Addressing Medication Adherence Technology Needs in an Aging Population

Jessica Pater*, Shane Owens, Sarah Farmer, Elizabeth Mynatt*, and Brad Fain
Georgia Tech Research Institute
Interactive Computing, Georgia Institute of Technology*
Atlanta, GA USA
[pater, mynatt] @gatech.edu; [shane.owens, sarah.farmer, brad.fain]@gtri.gatech.edu

ABSTRACT
Using technology to inspire behavior change motivated by a health goal is a challenge. Technologies, often rooted in sound scientific principles, sometimes do not perform as expected in real world scenarios. Quite often the barriers to use are not inherent in the behavior change model of the product or service, but are issues associated with the failure to appropriately consider the needs of the end users when designing an intervention. We deployed a large, multi-stage research study with aging adults to assess the facilitators and barriers of technologies aimed to create or support behavior changes related to medication adherence. Using the Fogg Behavior model, we analyzed the triggers made on behavior change through data from surveys, in-home interviews, participatory design workshops and the deployed technologies. Our results indicate that the user experience associated with delivery of the content is at least as important as the content. Additionally, experienced users are far better prepared to help researchers identify potential design issues than novice users. Because our participants were knowledgeable about the technologies and the features that worked and did not work, the concluding participatory design sessions were highly efficient in providing feedback on the type of mechanisms that resonate with this population and could lead to higher levels of behavior change in future technologies.

Author Keywords
Medication adherence; wearable technology; mobile application; behavior change

ACM Classification Keywords
H.5. Information interfaces and presentation: User-centered Design; J.3. Life and Medical Sciences: Health

INTRODUCTION
Adherence with medication, as part of a treatment regimen for long-term conditions, is a behavior that is often not sustained. The World Health Organization has reported that sustained. The World Health Organization has reported that for long-term conditions the treatment adherence rate is 50% world-wide [31]. Non-adherence to treatment regimens poses a serious health risk that can lead to emergency room visits, hospitalizations, further testing, further illness, accidents, or death [15]. One particular at-risk population is older adults who live in their own homes and may not, as a result, be monitored regularly by caregivers or healthcare providers. This severity of this issue is continuously increasing, as projections show that the size of this population will continue to grow, with 20% of the world population being over 60 years of age by 2045 [36].

While some research has been conducted to develop technological approaches for medication adherence in the aging population [4,15,20], very little - if any - research has focused on the facilitators and barriers to various technological and non-technological interventions developed to increase adherence in this population. In our study, we use the Fogg model for persuasive design to outline a research protocol in which we introduce different technologies and interventions into an aging population and assess what works and what doesn't as it relates to medication adherence. Through an informed, culminating participatory design workshop, we uncover motivations and triggers that translate into design considerations for those looking to optimize socio-technical health solutions for this population.

In summary, our work offers the following contributions to the HCI community:

1. We operationalized the Fogg Behavior Model to design a multi-stage research study that assesses the impacts of certain triggers on medication adherence in an aging demographic with hypertension.
2. We conducted a longitudinal in-home study with older adults living at home, assessing how they receive triggers based on messaging and mobile applications in addition to wearable technologies.
3. We articulate a suite of design considerations for the community that is focused on developing socio-technical health solutions, specifically medication adherence for older adults.

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PREVIOUS WORK

Medication Adherence

There are a variety of reasons that high rates of medication adherence are difficult to attain, which are complicated by age, ethnicity, co-morbid medical or psychiatric conditions, availability of education and resources, and socio-economic status. Fulmer et al. observed that in seniors, cognitive ability and mood can significantly impact adherence with a medication regimen [15] which can be further exacerbated by issues associated with aging like vision loss [9]. Other reasons could include complexity, high cost, difficulty remembering schedules, lack of understanding, not feeling sick, side effects, embarrassment, depression, health literacy, and belief systems [35].

Technological Applications to Adherence

Strategies for improving medication adherence have ranged from education, to more active assistance including coaching [8], reminders [21], mobile [12,32], and technological aides [4,18]. More advanced applications have seen innovations in medication adherence technologies that incorporate robotics [18] and ingestible sensors [20]. A review conducted by Haynes et al. considered several interventions aimed at improving medication adherence, including educating patients on dosages and refills [19]. Among the most effective technology-supported interventions for increasing medication adherence were pharmacist telephone follow-ups (after 3 days of medication), regular automated telephone assessment, self-care education telephone conferences with a managing nurse, special pill containers, reminders, self-monitoring, feedback, and reinforcement.

Technology interventions within this domain are not without challenges, most commonly related to adoption and costs [30]. Not only can they be expensive, but they can be inconsistent and prone to malfunction. These technologies can be difficult to use for patients with chronic diseases such as arthritis, especially for tasks requiring a physical manipulation opening and closing of the devices [13]. Many technologies require patients to have access to a cell phone with text messaging capability or own a device connected to the Internet. However, access to such technologies is not universal for older adults. A recent Pew study found that only 27% of U.S. adults ages 65+ own a smartphone [33]. Additionally, older adults have expressed privacy concerns with respect to health technologies [5]. This technology gap can hinder the ability of older patients to take advantage of interventions that otherwise may have a high potential of being effective.

Behavior Change Theories – The Fogg Behavior Model

HCI research has a long-standing tradition of integrating theories of behavior change into our research. Some of the more commonly theories include the Transtheoretical Model of Health Behavior Change [29], Social Cognitive Theory [2], Theory of Planned Behavior [1], and Self Determination Theory [16].

The Fogg Behavior Model for Persuasive Design enabled us to systematically explore facilitators and barriers to use. This model asserts that for any given behaviors to be realized a person must concurrently be properly motivated, have the capability of carrying out the behavior, and be triggered to perform the behavior [14]. Triggers succeed when the change is somewhat easy and there is a high motivation by the user. If the motivation drops or the triggers become too difficult, technology designers can use this framework to identify what potentially is causing the impediment to an individual's desired behaviors. Figure 1 highlights the components of this framework.

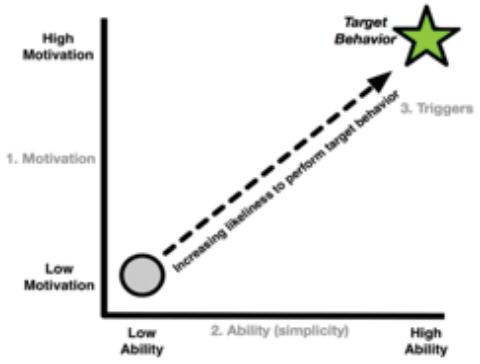

Figure 1. Fogg Behavior Model for Persuasive Design [14]

Fogg describes triggers as falling into one of three categories. A "spark trigger" is when a person lacks motivation and needs an extra push or "spark" to rally them into action. A "facilitator trigger" encourages users to believe that the target behavior is within grasp and that the user is able to ascertain the behavior even if this is not necessarily true. Finally, a "signal trigger" does not encourage the user to take action, yet signals that an optional action is available. The user typically has both the motivation and the ability to perform the behavior, yet lacks the drive to engage the behavior without some form or prompt [14].

We use the Fogg behavior model to guide the design of a technological intervention to encourage medication adherence. Through the longitudinal assessment, we identify facilitators and barriers associated with mobile applications and wearable technologies aimed at increasing medication adherence in an aging population with hypertension.

RESEARCH DESIGN

The research design comprised three phases. Each phase was six weeks in duration for a total of eighteen weeks. Phases 1 and 2 consisted of direct technology interventions. Phase 3 consisted of an informed participatory design activity. The initial phase included no technology interventions. The second phase included the introduction of three mobile technologies that sent messages to participants reminding them to take their prescribed

medications. Figure 1 gives a high-level overview of the research design for Phases 1 and 2. The affiliated University's Institutional Review Board approved this research protocol. All data collection took place between July 2015 and February 2016.

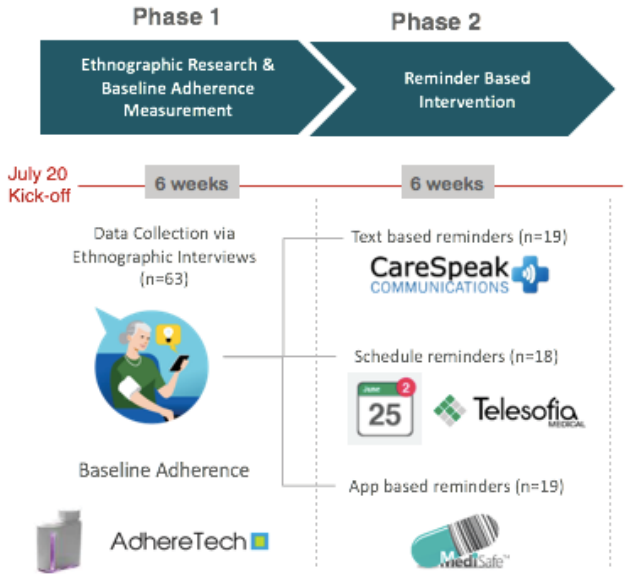

Figure 1. Research Design Overview

Technology Selection

It should be noted that this study was not focused on validating a specific technology or comparing one technology to another. The main purpose of this study was to validate certain behavioral approaches and their ability to increase medication adherence over time and to identify any potential barriers to reaching the technology's intended goals. Below is detailed description of each technology used in the study.

The *AdhereTech Smart Wireless Pill Bottle* was used in each phase of the research. These bottles collect and send real-time adherence data to a secure server. The system automatically analyzes and populates the data on a user dashboard [37]

Medisafe is a free, flexible application for Android and iOS that sends app-based reminders that it is time to take medication. The application can sync among family member's apps and alert each other if one person misses or skips their schedule medication [38].

Telesofia Medical is a platform that allows patients to setup up a medication schedule. Additionally, healthcare providers can automatically generate customized educational videos for patients [39].

CareSpeak Communications is a message platform designed to send text reminders, engaging patients and their caregivers in hopes to increase medication adherence [40].

Finally, we used the *Withings Blood Pressure Cuff.* This device is a wireless blood pressure monitor and health application that gives you immediate biometric feedback on your blood pressure and heartrate [41].

The AdhereTech smart pill bottle was used to more accurately assess medication schedule compliance. These technologies are popular market tools that have been begun to be assessed in the health technology and HCI literature [7,17,23]. Before this study, none of the participants reported having used any of the selected technologies.

Phase 1 – Preliminary Phase

During this preliminary phase, no interventions were deployed to the participants. The focus of this phase was to collect initial baseline assessments of all participants. Researchers met with individuals in their home where they conducted a battery of initial surveys, interviews and an observational analysis of the participant's home environment. In addition to the battery of surveys, participants used the AdhereTech smart pill bottle with reminder features disabled to passively assess baseline medication schedule compliance. This technology was used in each Phase of the research to assess adherence in addition to the participant reflections on their adherence measures.

Phase 2 – Reminder-Based Interventions

During Phase 2, the participants were split into three cohorts. These were stratified random groupings based on age, gender, and technology experience. Cohort A (n=19) were placed in the CareSpeak Communications group. They were sent text-based reminders associated with their daily prescription doses. Cohort B (n=18) were placed in the Telesofia Medical group and were sent calendar reminders based on their daily prescription doses. The final group, Cohort C (n=19), downloaded the MediSafe application on their smartphone and were sent app-based reminders about their medications. Researchers preformed in-home interviews at the end of the 6-week period.

Informed Participatory Design Session

During Phase 3, we invited a representative subset of participants to participate in a two 2-hour design session with the research team. At the onset of the first session, we presented the participants with technology challenges that we observed during Phase 1 and 2 of the research and asked them to brainstorm solutions for those targeted issues. Groups then shared their designs with the larger group which was followed by a discussion about the pros and cons of the proposed solutions and distilled contributions down to features/solutions that the group felt were the most actionable. During the second session, the participants were presented with the feature/solution set that was developed during the prior participatory design session. These were discussed at length and further refined.

METHODS

To test if the research design had an effect on medication adherence in the target population, we chose a mixed methods approach that includes the use of data from the deployed devices, user surveys, and participatory design groups. We deployed these methods over three phases of research. Below we describe in detail the participants and the tools used to collect our data. Table 1 highlights what treatments and assessment tools we deployed during each phase.

Recruitment

We recruited participants through the Georgia Tech HomeLab[1]. HomeLab is a testbed – a network of over 600 homes distributed throughout the state of Georgia. Participants represent a diverse cross section of aging adults and represent both U.S urban and suburban demographics. Participants in this testbed go through a detailed induction process where information about them and their homes are gathered. The project was socialized with participants via direct messaging through the HomeLab network.

Participants

A total of 63 participants from [redacted] opted to join this study. There were 41 females and 22 males, with a mean age of 72 years (SD = 7.7) ranging from 56 years to 85 years old. The ethnicity of our participants mirrored the composition of the larger community – 55% Caucasian/White, 38% African American and 7% other racial origin (American Indian, Filipino, Cuban, and Puerto Rican). Inclusion criteria for the study required that participants had hypertension, have at least three prescribed medications, and managed their own medications. We selected hypertension as a prerequisite because it tends to be a disease more common in aging populations and it is estimated that around 50% of patients stop taking their antihypertensive medications within the first year of treatment [10].

Survey Tools

We used multiple survey tools in this research. We deployed all of the surveys before the treatments took place. During each in-home interview, we administered the Medication Adherence questionnaire.

Medication Inventory

This internal survey is a standard instrument used for all HomeLab projects. Developed internally, this questionnaire asks participants about their medications, the dosage, the prescribing doctor, if the patient trusts the prescribing doctor, and if the patient received any form of education regarding the medication.

Medication Knowledge Assessment

This team created a survey to assess the following for each medication that the participants take: description of the medication, where it is stored, number of pills taken, dosage, side effects, date of next refill, and how the medication is obtained. There is an additional space for general comments the participant might offer about the medication.

Morisky 8-Item Medication Adherence Questionnaire

This simple inventory is one of the most widely used tools to assess medication adherence within patient populations [26]. Developed by Donald Morisky, this questionnaire asks patients about their compliance, how often they remember to take medication, and reasons why they might stop taking their medications [25].

Technology Experience Profile

This tool was adapted from the Technology and Computer Experience Questionnaire [6] and assesses an individual's familiarity and experiences with different technologies in several key technology domains including communication, computers, transportation, everyday technologies, and healthcare [3]. The goal for modifying the original questionnaire was to shorten the length and update the tool for technology innovations that were now available to the general public.

Phases	Treatments	Assessment Tools
1	• No Interventions • Monitoring base medication adherence • Duration – 6 weeks	• Surveys • Interviews
2	• Participants received reminders from smartphone application	• Surveys • In-home interviews
3	• No direct treatment was observed	• Participatory design session

Table 1. Overview of methodologies used during each phase of research

Interviews

Participant interviews took place at the beginning and conclusion of Phase 1 and Phase 2. Interviews were between 30 and 60 minutes in duration and were conducted in the participant's home. The interviews were semi-structured – there were standard questions that were asked of all participants but there were also more open dialogue where participants discussed technology issues or other unprompted items related to their participation. We asked about their medication routine and where they spend their time (i.e., how many days a week they spend at home, at work, "on the go", or elsewhere). Additionally, participants filled out information about routine and non-routine medication events. This inventory included if they ever missed medications, if they had specific triggers for medications, types of containers they used, and how they prepared their medications.

[1] http://homelab.gtri.gatech.edu

Informed Participatory Design Sessions

At the conclusion of the research study, two participatory design sessions were held with a subset of study participants – a total of 10 participants were involved in this research activity. The primary goal of these design sessions was for participants to design their ideal technology solution regarding their medication adherence. While unorthodox to have the participatory design sessions conclude a research project – a large corpus of HCI literature starts with participatory design sessions and then tests the crowdsourced approach(es)- the demographic group we focused on in this study was initially quite unfamiliar with health-based technologies. Pollack et al. demonstrated that having informed participatory design sessions at the conclusion of a research study can yield rich and insightful comments that would have been virtually impossible before because of the general unfamiliarity of a complex system to the novices they were trying to engage [28].

FINDINGS

Phase 1 – Preliminary Phase

Impacts on daily life

During the initial interviews, we asked participants how their medical conditions, including the hypertension control for this study, impacted their daily lives. Chart 1 shows the biggest impact on daily life is the decrease in their ability to do specific things or tasks and dealing with the associated symptomatic pain.

Self-assessment of medication adherence

During their initial interviews, participants were asked about the importance of taking medication on time. 78% rated taking their medication on time as very important. Of the remaining 22%, we asked what events would lead them to increase their ratings to "very important'. 21% answered if their symptoms increased, 19% said that if the side effects decreased and 7% responded they would change their score if there was increased involvement of their family. 21% responded that nothing would lead them to increase their rating.

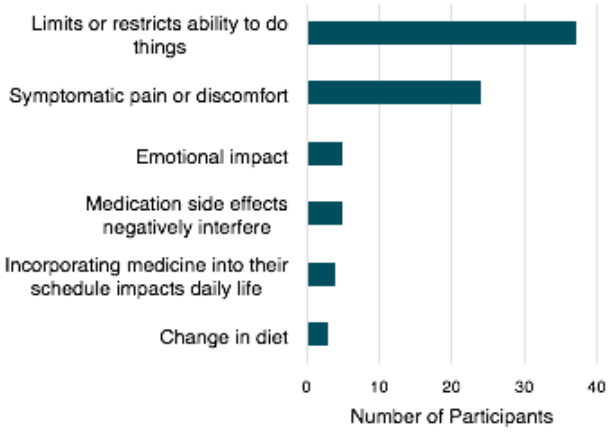

Chart 1. Impacts of medication on daily life

A large percentage (72%) of participants reported that they had missed medication doses in the past. When asked why they missed a medication dose, 64.9% reported they *unintentionally* missed their medication, 31.6% reported *intentionally* missing their medication (i.e. I'll take them later), and 3.5% were split between the two tendencies. Unintentional reasons included forgetting (29%), being distracted (16%), and being in a rush (10%). Intentional reasons included losing medication (10%), not wanting to (8%), and being busy (7). Chart 2 highlights the primary reasons that participants reported that medication doses were missed.

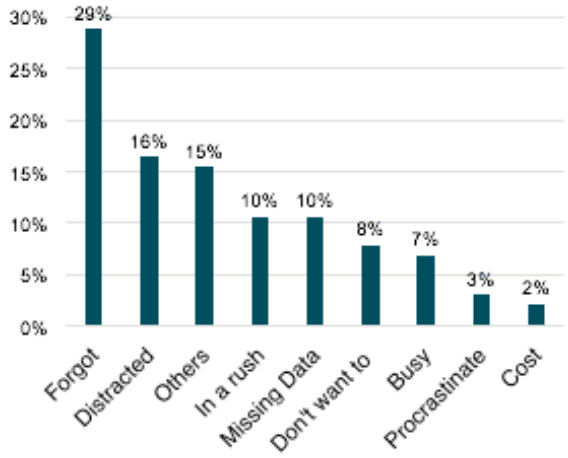

Chart 2. Self-reports for why medication was missed

The interviews also shed light onto why adherence was sometimes diminished. Two main themes emerged related to frustrations and barriers associated with medication adherence. The first is their schedule has a huge impact on their adherence. Participants talked about changes in their routines—travel for example—resulting in less than optimal adherence. If their previous daily activities interfered or there was a lack of established routine, lower adherence levels were reported. Participants also talked about medications being annoying. The time it takes to consume, organize, and refill medications can be perceived as a defeating barrier.

Triggers for adherence

Another component of the initial surveys and interviews was participants' description of what triggers prepare them to take their medication. 74% of participants recognized certain triggers helped remind them to take their medications. Examples of triggers include seeing their medication, having a meal (e.g. knowing their medication has to be taken with food), an alarm, and waking up/going to sleep (e.g. knowing that medication is directed to be taken before bedtime). 13% of triggers reminded participants to prepare their medications. Example of these include having an established routine, packing before you go out, and setting things out for later.

Motivation for medication adherence

Two key themes that from the interview questions focused on users' current motivations – how they physically felt and fear. This follows the Fogg Model that describes two of the key motivators being pleasure/pain – how the participants physically felt – and Hope/fear – the participant's fear of the consequences of not adhering to their medication regimen.

How the participants physically felt was very important. Negative symptoms of their conditions was the highest motivator for increased adherence. Inversely, if they began to feel too many side effects of the medications or had no feeling or physical indication of improvement from the medication, participants talked increasingly about non-adherence activities.

Another key motivator was fear. Participants shared experiences with serious health issues as motivators for having a stricter adherence to the medicine schedule. Additionally, fear of consequences of medical conditions worsening or becoming more of a burden motivated higher presentations of adherence. In the survey, 20% talk about adhering to medication for their doctors and/or loved ones (14% to receive acceptance, 6% to avoid others being upset with them).

Phase 2 – Reminder-Based Interventions

Setup

Setting up the reminder features of our deployed technologies proved challenging to our target population. 35% reported the largest barrier to setting up the technology was that it was confusing. Next, 21% reported that it was too time consuming to setup, 11% reported that their phone or tablet was incompatible with the technology and 9% were simply not interested in reminder technologies.

Usage

Before Phase 2 started, we asked participants to anticipate how much they would enjoy the upcoming experience using the reminder technologies. Upon the completion of Phase 2, we returned to this question and asked the participants how enjoyable their experience was. Chart 3 showcases that most participants rated their experience as more enjoyable than they initially anticipated. This result further validates our assertion that the disconnect with the users was not the technology platforms they used, but was a misalignment of the perceived utility of the triggers and their motivation for medication adherence.

Medication adherence

Upon the completion of Phase 2, we saw surprising results. After 6 weeks of the reminder treatment, we saw that there was virtually no change in participants whose adherence was calculated as on time (- 0.6%). There was a decrease in early medication adherence by 1.5% and a slight increase in the "missed, but taken" category with an increase of 1.1%. Between Phase 1 and Phase 2, there was an 17.3% increase in missed medications. Chart 4 highlights this trend and

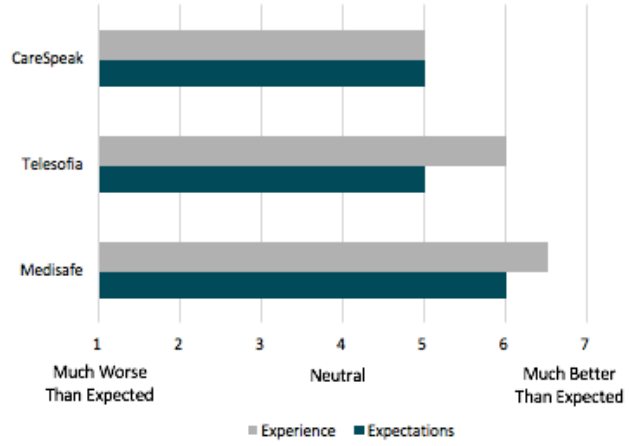

Chart 3. Reported user satisfaction

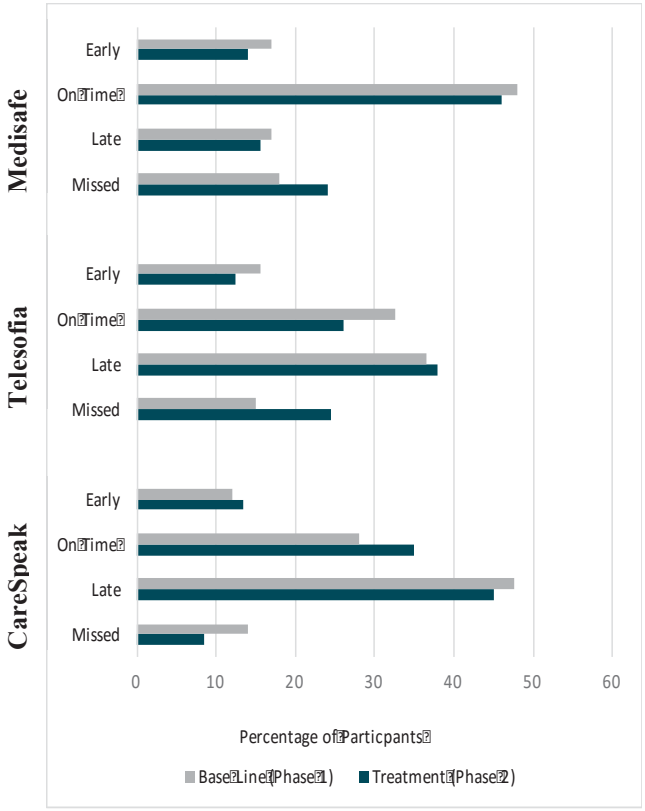

Chart 4. Reported medication adherence

also shows that there is a consistent pattern across technologies. According to the Fogg Model, this result points to a misalignment of the triggers and participant's ability, and not just the technology platforms.

Abandonment

When we look at the number of individuals who used the reminder technologies throughout the entirety of the phase,

83% of the participants did not stop using the technology. Of those who did stop, 2% stopped using it within the first week, 78% stopped using it between week 2 and week 4, and 20% stopped using it within the last 2 weeks of the phase. When asked why they stopped, an overwhelming majority commented that the messages were too frequent and users felt that they got the reminders after they had already taken the medication, rendering it a perceived waste of time. It became more of an annoyance than it did an aid. The Fogg Model stipulates that a trigger has to be useful if it is to have impact on the user. We believe that this is the misalignment of what Fogg would call the time and non-routine abilities of an individual and the spark and signal triggers. The participants were receiving too many triggers and instead of encouraging greater compliance, it potentially led participants to grow weary of utilizing the technologies. In several of the interviews, it was alluded to the interviewers that medication was still being taken, but they were no longer using or ignoring the technology. The participants had reverted back to their old systems.

Informed Participatory Design Workshops

When we assessed the data from Phase 2 it was evident that there were was a misalignment between our expectations for success using known motivational strategies for health change (including reminder messages [34], biometric feedback [11], motivation [22]) and the actual results of our intervention. To better understand what this population would find valuable from a motivational or trigger perspective, we developed a short workshop participatory design session (n=10).

The participants were given a list of features that were found on the technologies they had been exposed to over the 18-week engagement. They were asked to work in pairs or individually to create their ideal solution for a medication adherence ecosystem that would mediate the challenges they had encountered during the study. We also asked them to incorporate the technological feature(s) that they thought would be the most appealing for the general public. Because this population had been exposed to a suite of tools with a variety of functions and triggers, the participants were able to begin immediately working on ideas, cutting out a laborious familiarization process. As an outcome of the intervention study, participants already had features in mind that they believed would be beneficial to future systems. Thus, all participants were able to contribute to the group discussions, making the session lively, constructive, and productive.

The workshop uncovered many key themes important to the participants. Figure 2 highlights the features that were agreed upon by the participant as being the most important or interesting. Several of the themes stemmed from issues that participants wished the technologies could have supported. The alerts group was particularly important to the group. Having the technology actually send text messages or call an individual to alert them that there was a

Figure 2. Features curated at the Participatory Design Workshop

missed dose or that they had left their pill bottle at home (meaning they were likely to miss an upcoming dose) were key aspects they would like to see in the future. Additionally, the idea of flexibility was a feature that was heavily discussed. The ability to pause reminders, change the mode of contact (getting calls to the house phone instead of a text message), or connect to other smart technologies was something that participants discussed at length and posited that would be critical in long-term use of any tool.

The group worked together to negotiate what their ultimate design would be after they culled a wide range of features and attributes. The ideal solution has two key components: a smart pill box and mobile notifications. The pill bottle should produce light and/or sound, track when it is opened, use Bluetooth to connect to the phone, have 31 days, and be detachable – allowing the users to "break-off" boxes for a range of days. This would keep them from having to "lug it around". The second component should include mobile notifications. It should send messages, have customizable sounds/notifications, and have a mobile application or web portal that allows them to easily setup their medication regimen.

DISCUSSION

Validation of the Fogg Model

In this study, we aimed to validate certain behavioral approaches and their ability to increase medication adherence over time. We used the Fogg Behavior Model to not only guide the research design, but to ground our analysis of behavior change indicators as it relates to medication adherence in an aging population. While we cannot definitively rule out that issues with participants' utilization of the technology led to decreased adherence, we have data that highlights that they were happy and comfortable using the technology after the first phase.

The Fogg Model's central tenant is that if the motivations, triggers, and ability to perform must occur at the same time

for a person to perform a targeted behavior [14]. Throughout the analysis of Phase 2, we uncovered indicators of conflicting triggers. If a participant is already achieving high levels of medication adherence, spark triggers are likely to be misaligned with their current state. This misalignment could lead to boredom or complete lack of interest in the technology because the trigger is actually working against the individual. Fogg would predict that the anticipated behavior is unachievable because while the motivation and ability is in place, the trigger is not congruence.

We saw variations in medication adherence after the end of Phase 2. Some groups saw higher levels of missed or late reported rates of adherence. During the interviews, several participants pointed to issues associated to the reminders and that over-reminding or reminding at inopportune times actually led to missed medications and dissatisfaction with the technology. Future work is needed where the technology used is held constant and the triggers and motivations are manipulated to determine if different levels of adherence can be achieved.

Misperceptions

The baseline surveys and interviews in both phases highlighted several key misperceptions within the study design and within the participants understanding and use of the technologies. The key misperception of the study design was a combination of overestimating the level of supporting infrastructure within the study population as it related to several of the tools selected for the study. Several of the technologies were new-to-market and were not stable on certain older technology platforms. There were also issues with updates of several apps towards the beginning of the study. These initial technology issues, while not severe or ongoing, were enough to weaken certain participants' confidence in their stability and their usefulness.

Initially it was thought that several reminders were beneficial for this population based on successful trials with these types of technologies within similar gaining populations [24]. We found that our population was sensitive to being over-reminded or reminded during times that they deemed inappropriate. An example of the inappropriate timing included reminding them to take medication before lunch, but not reminding them to take the medication with them before they left the house for work. A comment we heard several times was "it seems like a waste to remind me to take a pill that you can't remind me to take with me." Future applications should look at using GPS coordinates to spark a reminder that the patient is moving away from the smart pillbox, reminding them to take their medication with them or be agile enough to allow users to setup dynamic reminder messaging.

Design Implications for Medication Adherence Technologies Focused on Aging Populations

The main focus of the participatory design sessions was to understand how the Fogg Model could be better operationalized to ascertain meaningful and sustained behavior change with regards to medication adherence. Through this process, several salient design implications were refined by the participants.

Flexibility. Participants wanted technologies that were customizable. If you are using auditory alarms for your medication and you have multiple medications, being able to program different sounds or prompts could help reduce the confusion that some older adults feel when they are faced with managing complex medication regimens.

The technology should also be flexible from the perspective of staying informed. For example, when users cross timelines they believe that the pill bottle should recognize this and modify itself to its new surroundings.

Reminders. The major design point for reminders is that these should be a precursor to the time when the medication should be taken, not after the fact. The technology should offer nudges and reminders if the medication is forgotten. The reminder should also be able to be put on "snooze" in the case that the user is not in the proximity of the medication.

Tracking features. Also, using the built-in features of mobile smartphones and these adherence technologies, when an user is a certain distance away from their medication, they should receive form of message or alert that they are potentially forgetting or at risk for missing needed medication.

Feedback. Daily/Weekly/Monthly reports should be available and accessible to the users as well as those that a user might designate – like a caregiver, a family member or a friend.

Contingency Plans. In the case of a cell phone being lost or the battery dying, the system should be intelligent enough to communicate with another form of communication like email or calling a landline. Also, communicating with designated in-case-of-emergency individuals would be appropriate within this scope.

CONCLUSION

As we continue to age as a global population, creating technologies and interventions that help enhance our lives will be critical. Utilizing technology to encourage behavior change associated with medication adherence is an important endeavor. If these technologies do not take into consideration certain barriers, there will continue to be a misalignment between technology design and effective triggers based on behavior change models. While triggers are an effective first step in understanding how to encourage medication adherence, more research is needed in understanding what motivations sustain adherence and how motivations and triggers work together to produce sustained behavior change.

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