MyTime: Designing and Evaluating an Intervention for Smartphone Non-Use

Alexis Hiniker[1], Sungsoo (Ray) Hong[1], Tadayoshi Kohno[2], Julie A. Kientz[1]
[1]Human Centered Design and Engineering, [2]Computer Science and Engineering
University of Washington
Seattle, WA, USA
alexisr@uw.edu, rayhong@uw.edu, yoshi@cs.washington.edu, jkientz@uw.edu

ABSTRACT
Though many people report an interest in self-limiting certain aspects of their phone use, challenges adhering to self-defined limits are common. We conducted a design exercise and online survey to map the design space of interventions for smartphone non-use and distilled these into a small taxonomy of intervention categories. Using these findings, we implemented "MyTime," an intervention to support people in achieving goals related to smartphone non-use. We conducted a deployment study with 23 participants over two weeks and found that participants reduced their time with the apps they feel are a poor use of time by 21% while their use of the apps they feel are a good use of time remained unchanged. We found that a small taxonomy describes users' diverse set of desired behavior changes relating to smartphone non-use, and that these desired changes predict: 1) the hypothetical features they are interested in trying, 2) the extent to which they engage with these features in practice, and 3) their changes in behavior in response to the intervention. We link users' desired behaviors to the categories of our design taxonomy, providing a foundation for a theoretical model of designing for smartphone non-use.

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Technology non-use; mindfulness; mobile phones; smartphones; productivity;

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

INTRODUCTION
Mobile devices provide users with the opportunity to leverage the power of technology in nearly every context and at nearly every moment. Prior work has shown that the potential to engage with technology at any time can come with a cost; some users report feeling burdened by pressure to be continually available to clients [29] or responsive to peers [1], while others feel the need to check in even when it poses a risk to their safety [4], well-being [35], or that of those they care about [30]. Overly simplistic cultural narratives pass judgment on both "distracted addicts" and "out-of-touch luddites" [17], leaving individuals with reason to worry they engage with their phones both too much and too little. This tension has given rise to investigations which explore the ways in which users refrain from engaging with technology when it is available.

As part of navigating this complexity, many users report taking deliberate breaks from technology or setting deliberate boundaries on their own use. Prior work describes users giving up Twitter for Lent [39], committing 'Facebook suicide' by deleting their accounts [34], refraining from smartphone ownership in favor of traditional feature phones [25], and setting up physical barriers to their own phone use while spending time with their children [18]. Yet despite these makeshift solutions, creating and adhering to self-defined boundaries is not always easy. Some users report that they want to self-limit but believe it would be impossible, some say that they do self-limit but are not always successful, while others say they successfully self-limit but in the process sacrifice aspects of technology use that they value [3,23].

Productivity tools to help users self-monitor or self-limit have become common, but little research has evaluated such tools empirically. Even less research has examined the design considerations that are likely to make such tools effective. The purpose of this project was first to understand the design space for supporting smartphone users in engaging in *targeted non-use*, the reduction only of usage behaviors that users wish to limit. We used our mapping of this space along with design feedback from 232 online survey participants, to create MyTime, a standalone app to nudge users toward an integrated balance of use and non-use they feel good about. We then conducted a two-week deployment study of MyTime with 23 smartphone users.

As a result of our background work, we first identified a small taxonomy of intervention approaches for targeted smartphone non-use. Through our online survey, we further identified two orthogonal user characteristics based on the non-use goals users set for themselves. In our deployment, we found that MyTime was effective in reducing the time users spent with experiences that they feel are a poor use of

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their time, while leaving the time they spent with experiences they value unchanged. The user-characteristics we identified predicted the features users engaged with and the effectiveness of those features in helping them meet self-defined goals. We link these user characteristics to the categories of our design taxonomy, creating a foundation for building a theory of designing for smartphone non-use.

BACKGROUND AND RELATED WORK

Technology Non-Use and Lagging Resistance

A recent movement in the HCI community advocates the study of not just the use of technology, but also its non-use [3,38]. Initial investigations have looked at why people abstain, take breaks from, or quit certain types of technologies, such as Facebook [3], Twitter [39], or other social networking sites [41]. Though non-use comes in many forms – ranging from lagging adoption [38] to death [6] – here we specifically explore short-term non-use decisions by active users as they balance time spent with technology with time spent without it.

A substantial body of recent work demonstrates that users sometimes feel conflicted about the time they spend with technology and that these mixed feelings are a contributing factor to technology non-use [1,14,34,36,41]. However, not all users with misgivings about their own behavior take action, and many report an interest in non-use that they fail to actualize [23]. To describe this gap, Baumer and colleagues coin the term *lagging resistance*, which they define as "a sense of wanting to quit but not doing so just yet" [3]. The opposite of lagging adoption, lagging resistance requires both the desire to change one's own usage behaviors coupled with barriers to making such a change. Our work builds on this construct by designing to support users in translating lagging resistance into action.

Tools to Support Non-Use

Designing for non-use is a relatively new area of exploration. In one recent study, a novel tool to reduce smartphone use in social groups successfully supported peer groups of college students in collectively cutting back on the time they spent with their phones [23]. We build on this indicator that technical interventions for non-use can be effective, first, by exploring the value of such tools in a less-constrained context (i.e., for individual rather than group use), and, second, by nudging users towards the integrated balance of use and non-use that they hope to achieve, rather than branding all reductions in use as positive.

A second research effort provided a large pool of anonymous smartphone users with a tool to set rules restricting their use of specific apps [26]. The seventy thousand rules set by the app's users suggests smartphone owners may be interested in such tools. The research team found themes in the types of apps users wished to restrict, and we build on this work by further exploring patterns in non-use desires and behaviors.

In addition to these early investigations into designing for non-use, many commercial products exist to promote productivity, reduce distractions, self-monitor screen time or restrict access to certain applications or features. One prior study examined the effectiveness of the commercially available tool "RescueTime" designed for tracking personal screen media use [9]. The research team found that users' lack of engagement due to the tool's limited salience, credibility, contextual information, and action advice rendered it ineffective. Though many other tools (e.g., "Procrastination," "Moment," "Chrome Nanny," and "Kill News Feed") have been developed for this space, little work has evaluated the effectiveness of such supports empirically.

Behavior Change in HCI

The focus of the MyTime application was to develop an intervention that could enable users to better set and meet their own goals for smartphone use and non-use. This approach has been used in many mobile phone-based interventions to support behavior change in areas as diverse as physical activity [11,13], sleep [8,20], nutrition [12], stress reduction [27], and using sustainable transportation [15]. The HCI research community has formalized design frameworks for creating persuasive technologies (e.g., [22]), and they have created or appropriated a variety of others based on existing theories of behavior change. Michie et al. provide a framework of behavior change techniques across 16 different clusters [31], while other researchers have developed interventions based on theories of goal setting (e.g., [10,32]), self-monitoring (e.g., [8,28]), self-efficacy ([16]), and mindfulness (e.g., [7]). Our research focuses on a new intervention for a relatively novel space (technology non-use) by using strategies involving promoting goals and planning, feedback, and monitoring.

Mindfulness

One recent trend in behavior change is encouraging what is known as "mindfulness." Brown & Ryan [5] provide a theoretical and empirical examination of the role of mindfulness as a state of consciousness that promotes well-being. Aspects of mindfulness include "open, undivided observation of what is occurring both internally and externally" [5,24] and it is related to other constructs such as self-monitoring, self-awareness, and emotional intelligence [5]. Research has linked achieving mindfulness with having a greater sense of wellbeing.

Within the HCI literature, there have been a number of research projects that have aimed to use mobile technology to promote mindfulness and awareness. The use of peripheral displays on phone screens has been used to promote awareness about exercise behaviors [11], sleep [2], impact on the environment [15], and general mindful behavior and meditation [7,42]. Our research focuses on developing a mobile intervention to promote mindfulness about smartphone use itself through the use of self-monitoring and reflection on goals for the day. We also seek to encourage smartphone users to limit mindless use that does not align with their own personal values.

PRELIMINARY WORK AND DESIGN PROCESS

Design Methods

Expert Panel Exercise: To explore the space of possible interventions, we conducted a design brainstorm with a team of five volunteer designers, one of whom was an expert in behavior change technologies and strategies. The design team expansively generated as many ideas as possible for smartphone-based tools that might encourage users to engage in behaviors that align with self-defined values or goals. The design team generated 100 different design ideas, e.g., a reporting tool that plots a user's usage relative to friends' usage, a lockout mechanism that makes certain apps unavailable each day until the user has walked 10,000 steps, and a background process that drains the phone's battery faster whenever the user opens an app that he or she has labeled as distracting. The research team clustered these designs through affinity diagramming to identify themes across solutions. These solutions clustered into eight different categories, shown in Table 1.

We created one canonical mockup for each category, intended to be representative of the most salient aspects of that category. Descriptions of these per-category canonical designs are shown in Table 2.

Formative Survey: We next created an online survey designed to both elicit participants' perspectives on their own smartphone use and to evaluate the design mockups we created. The first section asked participants a mix of 12 open-ended and scaled multiple choice questions about their feelings on their phone use. For example, one open-ended prompt asked: *"If you could change one thing about the way you use your phone, what would it be?"* while one scaled question asked: *"How do you feel about the amount of time you spend on your phone?"* with possible responses ranging from *"I would like to spend much more time using my phone"* to *"I would like to spend much less time using my phone."*

After completing the questions about smartphone use, survey participants saw eight different storyboards, one for each canonical mockup, presented one at a time in random order. After each mockup, an open-ended prompt asked them to describe what they liked and disliked about the proposed feature. A series of Likert-style questions then asked them how much they liked the idea, how interested they would be in trying this feature, how likely they think it would be to change their behavior, and how annoying they would find the functionality. After answering these questions for each of the eight mockups, they ranked the concepts in order of preference. Finally, we asked a series of questions about the contexts in which they find it difficult to manage their phone use and collected demographic information.

We recruited participants online through Amazon's Mechanical Turk service. All participants lived in the United States and had achieved a "Masters" qualification from Amazon for their prior work on Mechanical Turk, indicating a history of high-quality responses. We collected valid data from 232 participants (106 men) ranging from 21 to 66 years old (mean = 35, sd = 10). All participants were smartphone users, and reported smartphone ownership ranged from 1 month to 20 years (85% acquired their first smartphone between 2 and 6 years earlier). Participants were compensated $2.00 for completing all required questions. We advertised the survey saying we were interested in understanding the perspectives of smartphone users who are: "*interested in reducing your phone use or in changing the way you use your phone or both,*" making it likely that we oversampled individuals who are interested

Information	Agnostically providing information to the user about his or her behavior
Reward	Rewarding the user for engaging in behaviors that are consistent with his or her self-defined goals
Punishment	Punishing the user for engaging in behaviors that are inconsistent with his or her self-defined goals
Disruption	A temporary barrier momentarily prevents the user from engaging in a specific behavior
Limit	Certain behaviors are time- or context-bound or otherwise constrained within defined parameters
Mindfulness	The user is asked to reflect on his or her choices, before, during or after making them
Appeal to values	Reminding the user about the underlying values that shaped his or her decisions about desired use and non-use
Social support	Opportunities for including other individuals into the intervention

Table 1: Design taxonomy of eight organic categories of intervention types for targeted smartphone non-use

Feature (Category)	**Description**
Timer (Information)	A timer in the corner of screen displays the amount of time you have spent on the current app
Charity (Reward)	You have the option to make a donation (of someone else's money) to a charity of your choice if you stay off an app you have marked as sometimes distracting
Phobia (Punishment)	Pictures of something you dislike (spiders, a former partner, etc.) begin to appear sporadically in an application you have marked as sometimes distracting after you have spent a certain amount of time on it
Scramble (Disruption)	The icons of the apps you feel are sometimes distracting are periodically rearranged at random to new locations
Timeout (Limit)	You set a time limit for all distracting apps. The app automatically exits when you hit your limit
Aspiration (Mindfulness)	You see a prompt each morning asking what you would like to accomplish that day. This aspiration is periodically shown to you when you spend time on apps you sometimes find distracting
Watermark (Appeal to Values)	You select an image of something important to you (like your family, an image of yourself exercising, a picture representing a job you hope to obtain). This is used as a watermark in the background of distracting apps
Social (Social support)	Information about your progress toward your usage goals is shared with a small group of supporters

Table 2: Descriptions of mockups

in using their phones less. As a benchmark, prior work suggests that an interest in reducing phone use is widespread [40] and is reported by 60% of all smartphone users [23].

We coded responses to open-ended questions for themes, using conventional content analysis [19] and iteratively revising themes as we coded more data. Based on the themes that emerged, we chose to create three measures for each participant based on his or her response to the question: *"If you could change one thing about the way you use your phone, what would it be?"* For each participant we coded: 1) the type of change the user was most interested in making, 2) whether this change reflected some kind of reduction (such as reducing total use or reducing use of a particular app), and 3) whether the change the user wanted to make was context-based (such as only using the phone during lunch breaks at work or only using the phone after household chores are complete).

We also performed selective coding on the open-ended descriptions of the things participants liked and disliked about each mockup (i.e., coding 400 of the 1,864 different descriptions). For each mockup, we randomly selected 50 different responses to code; in all cases we found this subsample sufficient to achieve data saturation.

Design Results

Survey Results

Habits and Goals We first examined survey participants' attitudes about their own phone use. The majority of participants (58%) reported that they want to spend a little less time using their phones, 16% reported that they want to spend much less time, and 15% said that they do not want to change the amount of time they spend on their phones. The remaining 10% of participants reported that they want to spend a little more time using their phones.

The behaviors that participants reported most wanting to change fit into 9 different thematic categories. The most common desired change (33% of participants) was to limit or cut back on the time they spend on a specific activity, e.g., *"I would not get on social media as much,"* and the second-most common was to stop a specific activity altogether (14%), e.g., *"I would never use it to social network."* Though many responses reflected a clear non-use desire, this was not always the case. Approximately 8% a reflected desire to increase the amount of time spent on a specific activity, while 7% wanted to make a technical or usability change. Other responses reflected use and non-use desires simultaneously, with 10% of participants reporting that the thing they would most like to change would be to displace one phone use behavior with another phone use behavior, e.g., "*I would use text less and call people more often.*" All categories are shown with examples in Table 3.

User Attributes Two overarching themes emerged from users' descriptions of the change they would most like to make. First, many responses reflected an interest in reducing phone use in some way, thus we coded each response for this dimension. Across all participants, 79% reported that the change they would most like to make would be one that involves cutting back in some way, while 21% reported wanting to make a change that would not introduce any such restrictions. We labeled these two groups "*reduction-focused users*" and "*non-reduction-focused users*" for the purpose of highlighting that cutting down on some aspect of use is the most salient concern for reduction-focused users. While non-reduction-focused users may also be interested in cutting back in some respect, they report that other concerns take top priority.

Orthogonally, responses across many categories reflected an interest in making a context-dependent change, such as, "*I would use it less, particularly before bed,*" or "*I would use it more for work related activities so I can make better use of my time spent commuting.*" Overall, 12% of participants reported that the change they would most like to make would involve a contextually specific adjustment. We refer to these groups as "*context-focused users*" and "*non-context-focused users*." We used these two emergent user attributes, reduction focus and context focus, to guide our exploration of the ways in which differentiated non-use goals predict behavior.

Given participants' interest in reducing some aspect of their phone use, we looked at their responses to the question *"Describe one thing you do with your phone (such as an app you use, a website you visit, or a specific time or situation when you use it) that leaves you feeling drained of energy, unproductive, or dissatisfied"* to gain a richer understanding of the ways in which

Category (%)	Description: Example
Limit Activity (33%)	Cut back on use of a particular activity: *"I would use games and social media less. They really don't contribute much to anything."*
Stop Activity (14%)	Discontinue a particular activity: "*Uninstall facebook altogether*"
Reduce Total Use (13%)	Cut back on the total amount of time spent on using the phone across activities: "*I would like to look at less each day. It seems that it wastes my time a lot where I could be getting other things done.*"
Displace Activity (10%)	Replace time spent on certain phone activities with time spent on other phone activities: "*I would use my phone less for social networking and more for things like reading and keeping up with news.*"
Increase Activity (8%)	Engage in a particular activity more often: *"I would make use of the calendar and scheduling features more than I do. I tend to still remember appointments and dates and not bother putting them on my calendar."*
Technical (7%)	Make a technical or usability change to the phone or the user's pattern of interaction: "*I would like to know more about how to use it for data storage and as a word processor.*"
Limit Context (6%)	Cut back on an aspect of phone use in a context-specific way: "*I would stop using it when I was in the presence of other people.*"
Reduce Dependency (5%)	Reduce the need to check on the phone or to keep it always accessible: "*Not pick it up so frequently. It has become a nervous tic and almost an extension of my body.*"
Nothing (3%)	Not interested in changing: "*There is nothing I really want to change.*"

Table 3: What users most want to change about the way they

they wish they could self-limit. Participants' responses described eight different categories of activities which they routinely use in ways that leave them dissatisfied: communication (such as texting or instant messaging), dating apps, content aggregators, casual games, online shopping, pornography, social media, and video browsing. Of these, social media (37%) and games (30%) were the most commonly mentioned and made up roughly two-thirds of all responses. We also asked participants a parallel question probing the smartphone experiences they found satisfying, productive, or energizing. We spent less time analyzing these responses as participants expressed an overwhelming interest in reducing rather than increasing their smartphone use.

We also looked at the specific products that participants mentioned when describing experiences that leave them feeling drained of energy and unproductive. Of the 232 responses, 163 mentioned a specific app or website. The most commonly mentioned draining app was Facebook, which was described as draining and unproductive 70 times. The second-most frequently cited product was Reddit, mentioned 19 times. Eleven additional apps were mentioned by more than one person, specifically: Twitter, Candy Crush, YouTube, Instagram, Pinterest, Tumblr, Clash of Clans, Angry Birds, Tinder, and Buzzfeed.

Survey Results: Design Feedback

Next, we examined participants' responses to the mockups we designed and compared the extent to which participants were interested in trying each of the eight experiences. A repeated-measures ANOVA revealed a highly significant difference in participants' interest in trying these different designs ($F(7, 225) = 93.98$, $p < .001$). Post hoc analysis revealed that designs clustered into three groups, all of which were significantly different from each other based on participants' interest in trying them. The most popular group included the Timer, the Aspiration, and the Timeout, which participants were, on average, interested in trying (mean = 3.61, sd = 0.79, scale: 1 = strongly do not want to try; 5 = strongly want to try). The second cluster included the Watermark and the Charity features, which participants were, on average, neutral about trying (mean = 2.67, sd = 1.00). The third cluster included the Scramble, the Phobia, and the Social features, which participants were disinterested in trying (mean = 2.03, sd = 0.83).

We examined themes in participants' open-ended descriptions of what they liked and disliked about each idea to better understand the properties that drove their responses. Across designs, the most common motivations participants gave for liking a feature were: the perception that it would increase their awareness or understanding of their own behavior, appreciation that it would remind them of their own priorities, and appreciation of enforcement so that they could not easily avoid breaking their own rules. The most commonly cited aspects that participants disliked across designs were: the perception that the feature would interfere with or diminish their experience of using the app they are monitoring, the perception that they would have less control over their experience, the expectation that the feature itself would be painful to use, lack of enforcement or accountability, and the perception that they would quickly habituate to the feature, rendering it ineffective.

Finally, we looked at characteristics of our participants themselves to see if subgroup attributes predicted differentiated interest in these designs. We compared the extent to which reduction-focused and non-reduction-focused users were interested in trying each of the well-received designs (Timer, Aspiration, Timeout). Independent samples *t*-tests revealed that reduction-focused users were significantly more interested in trying the Timer (mean = 3.84, sd = 1.12) than non-reduction-focused users (mean = 3.40, sd = 1.23, $t(229) = -2.38$, $p = .018$). Reduction-focused users were also significantly more interested in trying the Timeout feature (mean = 3.70, sd = 1.23) than non-reduction-focused users (mean = 2.71, sd = 1.25, $t(229) = -4.97$, $p < .001$). There was no significant different between groups in their interest in the aspiration feature.

We hypothesized that this difference in interest was driven by reduction-focused users' interest in making a time-based change to their behavior, as well as the perception that the timer (information category) and the timeout (limit category) would keep them on a more regimented schedule. Given this, we predicted that the non-reduction-focused users would find the information provided by the timer more useful than the limit provided by the timeout. To test this, we ran a repeated-measures ANOVA with interest in trying each design as a within-subjects factor and reduction focus as a between-subjects factor. This revealed a significant interaction effect ($F(1, 229) = 5.336$, $p = .022$), such that reduction-focused users were equally interested in both interventions, while non-reduction focused users were significantly more interested in seeing information (timer) than in setting limits (timeout). This is consistent our intuition that users' specific non-use interests predict the intervention features they value.

Based on these findings, we hypothesized that context-focused users would be more interested in the aspiration feature (mindfulness category) than non-context-focused users, as reminding users of the things they think they should be doing at the moment may align with these users' concerns that they are choosing to use their phones when they would prefer to make another choice. We did not expect these users to differ from non-context-focused users in their interest in the timer or timeout, as these features are situation-agnostic and provide information and limits across all contexts.

An independent samples *t*-test confirmed that context-focused users were significantly more interested in trying the aspiration feature (mean = 4.11, sd = 0.88) than non-context-focused users (mean = 3.53, sd = 1.17, $t(229) = -3.139$, $p = .003$). However, we also found that context-focused users were significantly more interested in trying the timeout feature (mean = 4.00, sd = 1.05) than non-context-focused users (mean = 3.41, sd = 1.31, $t(229) = -2.67$, $p = .011$). This is

perhaps reflective of the fact that context-focused users are interested in making a change that could benefit from the enforcement that is central to the "limit" category, despite the fact that their focus is not specifically on time. As predicted, there was no significant difference in the interest in trying the timer.

Intervention Design

Based on these findings, we created "MyTime," an app for Android smartphones intended to encourage targeted non-use. We created an interface that displays all apps on the users' phone, allowing the user to select the icons of the apps he or she sometimes finds distracting (referred to as "monitored apps"). A time picker then allows the user to set the maximum amount of time he or she would like to spend with these monitored apps each day. Upon opening the app for the first time, the user is funneled through a setup experience which asks him or her to select these apps and set a limit (see Figure 2); these settings can be changed at any time by returning to the app's main interface.

We then created a background service which tracks the active app and maintains a complete record of the individual's usage. This includes silently recording the time the user spends with the monitored apps he or she has selected, as well as the time the user spends with all other apps on the phone. App-use is recorded in milliseconds.

We implemented all three of the canonical features that survey participants reported having an interest in trying: 1) passive information about time passing (Timer), 2) a message telling the user when he or she has hit the daily time limit (Timeout), and 3) a daily prompt asking the user what he or she would like to accomplish each day (Aspiration). Each of these features is described in more detail below and shown in Figure 3.

Timer Whenever a user opens a monitored app, a clock icon appears in the notification bar. If the user pulls down the notification shade, a progress bar is displayed showing the amount of time the user has spent on all monitored apps that day relative to the user's self-defined daily limit. This notification also displays the amount of time the user has spent on the current app. This image updates in real-time. This notification is persistent and does not disappear until the user exits the monitored app. See Figure 3, top left.

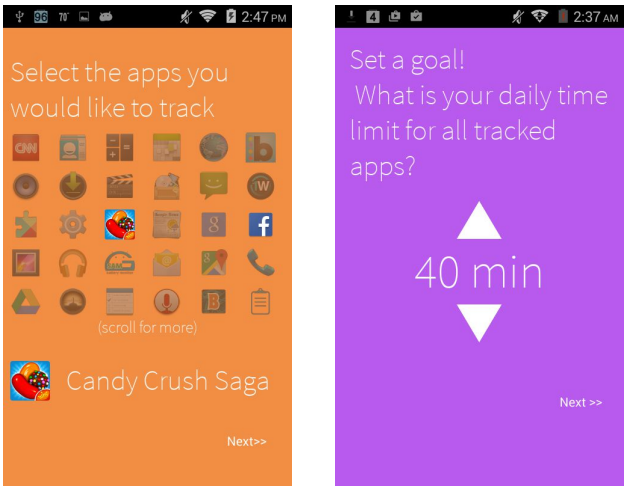

Figure 2: Screenshots from the MyTime setup, selecting apps to monitor (left), and setting a daily time limit (right)

Timeout When the user hits his or her daily time limit, a dialog appears saying *"Time's up!"* The user has two explicit choices: one button saying *"I need a few more minutes,"* which brings up a time picker, and a second button saying *"Exit [Current app name]."* Selecting the second option moves the active app to the background and returns the user to the launcher. The user also has a third option to dismiss the dialog by pressing the 'X' in the top right corner, pressing the back button, or pressing the home button. If the user dismisses the dialog without requesting an explicit extension, the warning dialog returns every 5 minutes or every 10% of the total daily limit (whichever is shorter) whenever the user has a monitored app in the foreground. See Figure 3, bottom.

Aspiration Each day, a push notification asks the user to enter an aspiration. Tapping on this notification brings up a dialog which asks *"What is one thing you would like to accomplish today?"* (Figure 3, top left). The dialog provides a space for a free-response answer, as well as options to snooze the prompt (in which case it returns an hour later) or to dismiss it for the day without setting an aspiration. If the user chooses to set an aspiration, it is displayed back to her whenever she sees a *"Time's Up!"* warning. If an aspiration has been set, the warning dialog says: *"Try this instead: …"* and then reflects the user's aspiration back to him. The user can choose to set additional aspirations throughout the day by going to the MyTime app. See Figure 3, bottom left.

DEPLOYMENT METHODS

We conducted a two-week deployment of MyTime with 23 Android smartphone users (4 men). Participants were recruited through a national recruitment service and represented 20 different U.S. states. Participants ranged in age from 25 to 60 (mean = 33.5, sd = 9.6) and represented 4 races and ethnicities (82% white). Participants' household income ranged from <$25,000 to >$125,000, with 57% reporting that their income fell between $50-75,000. Smartphone ownership ranged from 1 to 10 years. Participants were told that they had been invited to participate in a study testing an app to help people monitor their own smartphone use. Participants who installed the service and kept it running for the entire study period received $45 in compensation, regardless of the amount of time they spent using their phone or the extent to which they engaged with MyTime.

Participants first completed the same survey as the 232 participants in our survey study (described above), but with all of the mockups and their corresponding questions removed leaving only the questions about their usage habits. They were then invited to install the MyTime application. Our instrumented version of MyTime did not display any UI to participants for one week after it was installed. During this time,

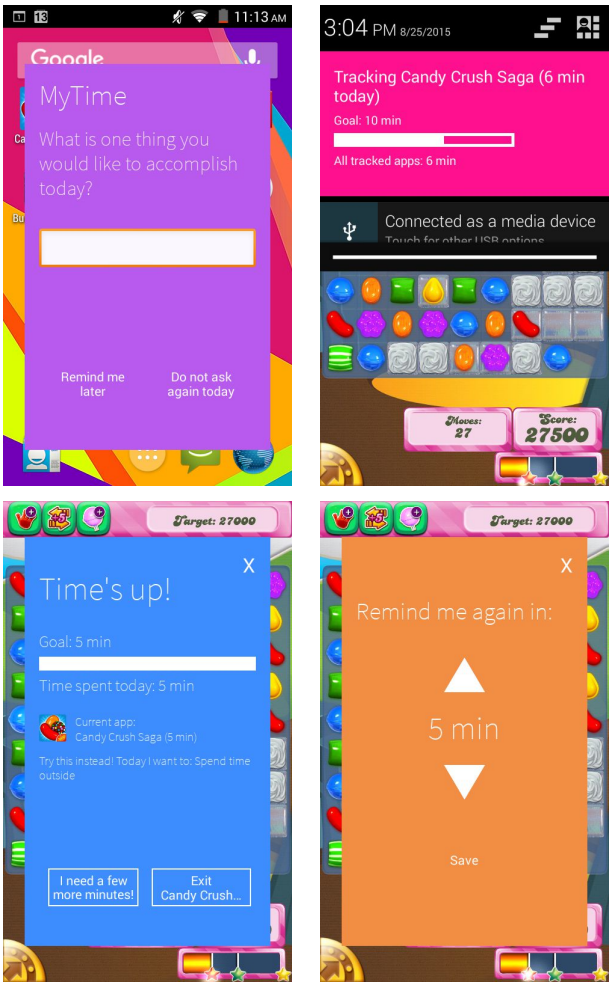

Figure 3: Screenshots of MyTime features. Top left: a daily notification asks the user to think of one thing she would like to accomplish that day. Top right: when the user uses a monitored app, he can pull down the notification shade at any time to see the amount of time on the current app and the amount of time today on all monitored apps. Bottom left: A dialog tells the user when he or she has hit the daily limit. Bottom right: After hitting the limit, the user can always request an extension.

MyTime collected baseline information about the participant's phone use by passively running in the background and tracking all app use. During this time, none of the features described above were available, and opening the MyTime app displayed a blank screen with a message to return after the first week had elapsed. Although all participants spent exactly one week in the baseline period, start dates were staggered based on staggered recruiting and included all days of the week. After one week of baseline data collection, MyTime became available, and all features were turned on.

DEPLOYMENT RESULTS

Deployment participants reported feelings about their own phone use that were similar to survey participants'. Most (77%) said that they either wanted to spend a little less time using their phone or much less time using their phone. In response to checkbox options asking whether or not participants wanted to reduce their use of various types of apps, participants most frequently reported wanting to cut back on their use of social media (86%) and games (73%).

Like survey participants, we coded participants' responses to the question *"If you could change one thing about the way you use your phone, what would it be?"* and found that all responses fit into one of the 9 categories that emerged from the larger survey study. Across all deployment participants, 77% were reduction-focused users; a partially overlapping 18% were context-focused users.

To understand what targeted non-use might look like for each participant, we next examined the types of apps participants chose to monitor and compared these to their survey responses about their own phone use and desired phone use. Collectively, our participants chose to monitor their use of 183 apps, 116 of which were unique. Monitoring was highly personalized, with the majority of apps monitored by only one person. Of the 116 distinct apps, only 9 were monitored by 3 or more people (see Figure 4). Of these, Facebook was the most frequently monitored, and nearly 90% of our participants elected to monitor their Facebook usage. The second-most commonly monitored app was the Google Chrome browser (39% of participants).

We compared the list of apps that each participant had described as being "*a good use of your time*" and "*a waste of your time*" in the free-response section of the survey to the list of apps they chose to monitor. We found that participants were interested in monitoring their time with both types of experiences. Across all participants with survey data, 82% monitored at least one app that they mentioned explicitly as something they would like to use less. We also found that 59% of participants chose to track at least one app that they reported feeling is a good use of their time. Of the 183 apps that participants monitored, 42 were listed by the participant as a waste of time, 48 were listed by the participant as a good use of time, and 78 were not explicitly mentioned by name. Thus, despite the fact that we messaged the project to participants as a mechanism for monitoring apps they sometimes find distracting, monitoring valued experiences was also prevalent. Monitored apps that were not explicitly mentioned

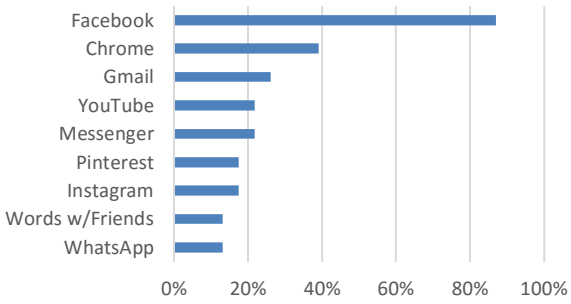

Figure 4: Percentage of participants who monitored each app. Includes all apps monitored by at least 10% of participants.

by name were thematically similar to the apps participants explicitly listed as a waste of time (such as other casual games and content aggregators), thus we chose to group these with the apps users reported are a waste of their time.

Time with Phones

Participants reduced their daily phone use by an average of 33 minutes (11% of total use) during week 2 (when MyTime was available) relative to week 1 (before MyTime was available). A repeated-measures ANOVA demonstrated that this was a significant decrease in total use ($F(1, 138) = 8.191$, $p = .005$, $\eta^2 = .056$). Specifically, participants reduced the amount of time they spent on the apps they monitored by 23 minutes, a daily reduction of 18%. A repeated-measures ANOVA revealed that this too was a significant decrease ($F(1, 138) = 15.292$, $p < .001$, $\eta^2 = .100$).

Given that participants monitored both the apps they feel are sometimes a waste of time and the apps they feel good about using, we next analyzed usage data based on participants' individual goals. There was no significant difference ($p = .364$) in the amount of time participants spent using the apps they monitored that they feel are a good use of their time during week 2 (with MyTime) compared to week 1 (baseline). However, participants spent an average of 24 minutes less per day (21%) on the apps they reported were a waste of their time. A repeated-measures ANOVA revealed that this reduction was significant ($F(1, 126) = 13.605$, $p < .001$, $\eta^2 = .097$). Thus, reduction in phone use was driven not only by the apps that users monitored, but specifically by the apps they monitored that they feel are sometimes distracting or a waste of their time. Figure 5 shows the change in participants' average use of the apps they value using and apps they find distracting.

Timeout Feature

Across all participants, MyTime displayed a *"Time's Up!"* warning 370 times. In response to these warnings, participants most frequently chose to dismiss the warning, doing so 64% of the time. Participants asked for an explicit time extension 30% of the time and exited the monitored app they were using 6% of the time. The extensions participants asked for (N = 113) ranged from 1 minute to 490 minutes, with the median extension length being 15 minutes, and the most frequently requested extension length being 1 minute (N = 16).

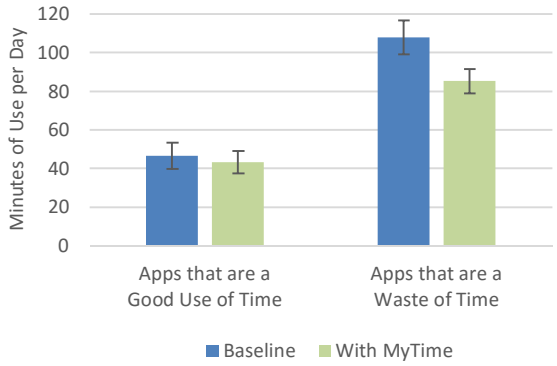

Figure 5: Number of minutes participants spent per day on the apps they monitored during the intervention period

Given that users appeared to be tracking some apps purely for informational purposes and other apps in order to reduce use, we examined participants' responses to warnings in each of these differentiated situations. First, we compared responses to warnings about apps users feel are a good use of their time and responses to warnings about the apps they feel are a waste of their time. A chi-square test comparing response type and app type revealed that participants' responses were significantly different in these two situations ($\chi^2(2) = 10.077$, $p = .006$). Post hoc contingency table analysis revealed that participants were significantly more likely to ask for an extension ($Z = 3.0$, $p = .003$) and significantly less likely to dismiss the warning ($Z = -3.1$, $p = .002$) when the app they were using was one they felt was a good use of their time than when they were using an app they felt was a waste of their time. A Bonferroni correction was applied to all column comparisons.

As participants most frequently selected the options "social media" and "games" as the categories of use they would like to reduce, we examined participants' responses to warnings about apps that fell into each of these categories. A chi-square test comparing participants' responses to the warnings they saw when using social media, games, and all other apps revealed a significant difference in the way participants responded to warnings about these different app types ($\chi^2(4) = 38.268$, $p < .001$). Post hoc contingency table analysis revealed that participants were significantly more likely to exit a social media app after seeing a warning than they were to exit a game or to exit any other kind of app ($Z = 4.8$, $p < .001$). Participants were also significantly less likely to dismiss a warning that they saw when using a social media app ($Z = -5.2$, $p < .001$). Participants' responses to the warnings they saw when playing games were not significantly different from their responses to other kinds of apps. A Bonferroni correction was applied to all column comparisons.

Finally, we analyzed participants' responses to warnings in light of the fact that our survey revealed that reduction-focused users are more interested in a feature to limit the time they spend on apps than individuals looking to make other kinds of changes. A chi-square test revealed that reduction-focused users were significantly more likely than non-reduction-focused users to quit the app they were using when they saw a warning ($\chi^2(1) = 5.652$, $p = .017$). These users also made progress toward their goal and showed a significantly greater reduction in use across all monitored apps than non-reduction focused users ($t(20) = -2.26$, $p = .028$) and specifically on the apps that they feel are a waste of their time ($t(20) = -2.59$, $p = .014$). There was no difference between groups in the change in time spent on apps that they feel are a valuable use of their time.

Aspiration Feature

Over the course of the intervention week, participants set a combined 57 different aspirations in response to the prompt

"What is one thing you would like to accomplish today?" Some of these were aspirations about their phone use, such as *"I want to spend less time using my phone,"* or *"Less Instagram usage!"* Others reflected general intentions and aspirations for the day, such as *"Get a wedding ring for my husband"* or *"Make cashew cheese."* Thus, participants' self-defined aspirations offered both reminders about their desired phone-use behaviors and suggestions for alternative activities. On average, participants set 2.4 aspirations over the course of the week, but this distribution was highly bimodal with half of all participants setting no aspirations and the other half setting an average of 5.1 aspirations (sd = 2.7). Thus, on average, participants appeared to either not engage with the aspiration feature at all or to engage with it regularly throughout the study period.

Because the daily aspiration, if set, was reflected back to participants when they saw the "Time's Up!" warning, we compared participants' responses to warnings when they did and did not have an aspiration set. A chi-square test showed that participants were significantly more likely to exit the monitored app they were using if they saw an aspiration than they were if they did not see an aspiration ($\chi^2(1) = 5.191$, $p = .023$). Seeing a self-defined aspiration about phone use or a suggested alternative left participants significantly more likely to quit the app they had been using.

Finally, we analyzed aspiration-setting behaviors in light of the fact that our larger design survey showed that individuals who want to change the context in which they use their phone are more interested in using a feature about intention-setting than other individuals. We compared the number of aspirations set by context-focused users to the total number of aspirations set by non-context-focused users. Because the distribution was non-normal, we used a non-parametric test. A Mann-Whitney U test revealed that context-focused users, who wanted to make contextual changes to their phone use, set significantly more daily aspirations (median = 8, IQR = 4.5) than non-context-focused users (median = 0, IQR = 3.5, $U = 2.65$, $p = .008$). Thus, survey participants' intuition held up among our deployment study participants: those who were interested in making contextual changes to their phone use engaged more with this feature than their peers.

DISCUSSION

Our results reveal that stand-alone interventions to support targeted smartphone non-use can effectively bring users closer to their self-defined usage goals, at least in the short term. The majority of our participants expressed an interest in reducing their smartphone use and, relative to their baseline behavior, spent significantly less time using their phones when MyTime was turned on. Our results further show that this reduction was not indiscriminate, but came specifically from the monitored apps that participants reported they feel are sometimes a waste of time, while time spent with monitored apps that participants feel are a valuable use of time remained unchanged. This suggests that MyTime effectively supported users in engaging in targeted non-use, tailored to their individual goals and perceptions of ideal behavior.

These results indicate that interventions to support non-use can preserve the value users reap from technology while surgically targeting experiences that users find to be a poor investment of their time. This differentiation is essential for building non-use persuasive technology in a world where users want to maintain many aspects of their smartphone use while simultaneously limiting others. It also demonstrates an advantage that technical solutions have over analog ones, as analog non-use strategies like asking a friend to change your password [3], leaving your phone in the car [18], or giving up Twitter for Lent [39], require all-or-nothing approaches that provide users with non-use benefits at the expense of experiences they value.

User Attributes and Design Taxonomy

Results from our background design work for this project demonstrate that users have diverse interests with respect to desired patterns of use. Some users wish they never played games on their phones, others wish they spent less time texting and more time making voice calls, others wish they used their phone to take notes more often, while still others wish they did all the things they currently do, but never right before going to bed. Despite this breadth, a small set of themes accounts for all of behavior change desires reported by our combined 256 participants.

These categories of desired change predicted the extent to which users were interested in adopting different design solutions. Individuals who want to change the way they use their phones in certain contexts were more interested than others in seeing reminders of their own priorities. Individuals who want to reduce some aspect of their phone use were more interested than others in seeing information about the amount of time passing. Both of these groups were more interested in a solution with enforcement than their counterparts who do not want to limit their behavior.

These assertions by survey participants about their hypothetical use held up among our deployment participants in their actual use. Reduction-focused deployment participants were more likely to exit the monitored app upon seeing a *"Time's Up!"* warning. This engagement paid off, and reduction-focused participants also cut back on their use significantly more than non-reduction-focused participants. Independently, context-focused participants recorded significantly more aspirations during their time with MyTime than non-context-focused participants, and participants who saw an aspiration were more likely to exit the app they were using. Reflecting users' own words back to them appeared to prompt them to change their current activity, and users who want to make context-specific changes were more likely to take advantage of this support. Thus, the types of changes users want to make predict 1) their interest in trying hypothetical features, 2) their engagement with those same features in practice, and 3) the effectiveness of these features in fostering specific patterns of behavior.

These same results also tie users' desired changes to specific intervention categories. We found that our instantiation of the "limit" category (the timeout feature) was of significantly more value to users who wanted to set boundaries on their use, and the "mindfulness" category (aspiration) was of significantly more value to users who wanted to make context-dependent changes. By mapping out the design space of non-use interventions and distilling it into eight organic categories, we hope to provide a skeleton for a predictive framework to link user goals to intervention approaches. We found that the types of changes users want to make cluster into a small set of themes, and that an expansive set of imagined interventions cluster into a small set of intervention categories. The fact that desired change predicts the differentiated effectiveness of these intervention categories suggests an opportunity for future work to establish a theoretical model of designing to support non-use goals.

App Type and Behavior Change

Our results indicated that thematic app categories, specifically social media and casual games, account for the majority of the experiences that users wish they limited more effectively. This is consistent with prior work in this space suggesting that particular types of experiences are most conducive to lagging resistance [26]. Our deployment results showed that participants were most likely to change their behavior in response to our intervention when using social media apps, suggesting that such interventions may be disproportionately effective in addressing social media-specific goals. Further work is needed to explore this possibility.

Limitations and Future Work

There are several limitations to our approach to supporting targeted non-use. First, smartphone use is a socially situated practice and our intervention is highly personal and individualized. It is harder for an individual to change a behavior when surrounded by social cues that run counter to his or her goals, though past work has shown that interventions for other socially situated practices (like eating or exercising) can be effective even when they are pursued individually (e.g., [11,37]). Future work remains to examine how social interventions that support a community in achieving communal non-use goals might differ from individual interventions such as ours.

Second, we broke down usage information by app as a first step in moving beyond a monolithic approach that views all phone use as equally problematic, but we did not support users in distinguishing between "good" and "bad" use of a particular app. Though we felt that "active app" could be a useful proxy for a participant's satisfaction with his or her current behavior (in part because there was very little overlap between the experiences that survey participants wanted to cut back on, like games and social media, and experiences they found valuable, like online banking and fitness tracking) this is certainly an imperfect proxy. Future work remains to explore context-specific non-use goals (e.g., avoiding social media during the work day, never using the phone at dinner), that allow users to target the patterns of behavior they wish to change with greater precision.

It also remains unclear how stand-alone or system-level solutions like MyTime compare to interventions built directly into the apps or experiences that users wish to limit. Perhaps redesigning the casual games or social networking apps that users find unproductive would be a more effective means of fostering a desired balance of use and non-use. Future work remains to determine when it is most appropriate for product designers to treat non-use desires as a guiding principle in product design, and when it is most appropriate for outside augmentation to provide this support.

We do not know how the behavior change catalyzed by MyTime fares in the long term, and prior work has shown behavior change in other domains can be difficult to sustain indefinitely (e.g., [33]). Other work has shown that self-monitoring tools are often insufficient in the long-run but can pave the way for adopting tools that support permanent change [21]. Further work is needed to assess whether the short term gains we report here persist over time and how we might design for users as they progress in achieving their desired patterns of behavior.

Finally, our results examine two coarse-grain user attributes (reduction-focus and context-focus) while simultaneously demonstrating that users have many nuanced distinctions among their varied goals for behavior change. There is an enormous space for future work to support increasingly subtle distinctions in desired patterns of non-use.

CONCLUSION

Our results suggest that lagging resistance among smartphone users is widespread, and a majority of our participants wished they used their phones a little less. We show that tools to bring users closer to these goals can be effective, and can be effective in inciting targeted change that differentially addresses a diverse set of specific goals.

Our results also demonstrate that the choices designers make when creating such tools predict the ways in which users will change their behavior, as well as the types of users who will change. We map out the intervention categories for this space and link specific intervention types to specific behavior changes. Though much future work remains to broadly support smartphone users in achieving the integration of use and non-use they desire, we believe that these findings nevertheless bring them a little closer to making their time their own.

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