



“Be Consistent, Work the Program, Be Present Every Day”: Exploring Technologies for Self-Tracking in Early Recovery

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Recovery from substance abuse disorders (SUDs) is a lifelong process of change. Self-tracking technologies have been proposed by the recovery community as a beneficial design space to support people adopting positive lifestyles and behaviors in their recovery. To explore the potential of this design space, we designed and deployed a technology probe consisting of a mobile app, wearable visualization, and ambient display to enable people to track and reflect on the activities they adopted in their recovery process. With this probe we conducted a four-week exploratory field study with 17 adults in early recovery to investigate 1) what activities people in recovery desire to track, 2) how people perceive self-tracking tools in relation to their recovery process, and 3) what digital resources self-tracking tools can provide to aid the recovery process. Our findings illustrate the array of activities that people track in their recovery, along with usage scenarios, preferences and design tensions that arose. We discuss implications for holistic self-tracking technologies and opportunities for future work in behavior change support for this context.

CCS Concepts: • **Human-centered computing** → **Empirical studies in ubiquitous and mobile computing**.

Additional Key Words and Phrases: self-tracking, substance abuse disorder, sobriety, self-care, patient-centered design

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1 INTRODUCTION

According to the 2018 National Survey on Drug Use and Health [3], over 20.3 million people aged 12 or older had a substance use disorder in the past year. Substance abuse disorders (SUDs) occur when recurrent alcohol or drug use cause a person to experience significant clinical or functional impairments in their everyday life. **Recovery** from substance abuse disorders is defined as the “process of change through which individuals improve their health and wellness, live self-directed lives, and strive to reach their full potential” [4]. It includes both abstinence and improved quality of life [4, 13].

Strategies, resources, and tools for supporting the maintenance of recovery behaviors have potential for immediate and long-term impact. Studies have found that people in recovery who are successful in achieving sustainable abstinence supplement their short-term clinical treatments with a long-term, self-driven maintenance program that promotes behaviors that contribute to a positive and healthy lifestyle (e.g., [1, 26, 37, 41]). These

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behaviors may be as diverse as attending peer support groups, meditating, volunteering, or participating in formal post-treatment programs. Yet, starting and maintaining desired behaviors is difficult, even when highly motivated. Recovery from substance use disorders is hindered by relapse rates of 50% or more (e.g., [43, 44, 56]), especially within the first year of abstinence (i.e., “early recovery”). Although this rate is similar to other chronic illnesses, substance abuse relapse can lead to much greater psychological and physiological harm [3]. This study focuses on people in early recovery (in their first 12 months of stable sobriety) because this is often when people transition out of formal, clinician-provided care to more independent, self-managed recovery.

Ethnographic and participatory design studies with people in SUD recovery have called for development and evaluation of self-tracking tools specialized for the recovery community, to support motivation, reminders, and accountability to commitments (e.g. [51, 58, 60]). Self-tracking has been defined broadly as the practice of recording data about oneself on a regular basis, and analyzing that data [39]. Self-tracking can be manual, automated, or semi-automated, with practices such as goal-based tracking, documentary tracking, and collecting rewards [15, 49]. Prior research has demonstrated the usefulness of self-tracking technologies in relevant parallel contexts, such as adopting new behaviors (e.g., exercising, saving energy [16, 18, 38]), as well as stopping or decreasing unwanted behaviors (e.g., smoking cessation, emotional eating [10, 47]). Yet, prior needs-finding work with people in recovery, an often marginalized population, has also documented mistrust and even “technophobic” perceptions of new technologies [58]. **To be beneficial for people in recovery, technology tools must take into account the unique needs, values, challenges, and existing practices of the recovery community** [50, 57]. Therefore, this work investigates how people in recovery might perceive and engage with manual self-tracking technologies in concert with traditional SUD treatment and supplemental maintenance programs to support their own recovery efforts.

To explore the perception and potential of self-tracking tools in recovery, we designed and deployed an ensemble self-tracking system as a technology probe for people in early recovery. The system allowed people to log and track daily activities that contribute to their recovery goals using three device modalities: an interactive mobile app for logging daily routines, a wearable LED display for awareness of ongoing daily progress, and an in-home ambient display that visualized an overview of the day’s activities. We recruited 17 people in early recovery from SUDs to explore ways of incorporating self-tracking using the probe over four weeks.

This study addresses the following research questions:

RQ1: What activities do people in early recovery choose to track?

RQ2: How might self-tracking technologies become a resource for supporting recovery strategies?

RQ3: How do people in early recovery perceive self-tracking tools in their everyday life?

According to Klasnja et al.’s guidance on evaluating behavior change technologies, qualitative and design-driven studies are well suited to contribute a deep understanding of *how and why a system is used* in particular ways by its target users, *explanations of potentially serious design problems* that overlook individual needs and issues, and useful information about which *design elements* in which circumstances can effectively encourage the desired healthy behavior [36]. With this framing, our findings describe participants’ lived experiences, system usage and perceptions, and design suggestions to advance our understanding the potential for self-tracking computational support in SUD recovery.

2 BACKGROUND AND RELATED WORK

2.1 SUD Recovery = Abstinence + Well-being

Substance abuse disorders (SUDs) are multi-faceted, and have been characterized as chronic diseases, like type II diabetes, cancer, and cardiovascular disease [6]. The U.S. Surgeon General estimates that 25 million people in the United States are in stable remission from a previously diagnosed SUD [2]. Recovery from substance abuse disorders requires long-term, holistic treatment rather than a cure [5]. A treatment plan may include elements like

taking medication [19], engaging in cognitive-behavioral therapy [54], building a support system by attending 12-step meetings [32], establishing a mindfulness practice [22], and more. Such treatment plans are specific to a given individual and often developed over time with professional and trusted peer support [26].

As an individual transitions from formal care to self-managed recovery, it is critical for them to continue engaging in positive behaviors that contribute to their recovery [25]. Maintaining sobriety is only one factor of a successful recovery. Increasing well-being and quality of life has received less attention, but is equally critical [4]. Dissatisfaction with quality of life in recovery can result in people dropping out of treatment programs and lead to relapse [13, 37]. Improving quality of life is especially important for women in recovery, who are also more likely to experience co-morbid mental health issues [13]. Incorporating a number of positive activities, from functional activities such as work and education to leisure activities, is an important way that people in recovery build and maintain the quality of life in recovery [13, 37]. SUD researchers across disciplines have identified understanding, sensing, and encouraging recovery behaviors as a significant opportunity and challenge for providing computational support for SUD recovery [57].

Contribution of RQ1: Existing measures of quality of life in recovery do not enumerate particular activities that are useful to individuals, or narrowly define and measure the impact of particular types of activities, such as employment, education, or volunteering. Our study allows participants to define their own meaningful recovery activities and how various routines support individuals’ recovery processes.

2.2 Sustaining Long-term Change with Recovery Capital

Long-term, self-sustaining recovery, where a person is able to maintain abstinence and positive lifestyle behaviors without outside assistance, has been shown to depend on a person’s recovery capital [21]. Recovery capital is the sum of *personal* (i.e. self-efficacy, motivation), *social* (social networks), and *community* (housing, skills training) resources that a person can leverage to support their recovery journey [12, 21]. Recovery is often cyclical, with people making several attempts before reaching a long-term stability. Participatory design workshops with people in recovery foreground the importance of exploring self-tracking technologies to help expand personal recovery capital resources [51]. However, there is a gap in understanding how these tools might be used in practice and what data and features are considered helpful by people in recovery.

Research in technologies for SUD’s have focused mainly on the abstinence and sobriety component of recovery. Sobriety-focused approaches emphasize substance detection, such as studies examining how drug or alcohol use could be detected using custom biophysical sensors [59], phone-based sensors [8], or even through social media traces [53]. However, tracking the act of using is too late to prevent a relapse, which is a process that begins with other *behavioral* signs [25]. Therefore, studies have examined the broader contextual determinants of relapse, such as detecting cravings, mood changes, or physiological markers through a combination of self-report and sensor-based tracking [11]. Another sensor-based approach is to detect and warn an individual and their care team of “risky” situations, for example by geo-fencing triggering locations (e.g., [20]). All of these approaches can help with initial cessation and maintaining abstinence, but to ensure well-being, people in recovery must also turn their attention to building a positive lifestyle.

Contribution of RQ2: There is little work on computational support for people attempting to incorporate positive and healthy activities into their routines, though these positive activities are highly predictive of successful recovery [37]. Our work describes how people in recovery employed self-tracking tools as a personal resource towards their recovery.

2.3 Considerations for Self-tracking for SUD Recovery

Self-tracking applications span self-motivated, recreational uses to more formal or “imposed” contexts, such as in prescribed self-monitoring for home healthcare [39]. When used for recovery, certain self-tracking tools may be

more or less useful over time or based on individual preference and motivation. In a study of smoking cessation, both use *and* non-use of self-tracking tools were part of people's strategies for successful behavior change [52]. We align our approach with the claim that self-tracking tools in SUD contexts should not pre-define ways of interacting with a device, but instead provide "*digital resources*" for people to use as they wish [52].

It is critical to investigate the opportunities and challenges of self-tracking in an SUD recovery context specifically, as prior research has cautioned that design approaches that are useful in other contexts may actually be triggering or otherwise harmful to the individual in recovery [47]. The specific activities that people participate in as part of their recovery process may not be unique (i.e. meditation), however the type of support needed to help maintain positive lifestyles distinguishes recovery from other contexts. From a methodological perspective, self-tracking for chronic health conditions often takes a clinician-focused approach rather than a patient-centered perspective [46], which may amplify the already substantial compliance problems in early recovery [31]. From a design perspective, popular strategies like gamification may be seen a dismissive or could be problematic for people in recovery with co-occurring gambling addiction [51], and some interface designs could cause concerns about stigma or act as reminders about the behavior one is trying to avoid [47]. Finally, prior participatory design work has highlighted that the recovery community brings a unique set of values, traditions, and perspectives that they feel should be honored in the design process [51, 58].

Contribution of RQ3: We designed and deployed an interactive technology probe to enable people in recovery to explore self-tracking tools and modalities. Their explorations and reactions provide valuable insight into the potential and pitfalls of self-tracking for SUD recovery. A third contribution of this paper is identifying how people in recovery perceive the role of self-tracking technologies in maintaining the lifestyle they want.

3 TECHNOLOGY PROBE DESIGN

3.1 Design Rationale

Technology probes are functional and flexible, inspiring users to think about new technologies and explore possibilities, and allowing researchers to test desired functionality and understand needs of real-world use [28]. We want to **understand the specific purposes and potential scenarios of self-tracking that people in recovery might enact, and how they wish to engage with tools intended to help them track and reflect on progress towards their goals**. To explore the use and perception of self-tracking technologies in recovery, we created a technology probe in the form of a multi-modal self-tracking system.

This development of this probe was inspired by prior ethnographic and participatory design work with people in early recovery, where participants and design researchers proposed technologies that could help people track their everyday activities done towards recovery [51]. However, any technology for people in recovery must support and enhance, rather than replace or complicate, non-technical ways of participating in recovery activities to prevent disenfranchisement and exclusion [58]. From our own long-term engagement with the recovery community, we also wanted to create a probe that: 1) explored interaction possibilities beyond a mobile phone, 2) could provide added value to existing recovery resources even with limited engagement, and 3) was perceived as simple even for people with limited exposure and less comfort with digital technologies. We consulted with counselors at our community partner, Journey Recovery¹, to ensure the design of the probe aligned with their efforts to assist clients in building recovery capital and would not disrupt normal treatment.

The probe and deployment study intended to familiarize participants with self-tracking practice and allow them to try out a variety of features and interaction modalities as they incorporated these new technologies into their everyday life. We used a "piggyback prototyping" method to construct the probe using an ensemble of bespoke and off-the-shelf components [23]. Off-the-shelf device components provided robust functionality to

¹ Anonymized pseudonym

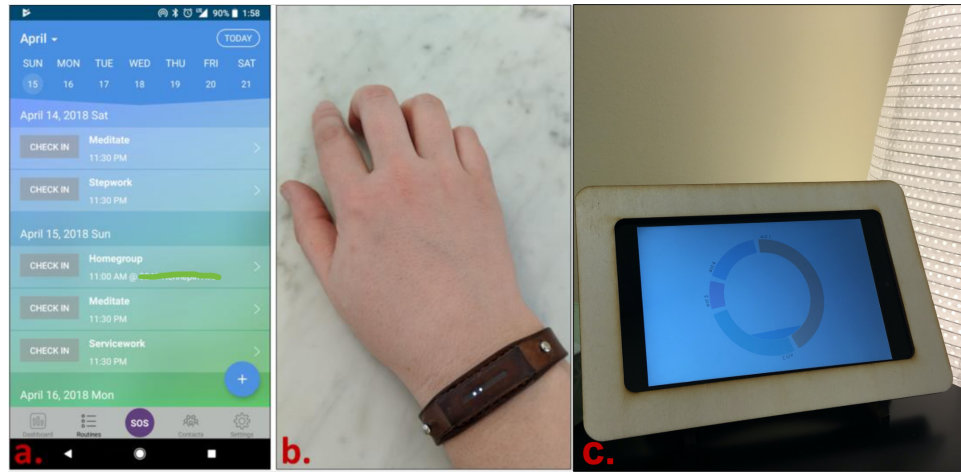


Fig. 1. Technology Probe modalities: (a) Mobile app, (b) Wearable LED display, (c) Ambient visualization.

minimize disruptive technical failures during the study and allow us to rapidly develop a probe with a range of features that users might encounter in a real-world system.

The technology probe consisted of three complementary devices designed to help people track their recovery activities throughout the day (Figure 2):

An interactive mobile app (A: WEconnect Recovery) that allows people to define activities they want to keep track of, create daily routines, and “check in” to register doing the activity during the day.

A wearable display (B: Fitbit Flex) that provided a glanceable visualization of a person’s progress completing their activities throughout the day, which could be used even when phones were not allowed or inaccessible, such as during program meetings or exercise.

An ambient visualization styled as a photo frame (C: Tablet) providing an comprehensive visual summary of participants daily routine and the completion progress.

Through these options, we explore how individuals in early recovery engage with these different modalities, which can guide the design of such devices in the future.

3.2 Components and Usage.

3.2.1 Routine Activity Logging. A routine-based self-tracking system is uniquely useful for people in early recovery. Early recovery goals often include attempts to structure days to incorporate healthier activities, positive behaviors, and regular routines leading to sustainable and independent lifestyles. Setting daily lifestyle goals and monitoring achievement of these routines was an important practice to our participants and a highly encouraged practice in the Journey recovery counseling programs.

Mobile Logging App. We partnered with WEconnect Recovery to provide us with back-end access to an activity logging app designed for people in recovery (Figure 1-a). This app uses validated design principles to maximize usability and efficacy for people in recovery, and has been used as a representative self-tracking app in prior exploratory design work [51].

The WEconnect app provided several touch points for participants to manually log activity completion: participants could check in from the app’s just-in-time popup notifications, they could “check in” for activities

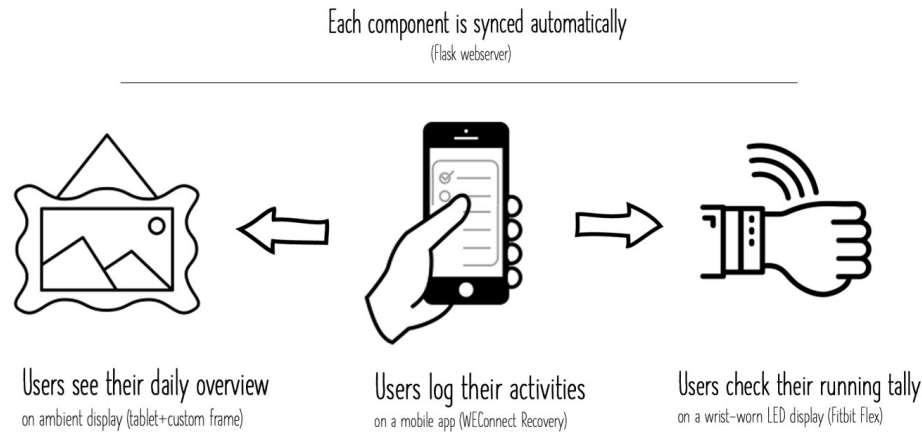


Fig. 2. The components of the system encompassed three common self-tracking device paradigms—mobile, wearable, and ambient—to give flexibility to participants about how they incorporated tracking into their lives.

periodically throughout the day, or check off all activities at once at the end of the day. Participants could also rely on the automatic location-based check-in when attending an event or meeting if they entered an address along with the time. As participants’ routines evolved, they could add, delete or modify activities each day. However, activities could only be modified on the day they were scheduled. To encourage consistency, the app displayed “streaks” of days where all scheduled activities were marked as complete.

Bridge Webserver. To record data throughout the study and synchronize the components of the probe, we built a custom web server and application using Python Flask server and Javascript. It regularly polled each users’ assigned WEconnect account via the API, recorded the activity check-ins, and performed necessary data conversions to update the wearable and ambient displays via each device’s API. The bridge server allowed us to log each user’s data remotely and fix any technical problems without requiring access to participant’s personal devices, minimizing disruptions to participants’ daily lives during the study.

3.2.2 Stylized Progress Displays. Providing stylized visual representations to the user of their activity increases users’ awareness of what they are doing and their adherence to their goals (e.g. [16, 29]). People who are new to self-tracking also show a preference for more intuitive and immediate visualizations, allowing them to quickly gain insights about their daily activities [48].

We explore two alternative visualization displays shown to be effective in personal informatics applications: a “glanceable” display and an “ambient” display [16, 24, 27]. A glanceable display presents information in a way where an overall impressions can be quickly and easily formed. An ambient display is designed to present information in a way that is not cognitively demanding. Systems that enhance awareness while requiring minimal attention are argued to increase overall engagement with data in self-tracking scenarios [24, 34].

Wearable, Glanceable Display. Researchers have found that embodied data, such as using physical objects or providing tactile information via a wearable interface can help support awareness and understanding of the data, and provide more casual access to data that purely visual or digital displays [14, 30]. In a preliminary study, we built custom hardware as a wrist-worn glanceable display, but found that robustness and power management concerns precluded field deployment. Thus, we repurposed a Fitbit Flex (www.fitbit.com) tracker as a simple wearable LED display that was updated in real-time as a user checked off an activity as “complete” in the app (Figure 1-b). The wearable was synced to WEconnect app data every 15 minutes by push updates sent by the

bridge via the Fitbit Device API. When a user activated the bracelet by a tap, the LEDs would light up one by one to show the user’s proportion of progress completing all planned activities. The wearable also gave vibration notifications when the daily goal was achieved.

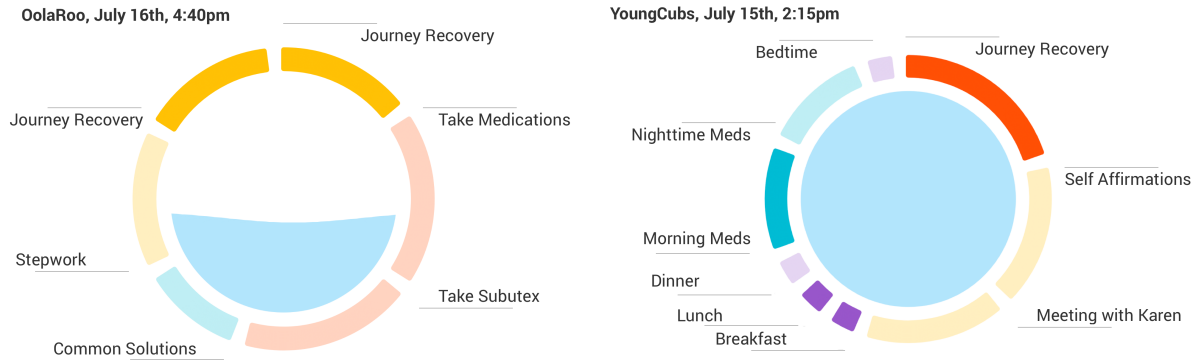


Fig. 3. Example Ambient activity visualizations. Left: partially complete, Right: Complete.

Ambient, In-home Display. The ambient display was set in a wooden frame with a stand to resemble a photo frame and to allow it to be setup on a table or shelf in each participant’s living space. The display used a Kindle Fire tablet with a full-screen webpage showing a Javascript animation, served by the bridge, which updated every 15 minutes from a users’ WEconnect data. (Figure 1-c).

The frame showed a dynamic, artistic visualization representing several dimensions of potential interest: each activity scheduled for the day, along with its completion status and priority (subjective importance rating), and the overall progress on the day. The priority of the activity was based on the importance rating participants reported in initial interviews (Scale 1-5, See Section 5). Additional activities added during the study that were not discussed in the initial interview were given a default “3” rating.

The visual design was based on the concept of informative art, intended to be visually appealing, unobtrusive, and easily interpreted [27]. It did not contain visual cues specific to recovery to prevent potential privacy concerns if the frame was placed in a public area. The animation featured a circular design with an inner sphere of gently flowing water and an outer ring of pastel colored arcs (See Figure 3). The user’s overall progress on completing their scheduled activities is rendered as a slowly filling sphere of water in the center. The outer ring shows the day’s individual activities as labeled blocks. The arc length and color of each block corresponds to the level of importance assigned by the user to the activity. Activities that have not been completed are faded, and become fully saturated when “checked in” on the WEconnect app.

4 STUDY DESIGN

4.1 Study Setting

This study took place in a large American Midwestern city in the United States in 2019. The research team partnered with a well-established recovery services provider, Journey Recovery, that offered support including group therapy, counseling, and housing assistance to people in early recovery. All research interactions, including participant recruitment, interviews, and tech support were conducted at the provider’s Counseling Center.

4.2 Participant Information

4.2.1 Eligibility and Recruitment. To ensure that each person participating had adequate access to quality care and treatment during this exploratory study, participants were required to be clients of a SUD recovery program. All volunteers also had to have access to a smartphone and Internet in their homes for the duration of the study. Most participants were living in recovery community housing (“sober homes”) with peers.

We recruited among current clients of Journey Recovery by word-of-mouth and snowball recruitment. Flyer advertisements with study information and contact information were publicly posted in the Counseling Center and announced in weekly meetings by the counseling staff throughout the month before the study began. Seventeen eligible people volunteered for the study (*Gender* men: 9, women: 7, gender fluid: 1; *Ethnicity* White: 11, Hispanic: 2, Black/African American: 2, Did not specify: 2). Participants ranged in age from 21–60 (mean = 34.6 yr, $SD = 9.58$), and had widely varying experiences with recovery, ranging from first attempts to those managing years-long cycles of abstinence and relapse. To protect participant’s privacy, we did not require participants to disclose their drugs of choice or using history. Fourteen people (14/17) completed the full study, with three participants withdrawing due to relapse or transfer to a different recovery program.

During the onboarding interview, we administered the BARC-10 “Brief Assessment of Recovery Capital,” a validated, self-report questionnaire that provides rough indicator of recovery stage and recovery progress [55]. The BARC-10 has been used in studies across a wide range of substance abuse disorders making it a ideal tool to gain a general baseline of our participants. An index score of 47/50 indicates a person has likely reached a point where their remission is self-sustaining. Our participants reported an average score of 42.41 ($SD = 5.61$), with 12 participants scoring below the index (see Table 1). This is as expected for people in early recovery, who are still developing behaviors and strategies to be successful.

4.2.2 Ethical Considerations. This study was reviewed and approved by our institutional human subjects research ethics committee as well as the Journey Recovery client safety committee.

Privacy Protection. Substance abuse disorders can be stigmatized among certain populations, so we endeavored to ensure that participating in our study did not put volunteers at an increased risk of involuntary disclosure of their treatment. The probe devices were discreet with no outstanding features that would draw attention to a person’s recovery status. Participants’ study data was collected anonymously— each participant picked a pseudonym which we use throughout the paper, and used numbered study accounts to manage their devices. Participants’ volunteer status and data were not shared with any entities outside the research team, including our community partners.

Vulnerable Populations. We worked with Journey Recovery to ensure that participants in our study had existing access to adequate medical care for SUD’s and co-occurring health conditions. Participants were assured that participating or withdrawing from our study would have no impact on their client status with their recovery services provider. In onboarding interviews, participants described their participation in the study as a positive elective: viewing it as an interesting hobby, a way to help them discover new strategies to be successful in recovery, and an outlet to contribute to the greater society.

4.3 Field Study Protocol

4.3.1 Overview and Compensation. The field study consisted of an onboarding interview session, four-week probe deployment period, and debriefing interview. The average study length was 33.73 days ($SD = 3.97$), with variation for scheduling a debriefing interview and collect the probe. The total possible compensation for participants was \$80, provided as a Target or Amazon gift card. Compensation was prorated based on length of time in the study. Participants could alternatively choose to keep the technology devices as the equivalent of their due compensation for the study. Five people chose this option.

4.3.2 Onboarding Session. The onboarding session was about 1.5 hours, including the consent process, completion of the BARQ-10 questionnaire, a 30-45 minute interview, and 30 minute technology orientation. The semi-structured interview consisted of questions about participants’ recovery goals and experiences, their routine and the importance of the activities to their recovery, and prior experience with digital or non-digital self-tracking or routine management tools. To enrich the discussion of their routine, participants were asked to write out a list of the activities they did during the week and to rank each activity on a scale of 1-5 in importance to their own recovery (5: essential to recovery, 1: nice to do but not important) (see Figure 4).

Participants were given an orientation to the different components of the technology probe during the onboarding session and were told that we wanted them to reflect on the experience of self-tracking and of using these technologies. We helped every participant set up the devices and provided daily on-site tech support at the Counseling Center. We did not impose minimum expectations of use on any device and did not tie compensation to usage patterns. The goal of this probe deployment was exploratory rather than evaluative, and this flexibility allowed us to observe scenarios of non-use as well as active engagement.

To get started, participants were instructed to enter one activity into the WEconnect app from the lists they made during the interview to get familiar with the features of the app. Participants were told they could add or remove activities from the app as they wished.

To avoid overload by introducing too many new devices at once, participants were given the WEconnect app and wearable first to familiarize with its features and acclimate to its use. The second week, participants received the ambient display with written setup instructions. To ensure the probe functioned as expected, the first reflection prompt of the week asked participants to send a picture of its location once they got it set up at home.

4.3.3 Deployment Data Collection. System Log. With the bridge application and WEconnect API, we recorded each participant’s activity details (i.e. activity type, GPS coordinates, duration) and completion status. All data was collected anonymously, with participants using numbered research accounts. We used this data to ground our understanding of participants’ subjective interview and reflection responses.

Reflective SMS Prompts. To gather ongoing reflections during the study, we planned for participants to complete a diary, with prompts scheduled three times per week to reflect about their system use, user experience, and questions about a person’s craving and mood to contextualize activity completion data. However, we learned from our participants during the onboarding interviews that several already had a journaling activity assigned to them from their program counselors and support group. To avoid conflicting with the recovery program activities, we modified the reflection component to be a set of SMS messages sent every other day with a brief reflection prompt. The regular SMS messages had the unexpected added benefit of allowing the study team to catch emergent technical glitches earlier than we might have otherwise.

Debriefing Interview At the conclusion of each participant’s deployment period, we conducted 30 minute semi-structured interviews about participants experience using the system, perceptions of its role, and preferences for device features. Since four weeks is a significant amount of time in an early recovery context, we also re-visited questions from the onboarding interview about participants’ experience in recovery.

4.4 Data Analysis

We audio-recorded and transcribed the interviews and logged the SMS interactions throughout the study. Both of these transcripts were analyzed with a combination of inductive and deductive coding. We drew pre-determined codes from our research questions and background literature, including “recovery goal,” “recovery definition,” “recovery strategy,” and “recovery challenge.” We used open coding and a priori coding to identify recovery activities, specific recovery strategies, device specific challenges, and unmet needs. To organize the insights from the qualitative data, codes were categorized into themes using affinity diagramming, yielding our findings about activity purpose, tensions, and resources.

We also analyzed recorded log data of app interactions, including the number of activities entered during the study and the daily “check-ins” (marking activities complete). To gain insight about the engagement these datapoints indicated, we cross-referenced each logged activity with comments about that activity from the interviews (references were made by linking research account numbers with the pseudonym). Through this process, we found that many activities listed and discussed as part of participant’s routines in the interviews were actually not logged by participants, which we discuss in our findings.

In addition to understanding participant’s recovery activities, we sought to understand how the various devices of the technology probe were employed. We asked participants for feedback about each specific device via weekly SMS prompts (i.e. “How has it been using the app/wearable/display?”) which elicited informative commentary from participants about their user experience, use, and non-use of the probe’s various modalities. In the debriefing interview, participants were asked to reflect on their overall impressions of self-tracking with each device. SMS reflections were coded according to their device modality (app, wearable, ambient) and their focus (device capabilities, uses, perceptions, and proposals). In the following sections, we report on our findings and discuss insights for future work.

5 WHAT DO PEOPLE TRACK IN RECOVERY?

To better understand what people track in their recovery (**RQ1**), we analyzed responses from the interviews as well as data from the activity logs. During the interviews, we asked people to list out activities they would consider a regular part of their weekly routine and to rate those activities by their importance to their recovery (e.g. Figure 4). The rating was subjective (scale of 1-5: 5 most important, 1 least important). We asked participants to self-define “importance” and explain their rankings. In addition to learning about participant’s recovery strategies, we expected these lists to be a starting point for participant’s self-tracking during the study.

We found a wide range of activities that participants described as important to their personal recovery. These findings extend prior conceptions of “meaningful” activities in a recovery context [13]. Whereas prior work has pre-defined important and useful activities using objective outcomes (such as gaining employment or skills), this work draws out individual’s subjective experiences and personal goals. In this section, we summarize activities by their described importance and illustrate various motivations with quotes from interviews.

Participant: Cassie 12-20 ALIAS: BJ

Activity	Rank 1 (least) - 5 (most)
Go to work	4
Eat three meals	3
Volunteer once a week	4
meet with sponsor	5
Share in group 2x week	5

Participant: BJ

Activity	Rank 1 (least) - 5 (most)
Bike	3
read	4
Grocery store	5
COOK	5
one AA a week 3 times 2	3
fishing	2
Help & hangout with brother	5
AFTERNOON TRACK JOURNEY	5

Participant: Jacob

Activity	Rank 1 (least) - 5 (most)
Meditation	5
EXERCISE	3
MARTINI	1
CLASS JOURNEY	3
EAT	4
SLEEP	4
READING	3

Fig. 4. Examples of activity lists written in response to interview question, “Think about the activities you do in a typical week, and their importance to your recovery” from participants: Cassie, BJ, Jacob.

5.1 Essential Recovery Activities

“Essential” activities were those participants felt were necessary to prevent relapse. Participants commonly discussed *recovery program activities* such as group therapy sessions (n=12), individual substance abuse counseling (n=2), recovery meetings (e.g. AA, NA) (n=17), and meetings with a sponsor (n=6). Required components of the outpatient recovery program were usually ranked as highly important.

In interviews, participants explained that they tracked essential activities such as recovery program events for awareness rather than memory cues. In these cases, tracking was a means to indicate when they were paying attention to more than just simple attendance. Program activities were regularly scheduled and usually not optional. For example, Cassie had a goal to take more initiative in sharing about her experiences during her regular group therapy sessions (ranked 5).

So sharing in group like two times a week. It should be important, and I should be doing that because I should be making the most out of my recovery treatment right now. So I'll put that at five. (Cassie)

While the activity listed in her routine (group therapy) was common to people in recovery, Cassie chose to track it for a specific goal that she had in her own SUD treatment journey. In this way, the importance of common activities, such as traditional treatment varied from person to person. This example shows how participants could self-track their participation in traditional treatment.

Participants also listed “daily necessities” such as journaling or planning for the day (n=4), going to work or looking for employment (n=5), and grocery shopping (n=3). These activities were often included in a “to-do” list of tasks rather than as goal-oriented endeavors. However, consistently setting and completing these daily tasks was considered important to participants because adding structure to the day was a key recovery strategy. Cat listed “walking”, “cleaning”, and “eating” as 4 and 5’s on her routine:

Cause if you're not doing anything and you're just like sitting at home and sitting on the couch watching TV all the time, like that's not like, that doesn't really give your life any kind of purpose and it doesn't give you any motivation to like continue. Like you have set activities and things that you need to do, then it gives you more structure. (Cat)

While other populations might take such activities for granted, regularly doing daily tasks were opportunities for people in recovery to practice managing everyday responsibilities and to gain independence.

Lastly, several participants listed activities that were ways of “keeping busy.” Keeping busy was described as a way to “replace the time” (Oscar), avoiding the common relapse triggers of boredom and idleness. People keeping busy kept their days packed with things to do, but the activities themselves did not matter as much as their role as a distraction and positive alternative to “using”(substances). Oolaroo describes the regular 12-step recovery meetings she attends as a way to maintain her momentum in recovery (ranked 4):

I usually do three or four meetings a week. It's just keeping myself busy with positive—you know. That's really important because downtime, it's good to relax, but if you're just doing nothing, it's not really conducive. It's been good this time around I just want to keep the momentum. (OolaRoo)

Avoiding “downtime” involved participating in scheduled events (such as 12-step meetings) as well as opportunistic moments, such as hanging out with sober house peers or joining in an outing rather than spending time alone and idle.

5.2 Consequential Recovery Activities

Consequential activities had serious outcomes tied to their completion or lack thereof, often dictated by an external authority. Varied commitments, such as a weekly volunteer position (n=6), a court appointment (n=1), and house chores (n=4), were listed and ranked as highly important because they fulfilled set obligations. Legal consequences were a particularly salient factor for tracking certain activities in their routines, with participants’ citing external motivators such as regaining a lost driver’s license, meeting probation requirements, or regaining custody of a child. Roy described attending daily recovery group meetings as highly important (ranked 5) because he was under orders:

It's an obligation because I got involved from ending up in the hospital. I'm legally required to come here. So it's meeting that obligation and then it's just something that I want to complete at the end. And in order to complete it, you've gotta be here. You've gotta attend. (Roy)

Sometimes the consequential nature was a higher goal than the specific activity. For example, Travis listed daily appointments to take addiction treatment medication, attending meetings with his counselor, and choosing to bike over taking the bus. But his express goal was to get his life in order so he could become his young son's legal guardian:

Once I get all situated, I have a 10 year old son I want to come live with me some of the time, and that's my main goal but that's going to take a little bit of time. I gotta have all that stuff done before we do that. ... I need to get myself right before I get all that. ... He's a big part of my life. That's my long – my best goal right there. (Travis)

Several people also listed consequential aspects of their routine dedicated to addressing physical and mental health issues. Several participants described dealing with serious medical conditions in addition to their SUD recovery, from unrelated chronic illnesses, to co-disorders (eating disorder, bipolar disorder), to old injuries that required physical therapy. Activities that were listed with a health maintenance purpose included taking medication (n=3), and attending or intending to schedule ongoing medical appointments (e.g. psychiatric counseling or physical therapy) (n=3). Tillie described seeing an outside mental health provider (ranked 3) as an important aspect of disentangling her identity and personality from her addiction, and also an important help in managing medication:

I think that a lot of the issues that we have, whether it be that causes us to use, or continue to use: that they're related to mental health. So I think that some of that is involved in our [SUD] treatment, but I think that it's important to also have outside appointments with another provider ...just to have another perspective too on your mental health. It's not all related to your addiction. I was diagnosed as being bipolar when I was [a teenager] but in retrospect, I don't know that I truly am bipolar, or if the ups and downs that I've had in my life are part of my addiction. (Tillie).

Attending to physical and mental health concerns, as well as outside obligations, were requisite for building a healthy lifestyle with high quality of life in recovery.

5.3 Personally Significant Recovery Activities

The personal significance of many recovery activities deserves special emphasis. For people in early recovery, gaining confidence in themselves as a sober person, rebuilding lifestyles and social relationships, and exploring ways to be happy and fulfilled without drugs or alcohol were powerful and important goals. While, each person varied widely on specific activities that fulfilled a particular purpose, there were common recovery-related motivators that provide useful insight.

5.3.1 Contrasting Lifestyle Behaviors. Some participants described adopting healthy behaviors as an integral part of their recovery process. In these cases, they contrasted “healthy” behaviors with activities characteristic of their prior substance abuse periods. Commonly mentioned healthy activities included exercise (n=11) and eating regular meals (n=5), activities which could be neglected when a person was using. For example, Oscar and Ace listed meals and exercise as part of their routine respectively because it was a marker of how each wanted to care for his health in recovery.

Breakfast... Um, I didn't used to eat breakfast when I was drinking, you know, I wouldn't eat til lunch but I feel like that was kind of running on fumes doing that. (Oscar, “breakfast” ranked 2)

For the time being exercise has got to be right up there, too. Just to maintain the healthy lifestyle and if you don't feel good, you're not going to act good, and if you don't act good you're just going to use. (Ace, “gym” ranked 4)

Although these healthy habit-forming activities were necessarily often and regular, they also tended to be ranked as lower in importance by participants. Jacob, a self-described fitness buff, explained that he ranked exercise at 2 (not very important), because “I mean, it's not like my sobriety hinges upon it.” Unlike an essential activity,

not doing a self-motivated healthy activity was not seen as an event that could trigger a relapse. Nonetheless, these lifestyle changes were seen as important for sustainable long-term recovery.

5.3.2 Personal Enjoyment and Quality of Life. Some activities were included in participant’s routines for stress-relief and personal enjoyment. These included outdoor recreation (e.g. riding bikes, fishing, taking walks; $n=5$), spirituality (e.g. meditation, praying, attending church gatherings; $n=5$), reading ($n=4$), cooking ($n=3$), and “decompressing” (e.g. doing things “for myself,” spending time alone, or taking a relaxing bath; $n=5$).

Quality of life activities could be difficult to reconcile within a routine-based self-tracking paradigm. For example, spirituality was described by participants as a way to gain strength and motivation in recovery, refocus one’s attention at the beginning and the end of the day, and develop a positive self-image. In interviews, participants described both *events*—such as attending church, and *moments*—like “being thankful,” as aspects of spirituality of their routine. However, *moments* were not consistently logged during the study, even when they were described as regular and even essential. As an example, Peaches discussed and tracked two spiritual activities as part of her daily routine (“meditation” and “listening to my gospel music”, ranked 5), but she discussed a third daily practice of thankfulness and positive thinking that she did not track:

When I wake up in the morning, I thank [God]. When I’m going through stressful times, I asked him to help me. And before I go to bed, I thank him. ...You know, I still have some habits that I slip into very easily without thinking... Just those type of things came so easy in my addiction. ...It’s the first thing I think about, but I’m learning to stop and think what would Jesus do or what is the right way, what is the next thing to do for the next right reason. That’s work on a daily basis. (Peaches)

Participants like Peaches did not record such daily “work” in the self-tracking app, although it was a regular and integral part of their day. The current schedule management affordances of productivity-oriented, routine-focused self-tracking may not invite the inclusion of activities that serve self-care, emotional, or spiritual purposes.

During the deployment, several participants appropriated the schedule structure by creating abstract placeholders to indicate an opportunity to do something enjoyable, but that was not actually planned or guaranteed to occur. For example Ace entered “fishing/ outdoors” (ranked 4) every week into the tracking app, but explained that he did not have a set plan to go fishing, he just liked to do it if he could.

Fishing and outdoors is generally like a weekend thing. Most weekends I do get a chance to get out there and at least go to a park or do some fishing or whatever the case may be. I really love the outdoors. That’s something that’s like food for my soul. So it’s something that I would probably put at a 4. That’s always been important to me even when I was using I liked to go out and have fun. (Ace)

Setting aside time for “*aspirational*” activities can not only be an important intermediate step towards actually planning an activity but also may be a motivator in itself.

5.3.3 (Re)Building Social Connections. All participants described some efforts to create and maintain healthy relationships and a social life. Building social connections is considered an important aspect of recovery, because isolation and loneliness are key triggers and warning signs of relapse [1]. Participants’ routines demonstrated different facets of building a social life in recovery, including spending time with family members and children ($n=5$) and socializing with friends or peers in recovery ($n=4$).

In particular, cultivating friends, peers, and mentors who were committed to sobriety (i.e. a sober network) was an important means of building a sustainable life in recovery. Attending social events and seeking opportunities to be with others was a way of overcoming the key challenge of isolation that many face in recovery. Chucky explained that in addition to support from friends and family, spending time with his peers in recovery helped him feel that he was not alone:

We’ll always kinda joke when we’re in meetings or in our sections that normal people wouldn’t get this. Cause there’s some things we say that normal people wouldn’t. “That... you guys did that?” and it’s like, “Yeah. You didn’t ever do that?” Just the things we subject ourselves to. So just having that camaraderie, having that fellowship is just really a blessing. ... I don’t feel like I’m alone in it, but yeah it’s my own little journey that I’m on. (Chucky)

It is important to note for some participants, social connections were seen as essential for their recovery. For example, Tillie ranked having daily connection with her daughter (rank 5) as critical to preventing relapse:

Connecting with my daughter is probably the number 1 thing. She's my biggest motivation, She's my biggest support, ... Sometimes it's not even talking to her: I can see posts that she made on Facebook or something, but feeling that I'm not disconnected from her is huge because, like what really put me in my downward spiral in my addiction was when she went [away] to college. That was like the hardest thing I've ever been through in my life. (Tillie)

Spending time with friends and family was something that participants wanted to commit to, but were not necessarily scheduled daily or even weekly events. While they appeared in the written lists, like other quality-of-life activities, they occupied figurative space in participant's routines rather than a concrete time slot. Likewise, aspirational and symbolic activities represented participants' process of rejoining society, rather than a scheduled event.

5.4 Activities Tracked Summary

Careful categorization is an important aspect of user-centered design, because it aligns the conceptual models of designers with the user's mental models of their activities. An effective categorization can also assist designers in mapping out technology features that support a particular class of activity. The WEconnect app, for example, categorized activities into "Support," "Clarity," and "Connection" options, where "Connection" routines required a link to a user's contact list to allow them to reach out with a single click, and "Support" routines offered templates for common recovery activities, like 12-step meetings. Understanding the activities that people include in their recovery routines can help identify gaps in what can and cannot be tracked and which paradigms fit people's existing needs and practices.

In our interviews and deployment study, people described and tracked a wide range of activities important to their recovery. These activities were important for a number of reasons, from being essential relapse prevention strategies, to being externally mandated, to being personally significant. Many of these activities overlap with existing self-tracking paradigms in health and wellness and routine management, and could be adequately supported with best practices identified in prior work (see 8.1). However, a significant subset of these activities were not tracked in the study or required some appropriation of standard designs in the provided tools. These activities tended to be personally meaningful, with a mix of goal-driven, opportunistic, and aspirational motivations with outcomes not easily quantified in current paradigms. These shortcomings may be usefully addressed by advancing self-tracking design in a new "self-care" paradigm, and by expanding designs to acknowledge and support aspirations as well as achievements.

6 DIGITAL RESOURCES OF RECOVERY TRACKING

To understand how people engage with self-tracking tools, we drew from log data of app interactions as well as participants' reflections. To investigate how specific features of self-tracking technologies functioned as resources that support an individual's recovery (**RQ2**), we analyzed SMS reflections and debriefing interview responses. In this section, we focus on aspects of the probe that participants specially called out as useful for their recovery.

6.1 Recovery Dedicated Theme

Early SUD recovery is a unique experience that participants sharply contrasted with the "*normie world*" (Tillie). The probe employed recovery-specific language, routine templates, and features (such as a sobriety day counter) familiar to people in recovery. These defaults were **validating** to participants, reassuring people like Vivian that the designers of the system could "*understand my life*."

Further, a dedicated recovery tracker allowed participants to more easily manage, review, and reflect on their work and progress on their sobriety plans, program milestones, and goals. Participants varied in what they

deemed relevant to track with the probe, but used the system as an aggregation tool for their recovery activities. While several participants, such as Tillie’s example below, already used analog and digital tools like calendars, to-do lists, and journals to keep track of their activities, having a single entry point to manage and review recovery-related information was more **convenient** than trying to piece it together from other sources.

I like having all of my sobriety things in one place. I do like that, to be able to pull that [information] off without having to like, weed through a calendar and see, oh these are the meetings that I went to. (Tillie)

In addition to the validation and convenience, the dedicated recovery tracker could provide **more nuanced support** for people who needed on-demand support or felt in danger of lapsing. For example, Peaches suggested adding a feature that could offer recommendations about nearby current recovery meetings, which are an important emergency support mechanism for people who feel in danger of a relapse:

...Because we could be put in a high stress situation, where a trigger starts us and then we don’t know... you know, we have to get on the phone and call this number or whatever to find out if there was a meeting. But if that was already programmed on our app, it would be much easier. (Peaches)

Participants also proposed adding activity suggestions to the app. Activity suggestions proposed by other members of the recovery community could lessen the cognitive load of finding new things to do and help people discover new interests in their sober lifestyle. Future work might explore the perceived relative value of direct peer-to-peer suggestions compared to system generated or anonymous community-sourced suggestions.

6.2 Mindfulness Scaffolds

Participants used reminders, notifications, and visualizations not only to keep track of schedules, but also to **keep themselves mindful about their broader aspirations and goals** (i.e. “creativity”, “look for job daily”). Recovery involves holistic change, including psychological and emotional conditioning. Roy explained that he placed aspirational activities in his schedule to generate reminders to keep him aware of his thinking habits and how he wanted to live his life:

This process made me realize, it wasn’t necessarily annoying, but it’s kind of like... I am reminding myself the way I want to live my life, and these are important things to me that should have crossed my mind once a day... At least it should cross my mind to do it. (Roy)

Similar to how participants included symbolic and aspirational activities in their conceptual routines, participants also appropriated feedback features as an attention guide and scaffolding for desired thinking processes.

In addition to the provided resources, participants suggested adding a note-taking field to each scheduled activity in the WEconnect app to allow them to document their experiences in the moment or reflect on the activity at the end of the day. Journaling was a therapeutic tool used in the recovery program to help people process their experiences in recovery. OolaRoo, for example, envisioned augmenting her tracked activities with journaling capability to highlight activities that were especially meaningful:

...maybe do entries for certain routines like, you know like if you go to a meeting and there’s something you gained from it, then you can make a little note in there and like kind of look, reference it you know. Cause a lot of the work that we do is like, things that you want to look back on, when you have a hard time or whatever, so I don’t know, that would be cool. (OolaRoo)

The notes field would provide a place to record activity-specific thoughts, such as take-aways from a recovery meeting, that a person could look back on later. Adding documentary reflection tools in addition to data visualizations can provide expanded opportunities for people in recovery to process the events, emotions, and progress of the day, as well as look back on their thoughts over a longer term [7, 17, 49].

6.3 Self-Efficacy Support

Based on knowledge about demotivating feedback in behavior change applications, the system did not have a penalty for missing tasks or incomplete daily routines. However, receiving nudges and notifications about a missed activity were perceived as negative feedback. For participants who were attempting to **regain a sense of stability and self-efficacy** in their new lifestyle, these were seen as constant reminders of their shortcomings.

Vivian explained that she stopped putting in as many activities after a while because the negative feedback caused her too much stress:

Like, some of these is like really pushing like 'achieve this'-type of mentality, but like balance is so important in my life, that like I don't wanna feel like bad if I don't achieve all of the goals. I would love to put all of my goals in there, but not feel bad if I don't do them all, because I wanna be able to have balance life. Calm, not like chaotic, like 'got to get all these things done.' Um, I don't like that type of pressure and stress. (Vivian)

The system features intended for accountability and motivation backfired in Vivian's case and caused her to reduce her tracking engagement. For people in early recovery, an achievement-focused user experience could result in self-tracking tools being more pressure and burden, rather than a helpful resource. Alternative tracking paradigms, such as documentary tracking and tracking for self-discovery, provide more process-oriented models that motivate sustained improvement [49].

6.4 Summary of Digital Resources

Part of sustaining recovery is gathering or developing resources one needs to be successful. People appreciated the validation and convenience of a recovery focused system, envisioning ways it could provide nuanced support to help them maintain their sobriety and improve their quality of life. The most salient benefits identified by participants during their month-long deployment study were the ways that the self-tracking practice and tools helped them to be more mindful and deliberate in their activities, guiding their attention to their aspirations and goals for themselves. However, early recovery is a time of significant change and volatility. The feedback of self-tracking tools must help people build self-confidence and self-efficacy rather than making them feel penalized or judged in their achievements.

7 HOW ARE SELF TRACKING TOOLS PERCEIVED AND USED?

To understand how people perceived their engagement with self-tracking tools in recovery (**RQ3**), we drew device-specific insights from the SMS reflections, log data, and debriefing interviews. From these observations of actual use and disuse, along with participants' reflections on their user experience, we draw out a number of design tensions in this technology space.

7.1 Engagement and Disengagement

Most participants had not engaged in self-tracking before the study, but they had some conceptual model of how it could work. All participants had some strategy for managing their daily routine, some with analog tools (sticky notes, dry erase boards) and others with digital tools (Calendar app, phone alarms). Many of these strategies were encouraged and supported by Journey Recovery program staff. However, only three participants had experience using sophisticated self-tracking tools, such as habit trackers (e.g. Habitica) or fitness trackers (e.g. Fitbit, Apple Watch). Of the three with previous experience, one person used a recovery-tailored application (Pink Cloud 12-step meeting tracker). None of our participants were familiar with the WEconnect Recovery app.

We chose to use the check-ins logged on the WEconnect app as a proxy measure of engagement with the system. Participants entered varying number of activities to their WEconnect routines, reflecting the actual variation in their level of activity and their differing tracking styles. With 15 participants whose log data was collected, each person entered an average of 5.55 unique activities via the WEconnect app ($SD = 2.42$). Participants checked-in to at least one activity on the app an average of 13.66 days during the study ($SD = 6.66$). Figure 5 shows an overview of participants' active interaction with the self-tracking system throughout the deployment study.

7.1.1 Logging Use & Non-Use . Participants engaged with the system primarily through the app: checking throughout the day for an overview of their daily routine, checking off activities completed, and reflecting on

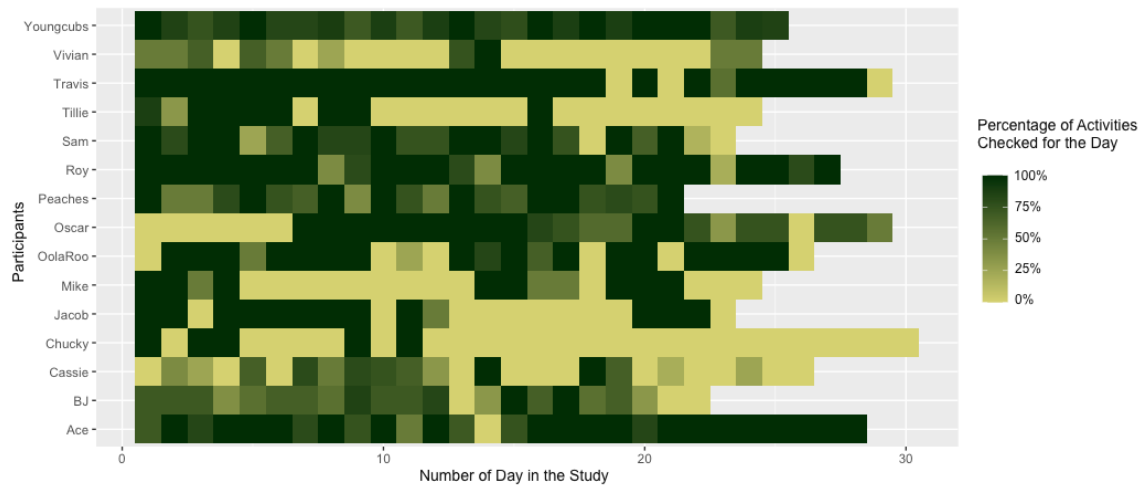


Fig. 5. Participants’ engagement with the self-tracking system, as a proportion of scheduled activities marked as completed.

their progress. At the beginning of the day, participants often checked the app for an overview of the day to stay on top of their schedules, and periodically reviewed all the activities tracked over the past week to reflect on their recovery journey.

Several people described relying on the just-in-time popup notifications to remind them to check-in. As Sam described, she would “*forget about it if it doesn’t pop up automatically*”. Participants often forgot to log their activities in time on the app when busy or overwhelmed during the day, and as is common among novice trackers [35]. Forgetting to track is not normally a problem, however WEconnect included an accountability feature that prevented participants from logging an activity after the day passed. Participants felt this was unnecessarily limiting:

That’s disappointing. Because I’m like, ‘I was there, I did that,’ you know? ...But also, if I just simply forgot to check in, ‘cause I am used to just my human self, and not checking with a computer device before I do human things. So, in that process, ‘I am just gonna do my meditation,’ I’m not gonna think to myself, ‘oh I’d better check in to this.’ Cause I am a human, I just do human things. (Vivian)

Those who enabled the location-based automatic check-ins found them convenient for regular, repeated activities such as their daily counseling sessions at Journey Recovery center. These participants described a “set and forget” mentality with tracking. Oscar reflected that location-based tracking enabled him to pay less attention to the device but gain the same benefit:

One of the locations I have set is for a meeting tonight that I go to. I don’t really have to do anything. I got the little vibrate in my pocket, ‘Oh, you just checked in.’ (Oscar)

Yet, several participants became inattentive while using the automation feature, so much so that they did not notice a glitch that caused the app to not actually check them in for several days, due to a misalignment with the address they entered and the GPS coordinates generated by the geo-fencing algorithm.

Missing entries, caused by forgetfulness or constraint, created a vicious cycle. When the progress overview displayed by the probe diverged with a participant’s own perceived progress, they felt frustrated and less motivated to continue tracking. As Vivian described, when the system failed to give her credit for all the activities she completed that day: “*I started giving up, because it was not reflecting my real progress.*” For people in recovery, it was important to acknowledge all of their effort.

7.1.2 Receiving Peripheral Updates. For participants who did not check their phone often, checking the wearable LED display periodically helped them “*understand the progress on this without necessarily having to pull the app up*” (OolaRoo). However, needing to remember to charge the tracker was tiresome for a few participants and led to disuse. One participant did not like wearing jewelry and thus did not use the device at all.

Some participants appropriated the wearable in informative ways. Although the step-counting function of the repurposed Fitbit tracker was not a part of our study, some participants figured out on their own how to use it to monitor their physical activity. Although the LED display was not actually reporting their physical activity (it reflected their check-ins), those who used the wearable as a step-counter reported feeling more engaged than those who only used the display feature. This suggests that the additional perceived utility also influenced use and non-use.

7.1.3 Displaying an Overview. Participants set the photo frame in both private spaces (e.g. on the dresser next to their bed) and public spaces in their home (e.g. kitchen, dining room, living room). Conscious placement helped integrate the ambient display into daily life. For example, Travis, one of the most active trackers, explained that placing the display by his bed helped to make it part of his routine by giving “*a reminder when I woke up or went to bed*.” Although participants all lived in shared housing, none felt uncomfortable with the level of detail about their activities disclosed in the visualization.

Participants also talked about having to “*put the tablet away*” because of limited personal space. Roy, for example, put the frame in a low-visibility spot atop a PC tower in a corner because it was the only free space he had. He suggested that it might be better for him to hang it on a wall. Sam, on the other hand, set up her frame out of view under her bed to avoid disturbing her roommates with the light from the display. Besides the physical and social constraints, the technical constraints also led to disuse. Tillie had to shut down her display because its constant updates exceeded her share of the limited Internet bandwidth at her sober house.

Understanding participant’s engagement and disengagement reveals important considerations for how to seamlessly integrate new self-tracking technologies into the everyday lives of people in recovery.

7.2 Design Tensions

Participants expressed varying interaction preferences after exposure to the ensemble of devices and modalities in the probe. While their preferences were individual, there were common themes among why certain modalities or devices were chosen over others. Two key tensions emerged in our analysis that explained how participants weighed the benefits of the resource provided against the burden exacted by the tool.

7.2.1 Amplification vs. Redundancy. The app, wearable, and ambient display provided different modalities to accommodate participants’ needs with tracking routines in different contexts. Some participants found this multi-modal tracking system to be more effective compared to only using the app. OolaRoo discussed how the WEconnect app and the wearable worked together to amplify the tracking ability and reflection support:

I mean I think it [WEconnect] works better with the Fitbit than it would without it. Like I felt like the Fitbit kind of amplified the features of the app. I mean I guess features are kind of the same... (OolaRoo)

On the other hand, some participants found the multiple devices to be redundant, and only used one or two devices throughout the study. Those who found the different devices redundant described the app as most useful, because it was the most interactive and multi-purpose device:

And the same thing with the tablet. It’s just another reminder to look at things. Um, I like the point of it, but I ended up not really using it... So, it did remind me of like, because it is just like a water thing that fills up. So, that was the same, kind of like the Fitbit, to remind you throughout the day. But I use WEconnect the most. (Cassie)

7.2.2 Convenience vs. Constraint. Automation was generally considered a valuable convenience feature, from feedback about the automated check-ins and suggested additions from participants. For example, participants

suggested ways to integrate the various apps they used to pull recovery-related activities into WEconnect automatically to reduce their effort in updating their schedules.

So, I think the biggest thing is, if it was integrated, you know? It's like one calendar you could use for all of your things, ... Cause it was hard to have... like, look at my daily schedule—all the things I have to do, then I got this too. But I think that it was a great tool. It's nice, a nice place to see 'I have been doing this straight for how many days,' and stuff like that. But it was hard to have a whole other app... (Tillie)

Such attention-saving features could potentially increase the utility of self-tracking tools. However, unknown constraints embedded in these automated features could disrupt participants' tracking attempts. For example, the location-based check-in feature in WEconnect served a dual purpose: along with convenience, it also provided system-enforced accountability for users. When a location was added to an activity, participants could not check-in unless their phone GPS registered them in that location. Even when participants noticed a glitch in the GPS and tried to update their activity manually, the app would not allow this action.

While convenience features like automated activity detection were perceived as useful, designers could also introduce constraints that disrupted the important rhythms that people in recovery had established.

7.3 Summary of Engagement and Perception

Participants used the self-tracking tools in the probe to track, overview, confirm, and reflect on their accomplished activities. The observed engagement with the self-tracking probe provide supportive evidence for the potential usefulness of these technologies for people in recovery. Many adopted a “set-and-forget” approach to tracking, which leveraged automation and just-in-time reminders to minimize the burden of active tracking. However, we saw that these convenience features could be loaded with secondary purposes that stymied participants' efforts to appropriate them in ways that fit the needs and patterns.

There were not clear group-wide preferences for a particular modality: each device had affordances and burdens that affected participants differently. We found that participant's perceptions of usefulness for the technologies in the study hinged on the interactivity and the uniqueness of function or data: accessory devices such as wearables or secondary data displays must provide enough unique utility to overcome the burden of maintenance and justify their inclusion into a person's limited physical or personal space.

8 DISCUSSION

A person's journey towards successful, sustainable SUD recovery has been described as working to achieve a balance of forces between meaningful activities, barriers to recovery, and individual needs [13]. To do this, people cultivate recovery capital: the personal, social, and community resources a person can leverage to achieving their unique, self-defined recovery goals. This study is a step towards understanding how self-tracking technologies might enhance the recovery capital of people who are working to achieve sustainable recovery.

Our findings indicate that self-tracking technologies show significant potential to assist people in tracking activities on their recovery journey. In response to **RQ1**, we discovered a diverse range of activities that participants tracked as *essential*, *consequential*, and *significant* in their recovery journey. Yet, to be effective in a recovery context, designers must adjust their support according to the role of an activity in a person's recovery journey, prioritize flexibility and adaptation, and consider ways to support aspirations. In the following section, we discuss lessons learned from this context that could further enhance adaptable design in self-tracking.

In response to **RQ2**, participants who used the self-tracking system found value in the practice and tools of *self-tracking as an attention guide*. They appreciated the ways that an activity-focused, goal-oriented paradigm helped to organize the many efforts and achievements they were making on their way to self-sustaining recovery. Further, the routine tracking template helped people plan and structure their days, providing a sense of normalcy and contrasting their recovery lifestyles with past living.

Much of the work in self-tracking for behavior change is applicable to the recovery context. However, in addressing **RQ3**, we found several unique design tensions linked to values and situations of people in early recovery that deserve special attention in future work. Therefore we discuss lessons learned from the deployment study that sensitized us to potential burdens of self-tracking tools and systems. While this combination of burdens may be unique to recovery contexts, sensitivities for this community can help inform self-tracking in contexts with other vulnerable populations at risk of being stigmatized [40].

To synthesize these insights, we discuss possibilities for a holistic approach to self-tracking that goes beyond flexibly tracking multiple activities to considering how tools can support entire lifestyle goals. We then discuss the potential burdens these technologies can place on people in recovery and ways that designers might mitigate emerging tensions. We close with special considerations for this design space and future work.

8.1 A Holistic Approach: Self-Care, Appropriation, and Semantics

Best practices in recovery treatment “should address the needs of the whole person to be successful” [6]. Prior research on self-tracking for people in SUD recovery has focused on methods and tools to monitor abstinence from substance use (e.g., [8, 59, 60]). However, the participants in our study chose to track a broad array of activities that supported their recovery (treatment participation, 12-step meeting attendance, etc.) and created a new normal in their lives (meeting obligations, exercising and eating regularly, staying socially connected, etc.). A holistic approach to SUD recovery resonates with parallel critique in chronic health tracking, advocating for more attention to patient-focused “self-care”, defined as “the activities that people living with a chronic condition (patients and carers) undertake to manage the condition as part of their everyday life,” including the lived experience, multiple goals, and complex priorities of everyday life [45].

In a critique of technology support for chronic medical conditions, Nunes and colleagues found that the majority of health technologies feature designs that create a dichotomy between management of the medical condition and activities of daily living. [46] They argue that this dichotomy is false and limits the usefulness of technologies for people managing chronic conditions, especially over a lifetime. Instead, technologies for long-term self-care benefit from a “daily life orientation” rather than a focus on medical outcomes [46].

Based on this research, tracking applications intended for recovery support would benefit from design approaches that prioritize flexibility, or what has been called “design for appropriation” [46]. While there were commonly tracked activities in our study, such as 12-step meeting attendance, all participants had unique activities that related to their personal goals (e.g., “creativity”) or individual needs (e.g., “alone time”). The recovery context may benefit from an approach similar to one taken by the OmniTrack prototype, for example, which allows users to define their own sets of custom trackers according to their specific activities and data collection needs [35]. In their field study, people leveraged this flexibility to create bespoke trackers for activities ranging from drinking coffee to sleep habits, which supported a number of different tracking styles beyond goal-oriented tracking, from documentary to self-discovery.

Yet, the holistic needs of recovery tracking go beyond a flexible, “one app” dashboard approach. Because most current tracking tools track one type of activity or goal (i.e. step counts, food intake), there has been little need or opportunity for people to define routine-level semantics such as the priority of a particular activity over others or an activity’s purpose in a larger set. We found in our study that these semantics are quite important to people in recovery, as the combination of activities work together towards the overarching goal.

Incorporating the nuance of purpose also allows for the inclusion of “aspirations” in a self-tracking routine. Aspirations could be implemented in a number of ways, from bonus activities that appear in a routine and boost a person’s progress without counting against them, to placeholder slots that accept write-in entries at the end of the day to show how a person incorporated this aspiration into their day. Here is an example of how a more nuanced approach might work:

Ace schedules “fishing” as a recurring event on the weekends, tagging it as an aspiration, and labeling it in his “de-stress and enjoy the outdoors” category. He sets aside time because he feels at peace when he’s outside in nature. However, one of his housemates invites him to a sober BBQ in the neighborhood park, and he decides to do that instead this week. In his recovery tracker, he notes that he attends a BBQ as his de-stress activity and also spent some social bonding time with his housemates. His old tracker would have noted “fishing” as a “missed” activity in his routine, and hassled him with endless reminders as if he forgot. However, this new responsive design understands his underlying intention, allowing him to track his activity accurately, and even gives him extra points for also seizing the opportunity to meet his goal of building up his sober network of friends.

A value-oriented approach that differentiates the progress and achievement support features across essential, consequential, significant activities could offer significant benefit. Essential activities could emphasize more long-term consistency-focused support and acknowledgement, while consequential activities might feature proactive reminders and recognition of each achievement. Personally significant activities might be intrinsically motivated, or more emotionally difficult, making encouragement and celebration more useful than reminders and demerits.

8.2 Mitigating Burden of Self-Tracking

Many of the activities people chose to track focused on specific actions or behaviors. In our study, participants mostly had to manually enter and check off progress on these activities, however many shared that integration and automation would have been preferable if it could be done accurately. Robust automated recognition of an arbitrary set of behaviors is in some ways the “holy grail” of ubiquitous computing, where state of the art in the area is just detecting simple behaviors (e.g., opening the refrigerator) but with broader more complex behaviors (e.g., cooking) being more difficult to infer [33]. Detecting such activities and behaviors in a recovery context is even more challenging as the activities occur throughout the world, rather than in an instrumented home or institutional setting.

The Ubicomp research community has explored the benefits and trade-offs of technology-enabled self-tracking along a continuum from manual to automated, representing a number of trade-offs that designers must choose between for specific applications and use contexts [15]. Manual tracking tends to have a higher user burden, is subject to inaccuracies from faulty memory or data entry, and is negatively associated with long-term engagement. Automated tracking can reduce user’s awareness of their activities or habits, requires a level of data collection that may challenge privacy concerns, and is technically challenging to implement broadly. Additionally, it can cause issues when it breaks, as we saw with geo-fencing in this study.

While many recovery activities may always need to be entered manually due to their ambiguous nature (e.g., “creativity”) or due to privacy constraints (e.g., “sharing in group”), there were other activities that have features that allow them to be automatically detected. First, many activities occurred at a consistent location each time (e.g., going to church, certain 12-step meetings, treatment), which can be detected with current smartphone technologies. Second, many activities related to proximity to other people (e.g., working with a sponsor, being with a person in one’s support network, being alone), which is not currently tracked by any systems we know of but may be trackable for specific people using bluetooth proximity (though state of the art in this approach also requires an instrumented environment [42]) or approximately inferred using phone-based audio sensors (e.g., [9]). Third, many activities may leave digital signals in other applications, such as calendar entries, digital journal entries, and use of applications such as a meditation timer and may be detected by interfacing with a phone’s operating system or using specific application APIs. There is both a substantial opportunity and a clear technical challenge in helping people specify sensor patterns relevant to specific activities, accurately tracking those activities, and seeking manual input or verification in cases of uncertainty.

Ayobi et al. [7] challenge the assumption that manual tracking is necessarily high burden. Using the example of bullet journaling, they argue that manual self-tracking can be complementary to automated methods as a

means of self-expression (creation of visual and textual representations) and self-exploration (experimentation with relationships between different data). Our participants suggested adding a journaling feature to the activity-tracking app to give them a space to reflect on their activities and record their thoughts and insights. While prior work has explored overview visualizations to help people reflect on their behavior patterns, research has yet to explore how integrating free-form reflection tools to comment on individual activities might enhance the recovery experience in people managing long-term health conditions.

8.3 Working with Sensitive Groups: Acknowledging Constraints on Autonomy

As future work explores the design of self-tracking tools for supporting independent and interdependent recovery, it is important to acknowledge that people in recovery may not have total autonomy over their activities or their data. Lupton argues that the “culture” of self-tracking, stemming from the Quantified Self movement, assumes that people have relative freedom and control over themselves and their choices [39]. However, Lupton critiques this notion by pointing to the influence of socioeconomic status on a person’s ability to act on information they learn about themselves. Relatedly, prior literature in chronic health technologies has sought to draw a distinction between “monitored” self-tracking work done under the direction and observation of a clinician, and tracking undertaken as part of an independent “self-care” regimen [15, 46]. The power dynamics between clinicians and patients can cause tensions around the degree of autonomy a person desires to have in handling their data.

Participants’ discussion of their activities show a mix of monitored and independent activities in their routines, with accountability to a range of actors beyond just their clinical care provider. For example, three participants described activities that were mandated by a court authority, and two participants described reporting some of their routine to the managers of their sober home. While no one directly shared their self-tracked data from the apps in our study, these scenarios were not uncommon.

Our probe and study was constructed with high privacy and autonomy requirements, which led to participant’s relative comfort with using the system for their own purposes. However, future work in this space must acknowledge likely constraints on privacy and self-determined data collection that many people in early recovery from SUD’s may experience as they appropriate these tools to manage their accountability to medical, legal, or social care bodies. Further, it is important for designers to always consider the possibility that a person may be compelled to use a particular self-tracking tool, and share the data collected, rather than having a free choice.

8.4 Limitations and Future Work

This study was conducted in 2019, before the global COVID-19 pandemic, which shifted many people’s perceptions and use of technologies. It was also conducted in an urban, North American context, where the values, resources, and practices surrounding and enabling recovery for substance abuse disorders may not necessarily translate to other cultural or sociopolitical contexts. Nonetheless, we believe the work conducted yields valuable insights for the design of these technologies for groups of people seeking to use self-tracking technologies as a digital resource to help them enact holistic changes in their lifestyle.

Future work can further explore specific implementations of the various modalities we included in our probe. While the openness of this exploratory probe study precludes strong claims, these findings demonstrate the value of continuing to understand self-tracking modalities in varied interaction contexts, and moving beyond mobile phone-based interactions into wearable, glanceable displays and ambient visualizations. Along these lines, future work can also explore incorporating the nuances of self-tracking, such as purpose and priority when tracking several activities and the value of aspirational and symbolic activities in a routine.

9 CONCLUSION

In this paper, we explore the potential for self-tracking technologies to provide meaningful support for people in recovery from substance abuse. We designed and deployed a technology probe to enable people in early recovery to track their everyday activities. We studied what activities people track in recovery and noted how current paradigms supported and limited handling spontaneous activities as well as aspirational and symbolic activities. We detail how various device features became useful digital resources, and some of the tensions and trade-offs that arose as the devices were appropriated by participants. The findings from this study demonstrate the positive potential of digital self-tracking tools as SUD recovery support resources and highlight opportunities for holistic, value-oriented design.

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