 minutes of Cardio (Your choice of video program)
5 reps each: 10 squats, 10 lunges, 10 pushups

Friday- 30 minutes of Dance (Your choice of video program or in-person class)
30 minutes of running (Outside or treadmill)

Saturday- 30 minutes of Cardio (Your choice of video program)
5 reps each: 10 squats, 10 lunges, 10 pushups

Sunday- 1 hour of relaxed, afternoon walking

Expert Created Plan for P19

One Week Workout Plan

General Outline

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Rest	Strength 1 10:15-11:00 AM	Rest	Cardio 1 9:15-10:00 AM	Strength 2 10:15-11:00 AM	Rest	Cardio 2 10:15-11 AM

**I chose arbitrary times in the morning for workouts that could give you enough time to shower and get ready. If you are an early riser like me, I'd definitely recommend going earlier in the morning before the IMA gets busy.*

Strength Training

This strength routine will focus on developing baseline strength and coordination and give you a taste of a more structured program. Since you may be new to these exercises, I've provided YouTube links with instructions on how to correctly perform them. Be patient and focus on developing correct form rather than grabbing the heaviest weights you can find! Since we're starting with only two days of strength training, each will be a full body workout so that we can hit all the major muscle groups at least 2x a week.

Strength 1

5 Minute Warm Up: Your choice! Jog, bike, elliptical, or row at a low-medium intensity. *Our goal here is to warm your muscles up for exercise.*
Each exercise below perform **3 sets, 8-10 repetitions. You should be able to complete each set without compromising form, but at the same time it should not be too easy. Don't be afraid to try several different weights until you find a level that challenges you safely.*

Lat Pulldown Machine: https://www.youtube.com/watch?v=UMC48BO-GQE

Bench Press: https://www.youtube.com/watch?v=VmB1G1K7v94

Lawn Mower: https://www.youtube.com/watch?v=-koP10y1qZI

Shoulder Press: https://www.youtube.com/watch?v=qEwKCR5JCog

Bicep Curl: https://www.youtube.com/watch?v=ykJmrZ5v0Oo

Front Raise: https://www.youtube.com/watch?v=-t7fuZ0KhDA

Barbell Squat: https://www.youtube.com/watch?v=Dy28eq2PjcM

Lunge: https://www.youtube.com/watch?v=8OYsCRAb5c4

Stretch and Cooldown: https://www.youtube.com/watch?v=TcSUK-whh_g
_____This is just a video with some ideas of some stretches. Feel free to use stretches that you like and are comfortable with. The idea here is to begin a stretching routine because it is important for recovery as well as flexibility!

Strength 2

5 Minute Warm Up

Incline Bench: https://www.youtube.com/watch?v=8iPEnn-ltC8

Side Raises: https://www.youtube.com/watch?v=7-onZ9-8qnw

Overhead Tricep Extension: https://www.youtube.com/watch?v=YbX7Wd8jQ-Q

Low Row Machine: https://www.youtube.com/watch?v=GZbfZ033f74

Pushups: https://www.youtube.com/watch?v=IODxDxX7oi4

Barbell Squat: (see above)

Leg Press: https://www.youtube.com/watch?v=kuuabK2xhwY
There are several different versions of a leg press machine at the IMA, you will find a larger one downstairs, it follows the same concepts. There are 2 similar to this video in the cardio room and two more on the top floor.

Cardiovascular Training

Since I haven't met you, and not sure what kind of cardio interests you most and what level you are currently at, I'll give you two options for the following workouts. You can either maintain a low-moderate pace for the entire time period (great for podcasts!), or give these workouts a try below! Secondly, I wrote these for a bike, but you can apply the same concepts for an elliptical, stairmaster, or even rowing machine. These workouts will be hard and are written to be modified to the individual. If it seems too difficult, space out the rest periods for longer durations, increase the resistance by 1, not 2, or maintain a moderately difficult resistance for as long as you can. Again, these are just options for you to try, see what works best for YOUR body, and have fun!

What I love about cardiovascular exercise are options! I know that it's starting to get sunny out so another great option is going for a jog or hike instead. You choose what you are comfortable with, what we want to achieve here is consistency.

Bottom line: **For the cardio days, you get to pick!** Below are suggestions for cardio machines.

Cardio 1

Interval Workout 1: Two Hills

To increase intensity, begin at a higher resistance OR maintain a faster pace throughout

- 00:00
    - Begin at a comfortable medium resistance

    - Not too easy but enough to make you work, this is your warmup!
- 03:00
    - Increase resistance by 2 levels
    - Focus on keeping your pace consistent, even if it is slower, try to be steady!
- 04:00
    - Increase resistance by 2 more levels
- 05:00
    - Increase resistance by 2 more levels
    - Even if you slow down, keep a steady pace!
- 06:00
    - Increase resistance by 1 level
    - Almost to the top of the hill!
- 06:30
    - Decrease resistance by 1
    - On the way down, but not done yet!
- 8:00
    - Decrease resistance by 2
    - Keep a steady pace
- 9:00
    - Decrease resistance by 2
- 10:00
    - Take off resistance until you reach your starting resistance
    - Recover at this resistance for 2-3 minutes, DON'T STOP!
- 13:00
    - Repeat

- At the end of your second round, take 5 minutes to continue pedaling, moving, etc. at a LOW resistance to slow you heart rate and begin your cooldown.
- Stretch

Cardio 2

Interval Workout 2: Sprints

- 00:00
    - Begin at comfortable moderate resistance
    - Enough to maintain a steady pace but still makes you work
    - This is your warmup!
- 03:00
    - Increase resistance by 3-5
    - You should be working *hard* and almost breathless by the end of each interval!
- 03:30
    - Decrease to beginning resistance
    - Recovery period
    - Keep a steady pace and don't stop!
- 04:30
    - Increase resistance by 4-6
    - Keep a steady pace! Your effort should be 8/10!
- 05:00
    - Decrease to beginning resistance

    - 1 minute recovery
    - Keep a steady pace, don’t stop moving!
- 06:00
    - Increase resistance by 4-6
    - 8/10 exhaustion
- 06:30
    - Decrease resistance by 2
    - 7/10 exhaustion
- 07:30
    - Increase resistance by 2-4
    - This is your peak! 10/10 exhaustion
- 08:00
    - Return to beginning resistance
    - Recovery for 2 minutes
- 10:00
    - Repeat
- At the end of your second round, take 5 minutes to continue pedaling, moving, etc. at a LOW resistance to slow you heart rate and begin your cooldown.
- Stretch

APPENDIX G. EXPERT EVALUATION RUBRIC FOR EXERCISE PLANS

1. The plan matches the exerciser's preferences, according to the profile.

Preferences might be listed under activities (Likes; Interested in, but have not tried; Tried, but did not enjoy; Other).

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Unable to determine

2. The plan matches the exerciser's constraints according to the profile.

Constraints might be listed in the profile under: constraints, access, comments left about exercising that might affect the person's ability to exercise

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Unable to determine

3. The plan matches the current short term goals of the exerciser.

If the short term goal is vague but the plan generally addresses the goal, response should be either "agree" or "strongly agree", rather than "unable to determine".

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Unable to determine

4. The plan matches the schedule of the exerciser.

Consider how realistic the plan is with other schedule obligations, in addition to the exerciser's commentary about schedule in the profile. If no days or times are provided and there is no commentary about schedule then select "unable to determine". If days are provided but no times and no commentary about allowing scheduling flexibility then select "neutral".

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Unable to determine

5. The vocabulary level of the plan can be understood by someone with low level of exercise literacy.
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree
    - Unable to determine

6. The information in the plan contains mistakes or inaccuracies.

Examples of mistakes or inaccuracies: wrong equipment/description associated with a named exercise

    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always

7. The plan contains irrelevant or inappropriate information related to exercise.
    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always

8. The plan explicitly names what exercises need to be done.
    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always

9. The plan specifies how to perform each exercise.
    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always

10. The plan explicitly states the reason for the activities recommended.
    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always

[conditional, if the answer above is not "Never"]

11. The reasoning provided for the recommendations refers to:
    - Benefits of the activities in general
    - Benefits of the activities for this person
    - Match with the person's preferences
    - Addressing constraints of the person
    - Other
    - None of the above

[multiple choice question]

12. The tone of the plan is encouraging.

If really ambiguous, select the middle option (sometimes).

- Never
- Almost never
- Sometimes
- Almost always
- Always

13. Compared to the ACSM guidelines, the plan's volume requirements are

Exercise volume can be met by any of the following criteria.

- 150 minutes of moderate intensity aerobic exercise per week.
- 75 minutes of vigorous intensity aerobic exercise per week.
- A combination of moderate and vigorous intensity exercise as calculated through the Moderate Intensity Equivalent (MIE) method, which equates to 150 MIE minutes of aerobic exercise per week.
- MIE calculations can be performed with the guidelines below:
    - If exercise is labeled as high intensity, double the time prescribed.
    - If exercise is labeled as low intensity, halve the time prescribed.
    - If exercise has no intensity specified, assume moderate intensity and keep the time as prescribed.

Reserve the "unable to determine" option for very difficult cases only (do your best to approximate)
For yoga, consider it to be light activity unless it is specifically listed as power yoga

- Greatly below the ACSM minimum recommendation range (<75 MIE)
- Slightly below the ACSM minimum recommendation range
- Within the ACSM minimum recommendation range (~150 MIE)
- Slightly above the ACSM minimum recommendation range
- Greatly above the ACSM minimum recommendation range (>225 MIE)
- Unable to determine

14. The plan's amount of exercise is appropriate for the exerciser, regardless of whether it fits in the ACSM recommended range of exercise volume.

Make sure to look at the whole profile.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Unable to determine

15. The plan's balance of aerobic and strength training activities matches the goals outlined in the ACSM guidelines.

The ACSM recommends a comprehensive program of exercise including cardiorespiratory, resistance, flexibility, and neuromotor exercise. Flexibility is important but doesn't carry the same weight as aerobic or strength. If a plan has both aerobic and strength, but no flexibility, choose the "agree" option.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

16. The plan's balance of aerobic and strength training activities matches the exerciser preferences.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Unable to determine

[only show this question for second week plans]

17. Compared to the person's stated activity for last week, the progression of the plan is:

ACSM recommends increasing time 5-10 minutes per session every 1-2 weeks until proper duration values are met. Do not exceed 5-10% increase in total time per week.

- Far too gradual
- Too gradual
- Optimal
- Too abrupt
- Far too abrupt
- Unable to determine

18. The exercise plan includes aerobic exercise.
    - Yes
    - No

[if the answer is no survey should jump to the Strength section]

19. The exercise plan includes a variety of aerobic exercises.
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree

20. The durations of the aerobic workout sessions are appropriate for the exerciser's current fitness level.

ACSM recommends 20-60 minutes of aerobic, resistance, neuromotor, or sport activities; or accumulative bouts of 10 minutes of activity during the day

    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree
    - Unable to determine

21. The intensities of the aerobic workout sessions are appropriate for the exerciser's current fitness level.

If intensities are not listed and not obvious, choose "unable to determine".

    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree
    - Unable to determine

22. The exercise plan includes strength training exercises.
    - Yes
    - No

[this is a conditional question in the survey for strength, if no, skip all strength questions]

23. Select the number of days per week for which the muscle group below is the **primary target** of a strengthening exercise.
    - Assume all major muscle groups are exercised for the following activities (or similar ones): yoga, pilates, rock climbing/bouldering, circus activities
    - For burpees, select chest, trunk, legs, and hips unless burpees with push-ups included are indicated (then also select arms and shoulders)

	none	1 day	2 days	3 days	4 days	5 days	6 days	7 days
Chest	○	○	○	○	○	○	○	○
Shoulder	○	○	○	○	○	○	○	○
Back	○	○	○	○	○	○	○	○
Arms	○	○	○	○	○	○	○	○
Trunk	○	○	○	○	○	○	○	○
Hips	○	○	○	○	○	○	○	○
Legs	○	○	○	○	○	○	○	○

24. The exercise plan includes a variety of types of strength training exercises.
    - ○ Strongly disagree
    - ○ Disagree
    - ○ Neutral
    - ○ Agree
    - ○ Strongly agree

25. The exercise plan includes intensity for strength training exercises.

Intensity can be present in the plan through mentions of capability to perform certain exercises or mentions of a certain number of:

- reps with a particular weight or for a certain period of time.
- Rate of Perceived Exertion (RPE) Scale (Either 1-10 or 6-20 point scale for difficulty)
- 1-Repetition Maximum (1RM) percentages (E.g., “About 70% of your 1 rep maximum”)

    - ○ Never
    - ○ Almost never
    - ○ Sometimes
    - ○ Almost always
    - ○ Always
    - ○ Unable to determine

26. The exercise plan includes an appropriate number of repetitions for strength training exercises.

Appropriate numbers of repetitions are:

- 8-12 repetitions for strength development in most adults
- 15-20 repetitions for muscular endurance
- Duration based exercises are appropriate for exerciser's fitness level.

    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always
    - Unable to determine

27. The exercise plan includes an appropriate number of sets for strength training exercises.

Appropriate numbers of sets are: 2-4 sets recommended, although 1 set is effective for novice exercisers

    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always
    - Unable to determine

28. The exercise plan progresses from multi to single-joint exercises and/or from larger to smaller muscle groups in a strength training session.

    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always
    - Unable to determine

29. The exercise plan includes an appropriate rest periods for 1-3 minutes between strength training exercises within a workout.

If rest is indicated, but not the appropriate amount of rest time, select "Unable to determine".

    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always
    - Unable to determine

30. The exercise plan includes a minimum of 48 hours between strength training of specific muscle groups.

Full body workouts could be performed every other day, but not on consecutive days. If open scheduling is used in the plan but the planner mentions pattern, then select “almost always” or “always”. If an activity is on the border between light and moderate (e.g., yoga, pilates), then don’t count it as a strength-specific day for the 48-hour guideline.

- Never
- Almost never
- Sometimes
- Almost always
- Always
- Unable to determine

31. The exercise plan includes specific exercise modifications in order to allow for easier or more difficult movements.

If the alternative is totally unrelated to the original exercise then don’t count it as a modification.

- Never
- Almost never
- Sometimes
- Almost always
- Always

32. The exercise plan includes specific exercise alternative, that are not modifications.
    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always

33. Flexibility exercises are advised for:

Mentions of flexibility, stretching, mobility, myofascial related exercises could include: static or dynamic stretches, foam rolling, or something similar in nature (exclusions: yoga, pilates, etc).

- None of the exercise sessions
- Some of the exercise session
- All of the exercise sessions

[conditional, ask plan flexibility for all major muscle only if answer is some or all for above question]

34. The exercise plan includes flexibility exercises for all major muscle groups or for multiple parts of the body.
    - Flexibility is explicitly recommended for all major muscle groups
    - Flexibility is explicitly recommended for some major muscle groups
    - General recommendations are made for flexibility
    - Flexibility is not recommended

35. Each exercise session includes a warm-up prior to aerobic or strength training.

ACSM recommends warming up for 5-10 minutes with light or moderate aerobic exercises. If walking or cycling is listed first for the day, that can count as a warm-up, even if it was not purposeful.

- Never
- Almost never
- Sometimes
- Almost always
- Always

36. Each exercise session includes a cool-down post aerobic exercise.
    - Never
    - Almost never
    - Sometimes
    - Almost always
    - Always

37. The exercise plan advises warming-up (e.g. 5 minutes of cycling) prior to flexibility exercises or advises performing the exercises after the workout.
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree

APPENDIX H. CLIENT RECRUITMENT SURVEY, CROWDFIT STUDY

We refer to regular exercise as any planned physical activity (e.g., brisk walking, aerobics, jogging, bicycling, swimming, rowing, weight lifting, exercise band workouts, mat exercises, etc.) performed to increase physical fitness. Such activity should be performed 3 to 5 times per week for 10-60 minutes per session.

Do you exercise regularly according to the definition above?

Yes, I have been for more than 6 months.
Yes, I have been for less than 6 months.
No, but I intend to in the next 30 days.
No, but I intend to in the next 6 months.
No, and I do not intend to in the next 6 months.

Have you done any regular exercise for the past 4-weeks? *
Yes
No

Out of the past 4-weeks, for how many weeks do you think you did regular exercise? *
1 week
2 weeks
3 weeks
4 weeks

Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.
Think about all the vigorous activities which take hard physical effort (you will not be able to say more than a few words without pausing for a breath) that you did in the last 7 days.

During the last 7 days, on how many days did you do vigorous physical activities? *
0
1
2
3
4
5
6
7

How much time did you usually spend doing vigorous physical activities on one of those days? Think only about those physical activities you do for at least 10 minutes at a time. Answer in minutes. *
300

Now think about activities which take moderate physical effort (you can talk, but not sing, during the activity) that you did in the last 7 days.

During the last 7 days, on how many days did you do moderate physical activities? *

0
1
2
3
4
5
6
7

How much time did you usually spend doing moderate physical activities on one of those days? Think only about those physical activities you do for at least 10 minutes at a time. Answer in minutes. *

Now think about activities which take light physical effort, but not walking (you can sing during the activity) that you did in the last 7 days.

During the last 7 days, on how many days did you do light physical activities, not walking? *

0
1
2
3
4
5
6
7

How much time did you usually spend doing light physical, not walking, activities on one of those days? Think only about those physical activities you do for at least 10 minutes at a time. Answer in minutes. *

Now think about the time you spent walking in the last 7 days.

During the last 7 days, on how many days did you walk for at least 10 minutes at a time? *

0
1
2
3
4
5
6
7

How much time did you usually spend walking on one of those days? Think only about those physical activities you do for at least 10 minutes at a time. Answer in minutes. *

APPENDIX I. CLIENT INTERVIEW PROTOCOL, CROWDFIT STUDY

Plans followed in week1 and week2:

General impressions

1. Can you tell me about your **first reactions** as you received the plan?
    - What were your expectations about the plan?
        - disappointed in any way? Or is this better?
    - In your feedback about the plan you said that [insert feedback]. Can you tell me more about that?
        - Probe: what did you find helpful in the plan, not helpful [jump straight into the specific activity questions if this doesn't apply]

2. What, if anything, did you do as you **prepared to follow** the plan?
    - Did you do anything to ensure you followed the plan when you received it?
        - E.g. put it in your calendar, print it out, schedule time to exercise, prepare equipment?
        - How often did you look at the plan?
        - did you look up any other information when you got the plan?
    - did you make any changes or customizations when you first received it?
    - Did you do anything to follow the plan on a daily basis?

Actual barriers or facilitators to following behavior (for each activity recommended)

3. I want to talk through some of the recommended activities with you. How did you **go about deciding whether to do an activity** as it was recommended, or with modifications? Or not at all? Or maybe add other activities?
    - What changes did you have to make?
    - What details did you have to fill in yourself?

4. Can you pick an activity and tell me **how you went about following** the recommendations?
    - What activities you were not able to follow?

[Pick an example of an activity **they performed successfully** (from their exercise log)]

5. Let's talk about some activities you said **you did** in the survey. I saw you did [insert activity] on [day]. What **helped you follow** this recommendation?
    - How did you prepare, if at all?
        - access to equipment? time management? planning ahead? any special preparation?
    - Were you familiar with the activity? Did you perform this in the past?
        - How was it different than other times you performed this?
        - If it's new, what information did you need to perform it?
    - In what ways did this activity fit in with your life?

[Pick an example of an activity **they had to modify to perform it** (from their exercise log)]
6. I noticed you **modified** [insert activity] in order to do it on [day]. Why **did you modify** this activity?
    - How did you change it?
    - In what ways did this activity fit in with your life?
    - Were you familiar with the activity?
    - How did you prepare, if at all?
        - access to equipment? time management? planning ahead? any special preparation?

[Pick an example of an activity **they did NOT perform** (from their exercise log)]
7. I noticed you **did not perform** [insert activity] on [day]. What **prevented you from following** this recommendation?
    - In what ways did this activity not fit in with your life?
    - Was there any information that you needed but did not have?
    - How did you feel about not doing the recommended activity?

[Pick an example of an activity **they performed but was not in the plan** (from their exercise log)]
8. I noticed you did [insert activity] on [day], and that was not in the plans. What made you perform this activity?
    - How did you prepare, if at all?
        - access to equipment? time management? planning ahead? any special preparation?
        - When did they decide to do this over a different recommendation?
        - Did you still follow the original recommendation?
        - How did you feel about not doing the recommended activity?

9. Are there any other activities that you **performed that were not in the plan**? [look at activities in their log and refer to activities performed not in the plan]
    - Why those activities? Why those over the ones in the plan?
    - Is there anything that can be improved in the original recommendations to do them?

Information needs in the plan
10. We've talked some about following the plan, but now I want to talk a bit about how the information was presented. In what ways was plan was **easy or difficult for you to understand**?
    - **What parts** of the plan were **easy to understand**?
        - What helped make it easy to understand?
    - What parts of it were **more difficult to understand**?
        - How could they have been better?

11. Now that we've discussed how easy of difficult it was to use the plan, I'd like to talk about **what wasn't in the plan.**

- Was there any information that would have helped you but seemed like it was **missing**?
- Did you go elsewhere to find that information? Where?

12. Are there **changes** you'd make to the **information included in the plan**?
    - What?
    - Why do you think that would help?
    - What information did you have to look for? Where did you find it?
        - Videos, magazines, other people

About the notes that came with the plan (without system these might or might not exist)

13. What did you think of the **notes** for the exercise recommendations made to you?
    - [pick a specific day and read the prep text] What do you think about the information provided with this activity?
    - What did you find useful / not useful about them?
    - What did you think about the information on **Why** the activity was recommended?
    - What was it like to receive the information on **how to prepare** for each activity?
    - What did you think about the **alternatives** provided for each activity?

14. [CF] How did you use the **information summary about calories**?
    - What about the **cardio and strength**?

15. [CF] Can you talk about how you made use of having physical activities scheduled alongside your other availability on the **calendar**?

16. Did you notice any difference between the notes provided in week1 and week2?
    - What were some strengths for the notes provided in each week?
    - What were some weaknesses?

Move to the plan for week2 [repeat any questions previously about barriers and facilitators to performing activities, skip questions only if they are redundant. Focus on activities that are different than previous week, or in differences in their reported behavior]

About Week2 plan

General impressions

17. Can you tell me about your **reactions** as you received the plan, compared to the first week?
    - How did you expect the plan to change?
        - Were you disappointed in any way? Or is this better?
    - In your feedback about the plan you said that [insert feedback]. Can you tell me more about that?
        - What they found helpful, not helpful, what information needs, organization of the information

18. What, if anything, did you do differently in the second week as you **prepared to follow** the plan?
    - Did you do anything to ensure you followed the plan when you received it?
    - did you make any changes or customizations when you first received it?
    - Did you do anything to follow the plan on a daily basis?

Specifics for week2

19. What were some **strengths** of this plan compared to the plan you received in the first week?

20. What were some **weaknesses** of this plan compared to the plan you received in the first week?

21. What did you expect would be different about the second week's plan?

Overall improvements they would make to the plan

[if not answered]

22. Are there any [other] **improvements** do you have for this plan?
23. To summarize, what part of this plan helped you the most?
    - What helped you the least?
    - [if not answered] What particular suggestions are useful / not useful?

24. Was there anything in the plan that **you didn't know** about until now?

25. What, if anything, about this plan **surprised** you?

26. If you could give the person who made this plan one piece of **feedback**, what would it be?
    - Please state explicitly what you would tell this person. Why?
    - How do you think the plans might have differed if you did?
    - Is there anything you wish you had not shared with them?

Presentation and layout of plan

[if not answered]

27. Are there **changes** you'd make to how this information is **formatted or presented**?
    - What? Why do you think that would help?

[Now go on and review Plan A and Plan B]

Let's open Plan A now. [then do the same for plan B]

28. How does it compare to the plan you had to follow?
    - You mentioned [their feedback] in your survey. Can you talk more about this?

29. Please point to some specific **strengths** of this plan over the plan you followed.

30. Please point to some specific **weaknesses** of this plan over the plan you followed.

Previous attempts to change

31. Have you previously tried to exercise more? How does following the plans compare to your previous attempts to exercise?

- What was your approach in the past?
  - Did it work? *[If yes:* What about your approach do you think was helpful?; *If no:* Why don't you think that approach worked for you?]
  - If they have tried other plans
    1. what worked about them
    2. did they stick with the plan? if not, why?
    3. how do they compare with the plan we sent?
- How would you go about figuring out how to exercise more

And before we wrap up, I want to ask if there's anything else you'd like to tell us or that you wish we had asked about?

[Thank them again, give them info about how / when they will get the gift card]

APPENDIX J. PLANNER INTERVIEW PROTOCOL, CROWDFIT STUDY

Thank you for taking the time to talk through your experience creating an exercise plan as part of our task. We are studying how people create exercise plans. To begin I want to emphasize that we value your work. It is very helpful for us to understand how you went about creating an exercise plan.

We sent you an email with a link for the task you performed. Can you open the link? This is the page you open as part of the Mechanical Turk HIT. I want to walk through each page with you and we want to learn how you used and interacted with each page.

Because I can't see your screen I will want you to walk me through what you see on each page we will go through and I will ask you a few questions. Do not browse between pages until we talk about going to the next page.

Imagine you are doing this as part of the Mechanical Turk task you did for us. We want to know how you normally do a task like this.

Intro Page

- Can you describe the page you are on now? [they should describe the intro page]

Let's continue to the next page, please click on "Review Guidelines". Let me know if a new page opens and what you see on it.

Exercise Guidelines Page (you will ask more about guidelines later)

Read through the exercise guidelines as you would while doing this task. Let me know when you finished reading and I will ask you a few questions.

1. What was your **reaction** to reading these exercise guidelines?
2. How **familiar** were you with the information in the guidelines?
    - amount of exercise, calories, balance of cardio and strength, pattern of exercise, description of activities
3. Can you tell me if you **agree** that these are the right exercise guidelines for a good exercise program?
    - Are there aspects you **disagree** with? Which?
    - Are there other considerations you would **include** as part of this?

Let's continue to the next page, please click on "Go To System Tutorial". Let me know if a new page opens and what you see on it.

Tutorial Page

Click "Restart Tutorial" and go through the entire tutorial of the different elements on the page, as you would while doing this task.
OR Click "Next" to go through the entire tutorial of the different elements on the page, as you would while doing this task.
Let me know when you finished reading and I will ask you a few questions.

4. What was your reaction to the tutorial?
5. Was there anything that was surprising to you?

Let's continue to the next page, please click on "Get started working with your exercise client".
Let me know if a new page opens and what you see on it.

Profile page
Please read through the profile and let me know when you are done

6. How would you use this profile to create an exercise plan for this person?
    - what information in the profile do you find particularly useful? Why?
    - Is there any information you wish **you had but did not**?

Let's continue to the next page, please click on "Start scheduling exercises". Let me know if a new page opens and what you see on it.

Schedule page (all sections below):
On this page I want you to **talk out loud through everything you see, anything you read, anything you click on**, I would like you to share it with us.

I would like you to start creating a plan for [profile username].
7. Tell me first how you plan to go about creating the plan.

Now start creating the plan, I want to talk through how you are creating the plan.
8. Please describe step by step how you choose a physical activity for this person and how you use the web page. How do you make use of / decide on:
    - Interacting with calendar
        - Duration of activity
        - Choosing time of activity in the day
        - Choosing day of the week
    - Choice of activity
        - Do you use search box? or scroll through list? (wait for them to talk about this)
        - How do you decide between activities?
    - How did you make use of the information presented for each activity on:
        - amount of cardio,
        - amount of strength,
        - calories in decision
        - description of activity
    - Did you **use** any other information?

- Did you **need** any other information?
- What was helpful in the information you were provided with? What was not helpful?
- Did they make use of the **profile** information?

9. How do you decide on the additional information you provided with the activity:
    - Reason for recommending this activity
    - How to prepare for the activity
    - Alternatives to the activity
10. How do you think the explanations you provided can help the person follow through with the plan you created?

11. Did you consider other activities that would be a good fit for this person?

12. Did you notice the graphs that are on the page?
    - What do you notice in them?

Use of last week's activity and plan

13. How did you use information about
    - the activities the person performed last week?
    - about the plan the person had to follow last week?
14. How were the activities you chose similar/different from last week's plan?

Now I want us to look at the plan you created

Barriers to following recommendations

15. Talk through each physical activity you recommended in the plan. Do you think there is anything that might come in the way of the person performing this activity?
16. Was there any suggestion for physical activity that you were **reluctant** to include in the plan?
    - what? why?

Guidelines page and Tutorial

17. You were presented with a few physical activity guidelines. Describe how you used the physical activity principles to create the plan. How did you decide on the
    - *amount* of physical activities you recommended?
    - *balance of cardio and strength* in the physical activities you recommended?
    - *spread* the physical activities *throughout the week*?
18. How do you think the physical activities you recommended compares to the level of *activity the person was performing before*?
    - How did you take that into account?

Information used to create the plan

19. What was most helpful information you had in creating the plan?
    - What was least helpful?

20. Did you search for any additional information? Did you want any additional information?
    - [gdocs] did you read through any of the links provided to you?

- for what info?
- particular websites?
- if not, why did you feel you didn't need additional info?

21. Was there anything you'd like to do but **couldn't because of the limits of the software** tools we provided?
    - What? (*alternatively*: In what ways were the software tools we provided limiting?)
    - And are there any ways in which you think the tools provided hurt the quality of the plan you generated?

22. Would you do anything differently if you were asked to create another plan for someone else?
    - would you change anything in the plan you created?
    - would you do anything differently?

Other system features

23. And before we wrap up, I want to ask if there's anything else you'd like to tell us or that you wish we had asked about?

[Thank them again, give them info about how / when they will get final gift card/]

APPENDIX K. INFORMATION SHEET CLIENT

Study Information Sheet

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When all your questions have been answered, you can decide if you want to be in the study or not.

PURPOSE OF THE STUDY
The purpose of this study is to evaluate the influence and design of suggestions for improving personal behaviors.

STUDY PROCEDURES
If you choose to participate, we will ask you to:

- **answer a set of survey questions**. This should take up to 15 minutes.
- **use a custom tool for a minimum of two weeks that provides you with suggestions about ways to improve your exercise.** The exercise suggestions will be provided by people who do not know you. You should use these suggestions as you see fit. We are not endorsing them, but rather make them available you. Do not follow any recommendation that you do not feel comfortable following.
- **answer survey questions daily during the study**. It should take up to 10 minutes each day to answer the questions.

To be compensated $50 for the participation in the study, you will have to complete the survey questions we send you throughout the study. You do not have to follow the suggested plan to receive this compensation.

At the end of the study, we might select you for **conducting an interview** about your experience using the system. If you are selected for an interview, we will compensate you with an additional $15 for completing the interview. The interview should last up to 1 hour. You do not have to follow the suggested plan to be selected for an interview or to receive further compensation.

RISKS, STRESS, OR DISCOMFORT
When beginning a new exercise routine, such as the plan you receive as a part of this study, there is some risk of injuries or adverse effects. Please read the following guidelines from the US Office of Disease Prevention and Health Promotion about physical activity safety http://health.gov/paguidelines/guidelines/chapter6.aspx and consult your doctor if you have any questions or concerns before following any suggestions. You should not follow any suggestions that you do not want to follow. You will be responsible for any costs associated with consulting your doctor.

You may experience some discomfort at answering questions about your behavior and preferences. You might feel that you are being judged for your answers because they are being

recorded, seen by other people and will be analyzed for the purpose of this study. We discuss these privacy concerns in the Other Information section of this information sheet.

BENEFITS OF THE STUDY
We hope that the results of this study will help people design solutions for behavior change applications. From using the system, you might learn new techniques to improve on desired behaviors, but it is possible you may not directly benefit from taking part in this research study.

OTHER INFORMATION
Taking part in this study is voluntary. You can end your participation in the study at any time. We will keep the study information anonymous. We will record your identifying information separately from your answers. None of the answers and ratings you provide can be traced back to you. In order to send you suggestions for behavior change, we will show some of your preferences to other people, but the data will not be associated with you. We will store this data on a password-protected computer. We may want to show or use specific parts of our data in research presentations or publications - at conferences, in university classrooms, in articles, or with companies and organizations with whom we collaborate.

Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk or harm.

Participant's statement
If you have questions about the research, please contact Elena Agapie at eagapie@uw.edu. If you have questions about your rights as a research subject, you can call the UW Human Subjects Division at (206) 543-0098. If you would like a copy of this information form, you can download a PDF or save this web page by choosing "file --> Save as".

APPENDIX L. INFORMATION SHEET PLANNER

Study Information Sheet

Title of Study: Supporting Behavior Change Through Crowdsourcing
Name of Lead Researcher, Department & Contact Information:
Elena Agapie, 510-621-3536, eagapie@uw.edu
Human Centered Design & Engineering, University of Washington

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When all your questions have been answered, you can decide if you want to be in the study or not.

PURPOSE OF THE STUDY
The purpose of this study is to evaluate the influence and design of recommendations for improving personal behaviors.

STUDY PROCEDURES
If you choose to participate, we will ask you to answer a set of questions on how a person could improve their behavior. This might involve analyzing the activities of a person, scheduling activities to improve behavior, providing recommendations on how to address behavioral barriers or how to plan and perform activities. All these activities should take up to one hour.

We will ask you to answer survey questions about your experience providing behavior change recommendations after you complete the task.

In order to be compensated for the study you will have to provide answers to the behavior change prompts we provide and to complete answering the survey questions we send you at the end of the study. The entire study should not take more than 90 minutes.

At the end of the study, we might select you for conducting an interview about your experience using the system. If you are selected for an interview, we will compensate you with an additional amount of money for completing the interview.

RISKS, STRESS, OR DISCOMFORT
You may experience some discomfort in providing other people with personal recommendations or in seeing other people's behavior. You may experience discomfort knowing that your recommendations might be followed by other people.

BENEFITS OF THE STUDY
We hope that the results of this study will help people design solutions for behavior change applications. From using the system, you might learn new techniques to improve on desired behaviors, but it is possible you may not directly benefit from taking part in this research study.

OTHER INFORMATION
Taking part in this study is voluntary. You can end your participation in the study at any time.

We will keep the study information anonymous. We will record your identifying information separately from your answers. None of the answers and ratings you provide can be traced back to you. In order to send you recommendations for behavior change, we will show some of your preferences to other people, but the data will not be associated with you. We will store this data on a password-protected computer. We may want to show or use specific parts of our data in research presentations or publications - at conferences, in university classrooms, in articles, or with companies and organizations with whom we collaborate.
Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk or harm.

PARTICIPANT'S STATEMENT
If you have questions about the research, please contact Elena Agapie at eagapie@uw.edu. If you have questions about your rights as a research subject, you can call the UW Human Subjects Division at (206) 543-0098. If you would like a copy of this information form, you can download a PDF or save this web page by choosing "file --> Save as".