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“Energy is a Finite Resource”: Designing Technology to Support Individuals across Fluctuating Symptoms of Depression

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Abstract

While the HCI field increasingly examines how digital tools can support individuals in managing mental health conditions, it remains unclear how these tools can accommodate these conditions’ temporal aspects. Based on weekly interviews with five individuals with depression, conducted over six weeks, this study identifies design opportunities and challenges related to extending technology-based support across fluctuating symptoms. Our findings suggest that participants perceive events and contexts in daily life to have marked impact on their symptoms. Results also illustrate that ebbs and flows in symptoms profoundly affect how individuals practice depression self-management. While digital tools often aim to reach individuals while they feel depressed, we suggest they should also engage individuals when they are less symptomatic, leveraging their energy and motivation to build habits, establish plans and goals, and generate and organize content to prepare for symptom onset.

Keywords

Mental Health; Personalization; Tailoring; Depression; Temporality; Digital Interventions; Motivation; • **Human-centered computing~Human computer interaction (HCI)**; *Empirical studies in HCI*

INTRODUCTION

Depression is a common mental health condition that dramatically impacts individuals and society at large. The effects of depression include distress, impaired quality of life, reduced labor participation, increased health care complications and costs, and risk of suicide [16,41,111]. While psychotherapy and other treatments can effectively reduce symptoms [33,35], demand for mental health services outstrips supply, and many individuals face

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challenges accessing services due to cost, transportation, and stigma [71,72,100,105]. Globally, fewer than half of those affected by depression receive treatment of any kind [121]. Tackling the problem of depression therefore requires scalable solutions that appeal to those who may be uninterested in formal mental health services or unable to access them.

Mobile phones and other digital technologies offer new opportunities to reach and support individuals with mental health conditions. Many individuals with depression express openness to engage with digital mental health tools, given their convenience, self-pacing, and reduced stigma concerns relative to face-to-face treatment [36,43,52,97]. These opportunities have generated increasing interest within the HCI community [19,104]. Researchers have developed systems to provide psychoeducation, build self-management skills, deliver motivational content, and connect individuals to remote support from counselors or peers [47,66,73,76,84,106,124,126]. There is also growing interest in the capabilities of smartphones for ongoing monitoring of depression via sensors and brief self-report measures [3,5,12,22,64,74,92,101,131].

Despite these developments, one primary challenge in designing digital tools for depression centers on the heterogeneity of depression experience. Individuals may meet diagnostic criteria for Major Depressive Disorder (MDD) with hundreds of different symptom combinations [40,135]. Furthermore, a single individual can have variable experiences over time. MDD is often characterized by periods of feeling symptomatic and periods of remission. Individuals may also experience day-to-day or moment-to-moment fluctuations in symptom severity, influenced by contexts and challenges in life. At present, most digital tools for depression focus on managing acute symptoms, with little attention to these moment-to-moment, day-to-day, and month-to-month fluctuations. Studies suggest high attrition for digital mental health tools [25,123], which may in part reflect failure to address important temporal dynamics.

While there has been growing interest in understanding mental health within HCI, design activities often involve short-term interaction with participants, such as in elicitation activities and one-time interviews. These methods, while valuable, provide limited insight into the ways mental health symptoms fluctuate. Recent work has begun to accommodate the dynamic nature of depression through context-aware and “just-in-time” interventions [32,79], but this work is at an early stage and has largely emphasized overcoming technical hurdles in detecting depression-related contexts and states and in modeling risk [104]. For ongoing monitoring to become actionable, we must also understand how changes in the experience of depression alter individuals’ needs and preferences for managing their condition.

To examine the dynamic nature of depression, we elicited five individuals’ personal experiences of depression and self-management over six weeks. Our study continues a research stream in HCI focused on temporality, which has shown that individuals coordinate an array of activities around rhythms in daily life [7,94]. Such considerations have relevance in depression given its episodic and fluctuating characteristics. Understanding these patterns has increasing value as mobile tools are developing the capacity to detect and adapt to user states and behaviors [74,125]. In this study, we ask two questions: (a) How do individuals

perceive their experiences of depression to fluctuate in daily life? (b) How do changes in experiences of depression affect the way individuals manage their mental health and pursue wellbeing?

The contribution of our study is to highlight the experiences that individuals with depression have over time, and the ways that “ebbs and flows” in symptom severity shift individuals’ goals, preferences, needs, and capabilities. Our findings allow us to critically engage with a series of premises under which researchers often operate when designing digital mental health tools, including tendencies to center primarily on individuals’ needs during acutely symptomatic states. Our findings suggest unmet potential to engage individuals when they feel less symptomatic, leveraging their energy and motivation to develop skills, cultivate rewarding habits, and customize support systems for themselves.

RELATED WORK

In the following sections, we summarize related work that motivates this study. This work highlights fluctuating aspects of depression as well as efforts to accommodate dynamic factors in treatment and self-management and in the design of digital mental health technologies.

Temporal Dynamics of Depression

HCI researchers have long studied how temporality can organize behavior in various domains of life. Although temporality often operates outside explicit awareness, individuals nonetheless come to understand and anticipate a number of patterns of change, timing, sequence, and repetition [10,87,94]. For instance, in medical work, providers develop an intuitive sense of “rhythms” occurring at several time-scales (e.g., lab results, changing shifts), which are central to coordinating work across team members [95]. Furthermore, introduction of technology may disrupt daily activities to the extent that it reorganizes established temporal patterns [10]; yet, if technologies attend to temporality, they can be woven into day-to-day life to support coordination and planning [7]. In general, this body of work suggests that supporting individuals in daily activities requires understanding the ways that temporality is experienced and acted on.

The mental health literature recognizes important temporal aspects of depression. As with other chronic conditions [28,108], these include long-term dynamics wherein a person gradually moves through an illness trajectory. Individuals with depression may evolve in how they conceive their condition, disclose their symptoms, inhabit a sick role, and manage their health [30,57,98], as well as changes in willingness to seek treatment [130].

In addition, depression has distinct temporal patterns relative to other chronic conditions. An episodic condition, depression features periodic relapse and remission of symptoms [26,112], with onset of episodes often profoundly changing mood, motivation, sleep, cognitions, behaviors, and physical and other symptoms [40]. There may also be change over the course of an episode, as symptoms improve over time until they resolve, and the individual is again in remission [113].

Yet, with some exceptions [23,38,53], the mental health literature has given less attention to the ways symptoms and their severity fluctuate across days and moments, whether an individual is in an episode or period of remission. Shorter-term shifts in mood and wellbeing may correspond to an array of situational factors (e.g., social interactions) that act as stressors or enhance coping capacity [96,115].

In sum, while most conceptions of depression emphasize how individuals feel and think during depressed states, the temporal fluctuations experienced by individuals with depression require consideration. Over a longer-term – months to years – relapses are common. On a shorter timescale, individuals might experience brief fluctuations in mood, motivation, and other symptoms. The next sections describe how temporal considerations have shaped treatment and self-management approaches.

Accommodating Fluctuation in Depression Management

Efforts to support individuals across change in depression experience have occurred both within and outside the formal care system. In clinical psychology and behavioral medicine, adaptation of treatment often happens gradually, as providers come to understand individuals' needs and circumstances, and establish a baseline against which to test treatment strategies [78]. Some attempts have also been made to formally match treatment approaches to symptom levels or the needs of the patient [37,82,117]. However, despite the potential of psychotherapy to accommodate changing needs and capacity, treatment is often time-limited, reflecting cost and resource intensiveness of services, as well as frequent early termination by patients [120].

Apart from clinical interventions, practices from the perspective of positive psychology and personal recovery also consider individuals' needs beyond acute symptoms. In positive psychology, individuals can enhance wellbeing through practices and habits in daily life, like gratitude, selfcompassion, and mindfulness [17,109,132]. These practices may bring benefit whether or not individuals have active symptoms or meet clinical criteria. Likewise, personal recovery perspectives extend their emphasis beyond acute symptoms to management of wellness over the long-term. This includes “wellness recovery action planning,” in which individuals outline the steps and strategies that can help them maintain wellness and identify and respond to signs of recurrence [27]. The role of supportive others may also be explicitly defined and agreed upon so that individuals maintain agency in times of severe unwellness. Critically, these perspectives engage individuals both when experiencing symptoms and when less symptomatic.

People living with mental health conditions may also employ an array of strategies in daily life to address changes in symptoms. Different from treatments prescribed by healthcare providers, “self-management” practices can be initiated and enacted outside the clinic [83], and focus on building self-efficacy and responsibility by placing the individual in control of their illness journey [127]. Individuals may select from an array of possible activities (e.g., journaling, physical activity, relaxation exercises) that fit specific needs at different times [9,42,114]. Furthermore, self-tracking practices using digital or non-digital tools [6,69] may allow individuals to better understand patterns in their symptoms and behaviors [59,70].

Although depression is characterized by fluctuations in experience, limited access to mental health services means that many individuals have little formal guidance for how to support their mental health and wellbeing when they feel asymptomatic. As we describe in the next section, digital tools could potentially play an important role in supporting individuals beyond their symptomatic states.

Adaptive and Context-Aware Mental Health Support

Digital technologies, in particular smartphones, offer new opportunities to help individuals manage depression. Since they are integrated into people's everyday lives, smartphones could deliver support to individuals in an efficient, cost-effective, and ongoing fashion compared to traditional in-person services [73,122]. These technologies have the potential to help individuals across diverse contexts and to reduce the burden on an already overburdened care system. However, whereas traditional mental health services allow providers to adjust treatment as they gain information about individuals, achieving such person-centeredness in computerized tools represents a significant challenge. Researchers have begun to make a number of efforts to overcome this challenge through adaptive systems.

Early digital tools for depression were largely didactic, translating in-person therapies into a digital form [51,55,123]; however, a robust body of work suggests that tailored rather than "one-size-fits-all" approaches have greater effect since they deliver more relevant information, in turn improving engagement and information processing [44,61]. While tools are often tailored to a user at the start of an intervention, tailoring can also continue over time to accommodate changing needs and contexts. This is increasingly feasible given developments in passive sensing and machine learning. In mental health, there is growing interest in the potential to leverage smartphones' sensing capacities to continuously monitor contexts and behaviors including location, physical activity, and social activity [12,22,74,92,101,131]. Machine learning techniques can be applied to this data to learn the relationship between signals and to predict psychological states and circumstances [12,74]. This has given rise to early context-aware systems. For example, one proof-of-concept smartphone app passively tracked 38 types of data (e.g., location, motion, time, etc.), alongside self-reported mood, in order to predict emotional states and tailor activity suggestions [18]. Similarly, Wahle et al. [129] evaluated a behavioral activation system to recommend activities based on physical and social activity. Sensing may also eventually facilitate linking individuals to more intensive treatment or clinician contact when needed, likely relying on underlying risk models that take multiple data streams into account [86,125].

While smartphones have significant promise to deliver adaptive tools, research in this area is in its infancy, and few adaptive systems are fully deployed. Further, as Bardram et al. [8] have argued, it is challenging yet critical to identify which contextual factors are most relevant to an individual's mental health. In addition, when recommendations within a system are pre-programmed, this creates potential for misalignment between recommendations and an individual's preferred activities. While asking individuals to self-report their preferences is possible, it requires substantial user effort [9]. In short, no

consensus yet exists on how to adjust digital tools to individuals' changing states, behaviors, and surroundings [15,125]. This paper seeks to contribute to adaptive system design in mental health by identifying, from participants' perspectives, how self-management strategies and support needs change across contexts and time.

METHODS

The data analyzed here come from a larger project aimed at designing smartphone-based depression monitoring and intervention technologies. Participants living with depression were recruited to use two smartphone applications for six weeks, one that collected passive data via smartphone sensors, and one that prompted completion of twice daily ecological momentary assessments (EMAs) about mood and experiences. The same participants completed weekly interviews relating to their symptoms of depression, their goals and challenges, the ways they managed their mental health, and the possible role of technologies in supporting them. These interview data are analyzed here. Research activities occurred at a large Midwestern University and received approval from the University's Institutional Review Board.

Participants and Procedure

Participants were recruited between February and June 2015 through an advertisement posted on a [Reddit.com](https://www.reddit.com) forum (subreddit) for the urban area where the study was conducted. The advertisement stated that the study aimed to understand how mobile technologies might help individuals manage depression. Interested individuals followed a link to a screening questionnaire. To be eligible, individuals were required to be 18 or older, available to visit the lab for interviews, able to speak and read English, and free of a visual or motor impairment that could prevent interaction with the smartphone apps under study. They were required to have an active email account, a smartphone with Android version 4.1 or higher installed, and Wi-Fi available at home. Moreover, participants were eligible if they scored 10 or higher on the 8-item Patient Health Questionnaire [PHQ-8] [63], indicating at least moderate depression.

Of 20 individuals who completed screening, 14 were eligible for the study, of whom seven were invited to visit the lab to learn more about the study and sign a consent form if they chose to proceed. While all seven agreed to participate, two participants subsequently withdrew from the study for personal reasons and their data were not analyzed. Of the remaining five participants, three were women and two were men, with a mean age of 28.6. All were employed and had completed either four-year college or some college. The participants were compensated up to \$115 for completing the screening survey, using the study apps, and participating in one-hour weekly interviews during the study period.

During the six-week study, each participant completed at least five weekly interviews about their day-to-day experiences, mental health symptoms and concerns, and methods of managing depression. Interviews were one-on-one, in-person, and ran for at least one hour each. Two participants completed six interviews each, and three completed five interviews each, resulting in a total of 27 interviews. Each participant, therefore, spent at least five hours with an interviewer, who was typically the same person across all the participant's

sessions. Thus, despite the small sample size, our design offers considerable data for each participant that allows us to focus on within-person variation over time [20].

Interviews followed a semi-structured protocol. The first interview with each participant focused on routines (e.g., work, social interaction, hobbies, other responsibilities), offering a foundation for later interviews to probe how daily activities and routines were perceived to relate to changes in mental health and wellbeing. Interview questions largely elicited experiences over the week since the last interaction, including: overall mood and wellbeing; goals and plans; significant events and stressors; and coping and self-management activities. In the first session, interviewers also helped participants install the two smartphone apps. Data from these apps informed questions and activities during the upcoming week's interview. For example, participants were asked to provide additional information about data collected from the previous week, including outlier scores. They were also asked to reflect on their data. Because this paper emphasizes individuals' lived experience of depression, we focus on the insights emerging from the interviews rather than the EMA or passive sensor data themselves.

Data Analysis

After transcribing interviews, data analysis proceeded using a team-based thematic approach based on Braun and Clark's methodology [14]. To start, the first two authors randomly picked one participant and open coded all five interviews independently, reading chronologically to retain temporal context. They then met to discuss, name, and define themes in the data, developing a preliminary codebook. In an iterative process, the coders used Dedoose, a qualitative data analysis software, to code transcripts from each other participant, meeting to revise the codebook by adding new codes and deleting ones that did not occur across multiple participants. Codes were then grouped hierarchically into axial codes. After agreeing to a final codebook, coders divided the remaining transcripts. Inter-rater reliability was not computed, which reflects in part that coders may segment a transcript differently even when applying the same code. However, we note that the two coders shared similar qualitative methods training and engaged throughout this process in discussions to resolve discrepancies, ensure consistency, and arrive at consensus. Consensus coding is designed to capture data complexity, avoid errors, reduce groupthink, and circumvent some researcher biases [14,46].

Ethical Considerations

Conducting research on mental health raises ethical issues. For example, interviewers risk inducing or exacerbating distress by asking participants to recount difficult experiences. As interviewers had varied backgrounds (a clinical psychologist, a doctoral student in human-computer interaction, and a research assistant), the clinical psychologist on the team provided training in interview skills relevant to the study population. Interviewers were trained to inform participants that they were not interacting in a clinical capacity (e.g., as therapists or counselors), but were gathering information that might improve digital tools for mental health support. They were also trained in empathetic listening and in assessing and responding to potential risk according to a safety protocol. If participants indicated thoughts of suicide or self-harm during the interview, the protocol called for conducting a Columbia-

Suicide Risk Assessment [89]. If indicated, interviewers were trained to refer to psychological or social services, involve the team's mental health practitioner, or call 911 emergency services.

FINDINGS

In this section, we turn our attention to how participants described their depression and associated symptoms as fluctuating and unpredictable in timing. We also describe how onset is characterized by shifting energy and motivation that can affect self-management practices. We conclude by describing how participants, when they are less depressed, make plans for handling their depression in the future.

Variability and Fluctuation in Depression Experience

Below, we describe participants' overall experiences of depression as a fluctuating, episodic condition. We highlight how our participants faced different primary concerns and identified different dynamic factors as contributing to their manifestation of symptoms. In some cases, the role of these specific factors also varied over time for the same participants, leading to an experience of depressed states as having unpredictable timing and triggers.

Depression as a chronic, fluctuating condition—While participants all lived in the same Midwestern city and shared a clinical condition, their stage of life, social relations, and primary concerns varied. P1 had recently graduated from college and was living with her partner and a new dog. P2 worked in a call center and had recently been promoted to a management role, which he found challenging. P3, an emergency medical technician, lived with her fiancé and was taking online classes as she contemplated a career change. P4 was recently divorced and experiencing loneliness and regrets over her failed marriage. P5 was in the process of settling into a new apartment with his partner who also struggled with mental health concerns, anxiety and panic attacks, which he navigated alongside his own symptoms.

Despite their different lives, depression was viewed as a chronic, recurring challenge in each. Its impact encompassed negative emotions and thought patterns, low motivation, loneliness, and impaired memory. These issues were discussed candidly, with participants adopting clinical terms (e.g., “*having depression*”). This included recognizing recurrence as an expected part of depression, with symptoms coming and going “*like a cycle*” (P2). Contributing to these views, participants all had prior engagement with formal mental health care (generally psychotherapy and/or pharmacotherapy), although current treatment varied. They also all identified a collection of self-management practices they used to maintain wellbeing, ranging from socializing, to creative practices (sewing, writing), to meditation.

Participants each identified core factors that negatively impacted their mental health, sometimes dramatically shifting their mood. For instance, P5 described feeling unprepared to help manage his partner's anxiety, reporting that he would try to “*find some way to navigate through that like fog and like show her that there are solutions.*” In light of the frequency of her panic attacks, he felt “*a little stressed out... like I have a reserve of stress relief that is being depleted.*” For P2, work responsibilities were most highly distressing,

leading to anxiety about the future, and regrets about the choices that had led him to his current situation.

Unstable meaning and valence of contextual factors—Although primary stressors were fairly stable for each participant, their strength of impact could vary, shifting between feeling manageable and unmanageable. For instance, despite recurring issues with his work stress, P2 still felt that particular interactions could “*blind side*” him, such as when his boss would text him outside of business hours with requests that he downsize his department. Similarly, although P5 had ongoing conflict with his roommates, these concerns suddenly escalated in their impact and left him “*stressed for most of the week and very lethargic and tired.*” Thus, while primary stressors had a consistent valence, they varied in how strongly they were felt to impact depression. Circumstances could converge such that stressors could suddenly overwhelm abilities to cope.

Some factors could even entirely shift in their valence, moving between precipitating depression to supporting mental health. This was the case for some social factors. With regard to coworkers, P2 described that interactions could be stressors or not, depending on a particular set of boundary conditions: “*it depends on the person, the time of day, and what it is I need for them to do.*” P1 reported a similar phenomenon when looking for support on Facebook, finding it highly varied in its quality, leading her to either feel supported or discouraged: “*It can go one way or the other.*” For P4, this ambivalence emerged in relation to watching Netflix. Asked if it makes her feel better or worse, she replied, “*a little bit of both.*” These factors had a shifting relationship to depression, playing a self-management role at times, but also having potential for a negative impact.

Overall, the shifting strength and valence of specific factors meant that fluctuations of depression symptoms largely felt unpredictable to participants, leaving them unsure how their experience would evolve over hours or days. However, as we discuss in the next section, some patterns did emerge as being stable, particularly in the ways these ebbs and flows of symptom severity would affect self-management practices.

Fluctuating Motivations and Self-Management Styles

While our findings suggest that periods of depression felt unpredictable in timing of onset and its triggers, they recognized relatively stable patterns in *how* depression was felt. They emphasized, energy, meaning the resources they felt they had to carry out activities, as well as motivation, meaning their interest in those activities. Participants described their experience as bifurcated into periods of lower and higher energy and motivation, each associated with distinct self-management approaches.

Self-management during lower energy and motivation—Periodic fluctuations in symptoms were often described in terms of the absence of energy, characterized by a state of lethargy. This included feeling that possibilities and actions were closing off to them. Reflecting on her various hobbies and interests, P2 stated, “*people can’t imagine getting out of bed, so they can’t imagine doing all this other stuff.*” This was echoed by P4: “*When things get really depressed, it’s just like I kind of feel like a, you know, lump on a log.*”

Depressed states also manifested in disinterest in specific activities, which P1 described as “*a shift in what I feel like motivates me.*” This was echoed by P3, who described, “*not wanting to do anything.*” This included many goal-directed activities that might otherwise have appeal. In this state, thinking about goals and ambitions could exacerbate distress, leading to feeling “*overwhelmed by the anxiety lens of all these things need to be done right now. And they ‘re such big, looming projects that you’re never going to get them done even though you need to get them done*” (P5).

Instead, participants described responding to their symptoms by engaging in activities they could get “*lost in*” (P5), or that could transport them to “*another universe*” (P4). Preferred forms of distraction included music, television, games, reading, and Internet use. In these activities, individuals largely sought to escape from thinking about their concerns, as P2 described in relation to video games:

Video games are just a great distraction. Especially if you want to take out some aggression. You can shoot stuff or play through particular stories if you just want to not be yourself. There are role playing games you can literally just play as a character. (P2)

With that said, participants did report that they could find ways to motivate themselves to work toward goals, even when symptomatic. These efforts were felt to require considerable exertion but could succeed if tasks were small and well-defined. In a best-case scenario, P1 reported that, when having a bad day or week, she would move through “*a lot of baby steps to get me to do something that would make me feel better.*” Similarly, P4 described completing small household tasks like the dishes: “*It helps me feel productive... There’s something with me and feeling productive, feeling useful.*” This highlights that, even when experiencing symptoms, a sense of accomplishment remains an important motivator, but it requires manageable activities.

Often, individuals built motivation to take small steps through internal dialogue, conveying that they would “*push*” or “*force*” themselves beyond their comfort zone, as P1 described in the context of her sewing projects:

This week... I was trying to take that tiny bit of motivation and go with it. I was like, ‘Oh, okay. So, I want to do this but I don’t really have the motivation to.’ So, okay, ‘Let’s just go to a thrift store. I’ll find some cheap fabric, and I’ll figure out what I can do with it.’ And then, every step of the way, it made me like force myself to go with that tiny little bit of motivation. So, I feel like that was something that I was just like pushing myself to go with my little bit of motivation. (P1)

Likewise, P2 described, “*You have to kind of get yourself out of that... I try to think positive affirmations to kind of combat those periods... to keep me going forward.*” These instances of internal dialogue were often direct, calling on oneself to take actions or adopt a different way of thinking.

Participants also indicated that technology-based tools could support them in taking these small steps. For instance, P2 proposed “*push notifications to keep me actually remembering*

to do the thing, for one thing.” Similarly, P1 described messages that might appeal to her on days when she had little motivation:

Maybe give a little tip on how to increase it. Maybe like, ‘Go to the gym for ten minutes, ‘ or something like that, you know? So, it’s not just some annoying notification telling me that I’m unmotivated. Giving me something that could possibly fix it would be good. (P1)

Along these lines, P3 imagined that after a streak of days with symptoms, a notification might offer suggestions like, “*Ask somebody for help*” or “*Have you talked to a friend today,*” simple suggestions that she otherwise “*may not necessarily remember.*” Design ideas varied, but many shared the theme of direct suggestions to perform small tasks, building accomplishment and positive momentum.

Self-management during higher energy and motivation—However, levels of energy and motivation were not always low. Instead, symptoms were felt to improve suddenly, resulting in good days or weeks. At these times, individuals recounted that they sometimes felt brimming with energy. This reversal was often quite dramatic, which P2 described as “*a complete shift of, like, ‘Oh, there it is. I feel much better.’*” Similarly, P1 described that, “*...some days I’m just like, ‘Oh yeah, I feel like I can get a lot done!’*” and P2 recounted “*these bursts of real energy.*”

During relatively energized periods, participants could more easily find motivation to undertake an array of activities that they enjoyed and that they could relate to their goals and values. For instance, P2 described that his spurts of energy were channeled into writing, as he would sit down and “*kick out tons of pages,*” leading to a sense of achievement “*that’s unlike a lot of other feelings.*” In addition, several participants reported taking steps to satisfy altruistic motivations, as when P4 ensured her customers were satisfied in her grocery delivery job, including by finding larger containers of products that would save them money:

I really do try to, uh, you know, to make it a good experience for people... when I can help somebody understand something or do something good for them or something like that, that satisfies me. (P4)

Thus, these periods were harnessed to work towards goals and act in accordance with values. This was due, in part, to the stark understanding that energy and motivation could recede at any time, and feel inaccessible, as explained by P2:

“I don’t even remember where I was coming from or how to get back in that same head space”

Reflecting this bifurcation of experience into periods of lower and higher energy and motivation, individuals indicated that technologies should engage them differently in these states. For example, P1 reported receptivity to messages that could reinforce the importance of seizing the moment, like, “*This is the time to be productive. Get a lot done.*” Thus, individuals kept the dynamic nature of their condition in mind, viewing energy as a limited resource.

Planning Ahead: Proactive Support for the Depressed Self

This section describes individuals' proactive self-managed in anticipation of their future needs, and how they felt technology could help.

Harnessing intermittent energy to meet future needs—Individuals' awareness of the ebbs and flows of their depression meant that, in the midst of feeling relatively well, they were mindful of their future needs. As P1 described:

When you have energy, you have to pour it into pursuing a goal, because it is a finite resource that you may not always have...I need to run with it, because I know that maybe tomorrow I won't feel like that. (P1)

In other words, given the transitory nature of their bursts of energy, participants felt compelled to put them to good use.

Beyond simply recognizing the urgency of making progress, individuals strategically applied their energy to anticipate and accommodate their later needs. For instance, since individuals often preferred consuming content to searching for or evaluating it while in a depressed state, they would do these activities in advance. P4 reported pre-sifting through messages on online support forums to find ones that might be helpful, part of a larger process of "*build[ing] an arsenal*" of content to help her more confidently confront depressed states. This also included content creation via her personal blog, which kept her reflections easily accessible: "*it's always good to go back and just have that.*" Similarly, P5 employed a strategy of leaving notes for himself: "*I recorded more positive experiences, and when I was having a bad day, then having them sort of recollected for me is always good.*"

Additionally, some anticipated the future by keeping priorities organized. Routines enabled participants to integrate positive behaviors like exercise or writing into daily life so they became ingrained. Similarly, several participants reported the appeal of making lists of goals and activities. Cognizant of fluctuating levels of energy, these lists might also be ranked, as when P1 returned to the idea of "*baby steps*," describing that she might plan by:

...writing down, from top to bottom, the task that will take the shortest amount of time to the longest. So, then, I can, you know, it feels good to check off a lot of things off your list. It's just taking like baby steps to do to like work my way up. (P1)

In these various ways, individuals sought to impose structure and organize their goals so they could remain on a positive trajectory even across dips in energy and motivation.

Customizing when less symptomatic—Participants discussed how digital tools may facilitate this planning. For instance, it was important to be able to customize elements of a digital tool, especially when feeling capable of doing so. For P3, this might include such elements as the color and format of pages within an app. She suggested that she might "*choose like what each screen looks like.*" Speculating about a tailored system, P2 emphasized the importance of having the final say in what he needed:

I want my device to do what I tell it to do... You can guide me through a questionnaire to narrow down what I'm actually looking for, if I don't know all the options that you have here. That's fine, because, again, the choice is mine. I know what I want; you're helping me find what I want instead of telling me what might be good for me. You know? (P2)

Critically, customization might also include inputting self-generated content. For example, P4 described how a system might prompt her to record positive parts of her days, creating a record that she could access later, or to input goals that could be checked off in the future. The system might also prompt her to write messages targeted at her depressed self. She suggested messages that might read, "*Don't forget to brush your teeth. Don't forget to take a shower.*" Whereas P1 thought it would be "*silly*" to receive pre-written messages from her partner as part of a digital tool, she imagined she would be receptive to those she wrote herself. With her partner, she described, "*I'm already in a state of mind [where] I'm taking something personally.*" In contrast, "*I think it would be better if I just saw something from me to me.*" In this way, it was important that directive prompts came from oneself rather than others.

However, participants recognized that active customization and content creation were unlikely to appeal to them in a depressed state, since "*if you're in a mood like that you may not even be motivated to mess around with your app, you know? When you're depressed, it's not like you think about how to help yourself*" (P2). Instead, individuals in depressed states conceived themselves largely as passively receiving and reading messages. Thus, while individuals wished to exercise agency through design of their own systems of support, this was only feasible in the right state of mind.

In sum, our results show a fundamental unpredictability of when symptoms would manifest, what specifically would trigger them, and how long symptomatic states would last. Yet, the actual experience of symptoms felt predictable in some ways, including in the effects on energy and motivation. Active symptoms led to a preference for low-burden and distracting activities. In contrast, many self-management practices appealed to individuals only when they were less symptomatic. Furthermore, awareness of depressions' fluctuations prompted participants to make good use of their periods of energy, organizing and prioritizing goals and curating resources in preparation for their future depressed states. These very different states have distinct implications for design, as the discussion explores.

DISCUSSION

The heterogeneity of depression experience represents a challenge in designing successful digital tools. While the digital mental health field has begun to recognize that tools must accommodate differences across individuals in precipitating factors, symptoms, and management preferences [77,97,110], we argue that tools must simultaneously accommodate important differences manifesting in the same individual over time. Past digital tools for depression have largely been designed around common symptoms, such as low mood and motivation or distorted thought patterns [51,55,90]. However, far from these aspects of depression being static, or even changing in linear fashion, our findings highlight

day-to-day and week-to-week changes, what we call “ebbs and flows,” and these manifested particularly in energy and motivation. While unpredictable in their specific timing and triggers, these ebbs and flows impacted how individuals performed daily activities and sought to manage their mental health.

As described in our Related Works section, temporality can, often invisibly, structure how individuals organize their daily lives [7,10,56,87,94]. Our findings demonstrate a similar phenomenon operating in depression self-management, with individuals planning their activities around fluctuation in symptom severity, often using less depressed states to work toward goals, build habits, and organize resources out of recognition that future depressed states will render such activities difficult. However, our findings also suggest some distinct aspects of temporality as experienced by these individuals with depression. Most notably, past work on temporality has emphasized how people detect predictable patterns in the timing of events, e.g., their “rhythms” and “tempos” [7,80,95]. These predictable patterns can help individuals orient towards the need to get work done as future events get closer (cf “temporal horizon” [94]). In contrast, our study highlighted how symptoms were felt to increase at unpredictable times, better described as *ebbs and flows* rather than the more predictable rhythms. Yet even without the ability to predict when symptoms would increase, individuals took various steps to plan and prepare for these onsets. While many recent efforts in digital mental health center on understanding and predicting specific timing of symptoms (e.g., via active and passive self-tracking) [12,22,24], our findings highlight the many anticipatory actions that individuals may employ without knowing if symptom onset is near or far away.

In the sections below, we discuss how the design of technology can better accommodate these recurring, if unpredictable, shifts in how individuals experience their mental health. This includes reconsidering some assumptions and areas of focus that underlie current design approaches for depression support. First, we discuss recent emphasis on smartphone-based depression monitoring to deliver context-specific or just-in-time support. We describe some challenges to this approach indicated by our findings, particularly the need to attend to the unstable meaning of contexts and events. Second, we consider recent approaches to tailoring digital tools to profiles of users. We suggest also recognizing that individuals with depression experience multiple states and discuss the need for tools to meet the differing needs of individuals across these states. Third, we engage with the premise that systems should maximize the user’s control and agency. While affirming the importance of agency, we consider how participants concentrate decision-making during periods of relative wellness to relieve the burden on themselves during depressed states. Finally, we discuss how technologies can support individuals in planning, curating, customizing, and creating content when they feel the most motivated to do so.

Responding to Unstable Contexts and Events

Recent years have seen growing optimism toward the potential applications of digital technologies to deliver individualized and timely support by gathering ongoing data about a user’s contexts, states, and behaviors [12,19,74,79]. Our findings affirm this approach, with dynamic factors being very salient to our participants, and onset of symptoms and episodes

often described as manifesting in relation to events and contexts in daily life (e.g., work, relationships).

Our data also reveal important challenges to passive monitoring approaches. First, participants' experiences of depression were influenced by a vast array of factors, with the relevance of each varying from person to person. This suggests the importance of models that draw on numerous data streams and incorporate individual-level data [24,91]. Furthermore, there was wide variety in the activities individuals viewed as supporting their mental health (crafts, writing, meditation, social interaction, etc.), suggesting the importance of matching activity prompts to individuals' idiosyncratic self-management practices [9]. Second, and more problematically, factors or activities could be perceived by the same participant as both triggering and helpful, sometimes shifting rapidly. Such shifts were evident particularly for social interaction and media use. For example, distracting activities such as Netflix could benefit participants but also make them feel worse (as described in the Findings). This unstable valence suggests a challenge even within person-specific models. The success of adaptive technologies for depression will require understanding not only the differences in individuals' triggers and preferred self-management activities, but also the ways these factors play different roles at different times for the same individual.

To combat these challenges, it may be critical for users to provide ongoing input to contextualize sensed data. For instance, systems might prompt users to periodically update valence information for factors affecting depression, such as noting whether or not social interactions are currently helping. Past work likewise observes a fundamental ambiguity of self-tracked data that requires "situating" it in users' subjective context before it can be understood and used [81,88,93]. Elaborating on subjective meanings of key factors could also benefit users by cultivating self-awareness. While participants generally did not view self-tracking alone (e.g., completing EMAs) as helpful, they did point to the interviewers' questions about their data as spurring productive reflection, consistent with other research [60,103]. This suggests that subjective assessments of stressors could serve dual purposes of improving models and facilitating insight, particularly if the burden of EMA can be reduced [13,49].

Designing for Multiple States

The digital health community increasingly recognizes the importance of moving beyond one-size-fits-all tools and toward tailored tools that align with users' self-management approaches and priorities [61,85,107]. The primary contribution of our paper is to show that fluctuations in depressive symptoms profoundly influence individuals' self-management practices and their preferred ways of using technology. Here, we explore these findings' implications for design, describing how technologies could recognize profiles for more and less depressed states, and enable customization of tools when individuals feel less depressed.

Recognizing Multiple User Profiles—Factors such as demographics, technology skills, and comorbidities impact how mental health symptoms manifest and how individuals pursue wellness. This has led to efforts to understand and address the technology needs of low-income populations [2], those with comorbidities [1,4], and different age and cultural groups

[45,54,67,90,134]. Other work emphasizes personality differences, identifying key “user profiles” or “personas” of depressed individuals, and proposing different tools for each [31,39].

To some extent, this “user profile” approach, emphasizing differences between individuals, may also obscure how differently the same individuals self-manage at different times. Our work finds heterogeneity of depression experience *across* individuals, but also suggests variation *within* the same individuals that is perhaps as important. In particular, while depression self-management is often framed as a way to address active symptoms, we found that individuals engaged in numerous activities when they felt relatively well, which they perceived to help them stay well and to satisfy desires for accomplishment, altruism, and self-understanding. Viewing depressive symptoms as fluctuating also led participants to take advantage of their periods of higher energy and motivation. This included proactive self-management through finding, curating, and creating resources to help themselves in the future. When energy and motivation were lower, individuals reported disengagement from many activities. They did, however, report effective ways to build motivation through taking small steps, such as doing dishes or short workouts. These two different motivational profiles may be addressed through different digital tools and interactions.

Thus, our findings suggest the importance of broadening the focus of digital health tools to accommodate self-management styles across the ebbs and flows of symptoms. Consistent with prior work [65], checklists that encourage small accomplishments could be useful during periods of depression. Our findings also affirm benefits of having activity suggestions organized and in place [48]. In contrast, little work has considered how tools might support the same individuals when they feel relatively well. Our findings suggest that individuals in less symptomatic states may be receptive to prompts that call on them to apply their energy to activities that help them feel in control of their wellbeing, including through hobbies and activities that are enjoyable or that allow individuals to pursue values like altruism. Also, consistent with a robust literature on the appeal of self-experimentation [60,68,133], individuals might benefit from using periods of relative wellness to further self-understanding by reflecting on patterns in their data.

On the whole, it would be useful to consider within-individual profiles that correspond to states of energy and motivation and that reflect these states’ distinct self-management implications. Thus, rather than an individual being assigned a single, static profile, she might be able to switch between profiles as her symptoms fluctuate. By appealing to users across states, digital tools could perhaps sustain engagement over time such that resources remain accessible and in place when they are most critically needed.

Customization as a State-Specific Strategy—Our findings also point to the importance of bringing users into the process of adapting tools to their own needs through customization. Unlike tailoring, where a system automatically (passively) adapts to an individual’s traits, states, or contexts, customization calls on the user to actively decide how the system should adjust, including through selecting from multiple services, creating idiosyncratic content, or specifying preferred timing, frequency, or tone of messages from a digital program [68,73,119]. Therefore, customization centers personal insight into one’s

own needs, and helps the user play an active role in his or her own health [21,118,128]. Yet, optimal level and type of customizability is unclear, especially given the potential gap between what individuals prefer and what will actually help them [50,102]. This gap may be especially large in mental health conditions that may impair users' decision-making processes. Furthermore, customization may be burdensome. Providing options for customization can satisfy a basic need for autonomy, but only if meaningful options are available when users feel competent and motivated to weigh them [58].

Our findings affirm the importance of autonomy via customization, but add nuance by suggesting variable desire and ability to customize tools based on the ebbs and flows of symptoms. Depressed states were described in terms of low motivation, which included disinterest in making decisions or charting a course. Reticence toward decision-making was also reflected in some common strategies that individuals employed to motivate themselves when depressed, including internal dialogue in which they "force" themselves to make efforts. Such instances feature extremely low motivation that is perceived to call for a more prescriptive, or "directive," approach at self-persuasion. They also reveal individuals' awareness that there is a more authoritative, confident, and capable version of themselves who can help. This is in line with our more general finding of two distinct motivational profiles (i.e., high, low) for our participants, and the relationship between them. For instance, since individuals often prefer low-burden activities (e.g., reading, viewing) when they feel depressed, the same individuals, when more motivated, apply their energy to finding, organizing, and creating resources and content (journals, lists, messages).

It is worth considering how systems may be designed to utilize this relationship. For instance, what might it look like to design tools through which the "motivated self" supports the "depressed self"? These tools could take advantage of a user's agency during the windows of time when she feels most interested and able to exercise it. This may include prompting the user to add services to a separate profile for her depressed self, selecting the support strategies she wants to launch upon particular triggers or symptom levels, and even selecting or writing messages to send herself when thresholds are met. Whereas work has examined messages from peers and experts [34,62], self-generated content may help individuals with mental health conditions motivate themselves in highly individualized and directive ways. Our finding that participants prefer directive support when symptomatic contrasts with literature that generally indicates benefits of non-directive support [11,116]. However, it may matter *who* is delivering support; allowing individuals to actively shape their own content and services has the potential to feel more engaging and less coercive [118].

Future Directions

Our findings suggest questions about how to balance imperatives to provide structure and choice in digital health tools. While research indicates that individual differences exist in preferences for passive tailoring versus active customization [119], how these preferences are shaped by mental health conditions or illness states remains unknown. Along these lines, it would be useful to experimentally compare mental health tools that automatically tailor content and services, allow the user to customize the same elements, or facilitate some

combination of these approaches. It would also be useful to identify specific forms and levels of involvement in customization that allow users to perceive that they are responsible for actions of an adaptive system. Many elements in an adaptive system (content, services, algorithms) are technically created by many others (programmers, designers, etc.), but these can nonetheless be actively adopted by users to compose a purposeful self-management system. In these instances, we might investigate whether users perceive support as coming from others, from a computer, or from themselves. Perceptions of the “source” of content (e.g., computer vs. human) have been found to shape receptivity to messages in other contexts [75,99].

Limitations

This study has limitations related to the size and representativeness of our sample, and the study timeframe. The small sample size corresponds to our primary focus on differences across time in the same individual’s experience. However, it limits our ability to speak to the ways that individual differences could shape perceived temporal patterns of depression. Furthermore, our sample may not be representative of those with depression. Our participants were young and likely tech-savvy (recruited via Reddit). Selection bias may have emerged if participants joined the study out of interest in using the mobile apps under study or receiving compensation for app-related tasks. Self-selection into the study could also be based on interest in understanding their mental health. These participants were all willing to identify with a depression label, but many who have depression symptoms are uninterested in depression-specific research and support [29,30]. Our participants reported proactive self-management of symptoms, but this may reflect their view of depression as a chronic, fluctuating condition; this pattern may not hold among those who reject this view of depression. Finally, while this study found that short-term fluctuations in symptoms were salient, our study timeframe may be too short to capture remission of episodes or movement through stages in an illness trajectory.

CONCLUSIONS

Depression support via digital technologies has promise to overcome limited availability of mental health services, but this requires attention to individuals’ dynamic styles of managing their condition. On the whole, our results suggest marked differences in how individuals approach self-management across fluctuating symptom severity, particularly as relates to energy and motivation. We have argued that individuals experience brief windows of time in which they have relatively high levels of energy and motivation, and this may present an opportunity for designers of digital mental health tools. Such tools could engage individuals in these states to take an active role in their mental health, including building habits, organizing goals, or customizing systems that will better adapt to their cycles of recurrence. Calling on individuals to engage in these ways may have benefits in aligning systems to one’s future preferences and needs, while also allowing individuals to exercise agency in their self-management.

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