Technology-Mediated Strategies for Coping with Mental Health Challenges: Insights from People with Bipolar Disorder

TIAN XU*, Information Science, University of Colorado Boulder, USA
JUNNAN YU*, School of Design, The Hong Kong Polytechnic University, Hong Kong, China
DYLAN THOMAS DOYLE, Information Science, University of Colorado Boulder, USA
STEPHEN VOIDA, Information Science, University of Colorado Boulder, USA

Technology plays an increasingly pivotal role in mediating mental health support in people's everyday lives. However, it is not clear how that mediation is occurring, to what end, and what technologies are implicated. In this study, we examine these questions with a mixed-methods analysis of conversations among participants in several Bipolar Disorder (BD) communities on Reddit. Analyzing posts produced over four years, we identify a wide variety of technologies that people employ to manage their mental conditions, such as communication technologies, online communities and tracking tools. Using this taxonomy of technologies as a framework, we then summarize three technology-mediated management strategies that these technologies enable, including serving as community, episode, and information mediators. We argue that with a comprehensive and nuanced understanding of people's in situ technology use, we can identify research and design opportunities for designing human-centered technologies to help people manage mental health challenges more effectively.

CCS Concepts: • **Human-centered computing** → **Collaborative and social computing**; **Empirical studies in HCI**; *HCI design and evaluation methods.*

Additional Key Words and Phrases: personal health informatics; mental health informatics; bipolar disorder; Reddit; technology mediation

ACM Reference Format:
Tian Xu, Junnan Yu, Dylan Thomas Doyle, and Stephen Voida. 2023. Technology-Mediated Strategies for Coping with Mental Health Challenges: Insights from People with Bipolar Disorder. *Proc. ACM Hum.-Comput. Interact.* 7, CSCW2, Article 240 (October 2023), 31 pages. https://doi.org/10.1145/3610031

[CONTENT WARNING] Due to the sensitive nature of the content covered in this study, we invite reviewers and readers to care for themselves while engaging with this work. Bipolar Disorder and similar mental health diagnoses impact many of our lives and can bring with them difficult emotions or traumatic responses. Paraphrased excerpts from the corpus referenced in this article communicate frustrations around provision of mental health services and include discussions of suicidal ideation.

*Both authors contributed equally to this research.

Authors' addresses: Tian Xu, tixu6250@colorado.edu, Information Science, University of Colorado Boulder, UCB 315, Boulder, Colorado, USA, 80309-0315; Junnan Yu, junnan.yu@polyu.edu.hk, School of Design, The Hong Kong Polytechnic University, 11 Yuk Choi Rd, Hung Hom, Hong Kong, Hong Kong, China, 000000; Dylan Thomas Doyle, dylan.doyle@colorado.edu, Information Science, University of Colorado Boulder, UCB 315, Boulder, Colorado, USA, 80309-0315; Stephen Voida, svoida@colorado.edu, Information Science, University of Colorado Boulder, UCB 315, Boulder, Colorado, USA, 80309-0315.

2573-0142/2023/10-ART240
https://doi.org/10.1145/3610031

1 INTRODUCTION

Technologies ranging from self-tracking apps to healthcare platforms (e.g., telehealth systems) to everyday technologies (e.g., social media) play critical roles in the day-to-day lives of people with mental health challenges. Notably, these technologies can make treating mental illness more accessible, increase patient engagement, and result in more effective and affordable management outcomes [28]. However, they may also lead to negative impacts on individuals' mental health conditions, such as triggering symptoms and causing anxiety (e.g., [51, 59]). Previous studies highlight the benefits and potential side effects that technologies can introduce to people with mental health issues (e.g., [28, 51, 58, 59, 62]). Nevertheless, these studies are predominantly focused on specific technologies, such as particular social media platforms (e.g., [3, 15, 35]) or mobile applications (e.g., [9, 52]). In practice, however, people generally use a suite of technologies—a technology ecosystem—to manage mental health conditions (e.g., [18, 50]). Ongoing efforts in investigating mental health technologies are inspired by lived informatics [67] and personal social media ecosystems [27]. While a few studies (summarized in [29, 51]) have examined the roles of various technologies in the context of mental health management, a common limitation among these studies has been their limited sample sizes.

More research is needed to provide a larger-scale and more comprehensive understanding of what technologies people use to cope with mental health challenges in their day-to-day lives—and for what purposes or aims they employ these technologies. Without this kind of holistic perspective on in situ technology use, HCI researchers and designers may lose valuable insights into people's complex needs and lived experiences. Critically, this missing information could otherwise be used to inform novel technology or system designs to support effective condition management. In this research, we examine technology support for mental wellness at a large scale through studying conversations about these technologies in a global online community (Reddit). We follow a case-study approach [11] to explore the technology ecosystem of people's management of their mental health challenges using the experiences of people with Bipolar Disorder (BD), given the condition's complexity, as well as its overlap and frequent comorbidity with other serious mental illnesses (e.g., anxiety, depression, mania).

Bipolar Disorder, also called manic depression, is considered a serious mental illness (SMI) and a major mental health challenge worldwide. Clinically, people with BD experience the symptom of manic episodes, i.e., a period of experiencing irritable, elevated, and extensive mood, which is continuing and unusual [4], weakening patients' social or occupational functioning, even leading to hospitalization [40]. During manic episodes, some people may also experience psychotic symptoms and delusions (e.g., megalomania) [39, 40]. Additionally, some people show the symptom of hypomanic episodes, which are similar to those in manic episodes but less severe and of shorter duration [40, 55]. Based on the kinds of symptoms that people experience and their severity [40], BD is further classified into Bipolar I Disorder, which manifests more than one manic episode together with at least one major depressive episode, and Bipolar II Disorder, which is symptomized as more than one hypomanic episode with one major depressive episode [55]. Bipolar Disorder is described as "rapid cycling" when four or more episodes are experienced during a 12-month period; this is considered a particularly dangerous diagnosis, as rapid cycling increases the risk of severe depression and a higher incidence of suicide attempts [55].

Roughly seven million adults in the U.S. have been diagnosed with BD [63] and 46 million people globally are impacted by the illness [24]. BD often appears during adolescence and young adulthood (10–25 years), a critical developmental stage [61]. It is reported that the number of children, adolescents, and young adults diagnosed with BD has significantly increased over the last three decades (roughly 40 times from 1994 to 2003) [17, 20]. Unfortunately, BD is a chronic

disease and currently has no cure. People with the condition must manage it for a lifetime. The life quality of those with BD can be poor due to BD impacts, such as relationship problems, interrupted education or undermined career advancement, and the physical and emotional stress of indefinitely managing the disorder [39]. Additionally, because one in five cases of BD result in suicide, BD has been recognized as one of the ten most debilitating illnesses worldwide [8]. In addition to the physical and mental suffering on an individual scale, mental health illnesses like BD can result in high economic costs as individuals managing the disorder contribute less effectively in the overall workforce [71]. Due to the devastating and recurrent impact of BD, medical treatment is essential for long-term management [13, 55]. However, it is often difficult to find an effective medication for the condition, particularly for people experiencing frequent episodes of mania or depression [13, 55]. Therefore, various tools and treatments outside of medication-oriented interventions have been developed to help people manage and cope with BD. In particular, various technologies, the focus of this research, are playing an increasingly important role in people's day-to-day mental health management. For example, people with BD often use self-tracking apps to manage mood disturbance, which has shown to bring positive outcomes (e.g., [50, 58, 70]).

Given the strain on formal mental health resources, particularly in light of the COVID-19 pandemic [43], research is needed to better understand how individuals are using these technologies to help self-manage mental illnesses. The pervasiveness of BD and the challenges it imposes provide a meaningful and valuable case study to explore the ecology of technologies in mental health contexts and their roles in people's management practices. The insights can drive the design of more effective assistive tools to help those in need. Note that we define technologies as broad digital media used in people's everyday lives, which include but are not limited to hardware devices like computers, smartphones, and televisions, as well as software running on these hardware devices, such as mobile apps and video games. In this study, we examined two primary research questions:

RQ1: What technologies do people use in everyday life to manage their mental health challenges?

RQ2: What are the roles of these technologies in mediating people's strategies to cope with mental health challenges?

In order to answer these questions, we extracted and analyzed posts about technology use from a popular platform where people with BD share their conditions and experiences and provide support for each other—BD subreddits hosted on Reddit. Through the analysis, we identified various technologies and classified them into nine types, such as communication tools, professional services platforms, and self-tracking/co-tracking applications. These technologies play important roles in people's management of their mental health conditions, which are summarized into three categories: community, episode, and information mediators. Our study expands the understanding of the rich technology ecosystem employed as part of mental illness condition management. Based on our findings, we further highlight research gaps in the context of mental health technology and contribute design implications for technologies to better assist people in coping with mental health challenges, such as providing anonymity functions for mental health-related technologies and balancing the user–system agency in self-tracking applications. Finally, we reflect on our research methods and expand the discussion about using machine learning to better assist thematic analysis for more powerful outcomes.

2 RELATED WORK

This study examines technology use and mediation in mental health management of people facing mental issues through the case of people with bipolar disorder. Therefore, the related work includes two parts: technology use in the contexts of mental health and bipolar disorder.

2.1 Technology Use in Mental Health

In the last decade, HCI researchers have explored various forms of technology use in the context of mental health as well as developed tools and systems to support people with mental health challenges (e.g., [9, 47, 62, 70]). A primary body of relevant literature is centered around social media platforms and/or online communities, e.g., Facebook, Instagram, and Reddit [3, 15, 26]. Studies show social media can have both positive and negative impacts on mental health conditions and treatment. For example, after reviewing prior literature on technology use for mental health issues, Naslund et al. argue that online social networking sites are primarily beneficial to people with mental health illnesses because they "challenge stigma, increase consumer activation, and access online intervention" [58, p. 116]. Moreover, scholarship argues that seeking help, exchanging information [3], and providing mutual support on social media can break down barriers imposed by distance and time [22, 62]. At the same time, social media such as Facebook and Instagram impose certain negative impacts on people with mental health illnesses [1, 12, 64]. For example, Abi-Jaoude and colleagues [1] argue that social comparison caused by social media could result in mental distress among children and adolescents, and—worse—lead to self-injury and suicidality. However, the relationship between social media use and people's mental health states remains unclear. For example, through surveying 467 undergraduate students in the U.S., Berryman et al. [14] found that social media use only weakly correlates with mental health states. What is certain is that technology, including social media, has mixed effects—it is a "double-edged sword" [51] that brings both benefits (e.g., social interaction facilitation, peer support network access, and engagement promotion) and challenges (e.g., impacting symptoms, facing hostile interactions, and consequences of daily life) [59].

Research in HCI also shows that people use various technologies to manage mental health in day-to-day life [19]. Specifically, many studies report different types of tools or system development for mental health management, such as self-tracking mobile apps (e.g., [10, 52, 70]), family-centered tracking apps (e.g., [72]), and helplines [65], among others. Some researchers broaden the scope of technological support through tangible interactive devices. Roquet and colleagues [25] employed embodied cognition and tangible interaction theories from learning science to examine how a fluffy tangible toy called Purrble supported emotion regulation of youth with mental health challenges, indicating such support is "in-the-moment" and can help youth develop coping strategies. Beyond these supportive tools, some technologies are designed to help detect and predict mental health conditions (e.g., [5, 7, 26]). For example, Balani and De Choudhury [7] developed an algorithm to predict self-disclosure levels (high, low, or no disclosure) in mental health communities on Reddit, suggesting that such detection can be used for community moderation and intervention.

Nonetheless, these previous studies mostly focused on individual technology use and only a few examined the holistic technology ecosystem supporting people's mental health management (e.g., [2, 12, 29, 51]). Matthews and colleagues [51] surveyed 84 participants with BD and categorized two types of technologies used in their everyday-life condition management: software technology (e.g., text messaging, email, Twitter) and hardware technology (e.g., smartphone, desktop computer). This study, together with a few others [18, 29], highlights the fact that different technologies co-exist and co-mediate people's management of their mental health conditions. However, we still lack an understanding of the technology ecosystems used by people facing mental health challenges, such as a full scope of the kinds of technologies involved and how they mediate people's strategies in coping with mental health challenges. This gap is also highlighted by the recent HCI call for additional studies investigating the scope of the technologies and how people use them for condition management in day-to-day life to advance the understanding of "the breadth of tools, services, and other approaches to mental health support, nor the best practices of their use" [19]. Our study aims

to bridge this gap between people's everyday technology use for condition management and the lack of holistic understanding of *in situ* use in HCI studies through a case study of how people with BD navigate and use technologies to manage their mental health conditions.

2.2 Technology Use in Bipolar Disorder

Since our study gains insights from the case of bipolar disorder, we present relevant studies about technology use in bipolar disorder within HCI in this section.

Bipolar disorder (BD) is a life-long illness that affects the emotional stability of individuals' sleep–wake routine, cognition, mood, and energy [51, 61]. As technology becomes increasingly ubiquitous in mental health contexts, it likewise increasingly intersects with the lived experience of people with BD. For example, people tend to use more apps when in a manic episode with high fluctuations (i.e., hyperactivity).

Matthews and colleagues [51] found that technology use symbolizes, triggers, and supports BD conditions. Additional research has found that patterns in technology use are closely related to conditions, both positively and negatively [3, 29, 59, 62]. Importantly, technologies can assist with episode onset prediction and intervention [2, 51, 56], supporting people seeking stability [10, 70], which is a critical concern among people with BD [53]. Such supporting functions are mainly achieved through collecting and analyzing personal information. For example, self-tracking applications provide support through monitoring daily rhythms [70], mood, sleep, alcohol, and activity [9]. For example, MoodRhythm [70] was designed and developed to help people with BD maintain their personal rhythms. The app deployed Interpersonal and Social Rhythm Therapy (IRSRT)—a behavioral intervention aimed at social rhythm regulation—as an instrument to passively sense and allow users to self-record sleep and social routines (e.g., recording the first time to contact a person in a day). In addition to individual tracking, collaborative tracking, such as family tracking, is emerging in the context of BD. This approach resonates with the importance of collective personal informatics systems in the recovery journey highlighted in Murnane et al.'s framework situating personal informatics in social relations [57]. For example, Hoefer et al. [44] proposed a visualization system that can present mental health data from multiple stakeholders of people with BD.

These prior studies highlight the importance of technology use in coping with BD. To inform future technology designs that can provide better condition management support for people with BD, there is an additional need to delve into people's lived experiences and gain a holistic insight into the technology used. Our study expands on previous studies by identifying the technological ecosystem of people with BD and systematically analyzing the roles of different technologies.

3 METHODS

We utilized a mixed-methods approach for our study, combining computational methods (i.e., topic modeling) and thematic analysis (i.e., qualitative open coding) to identify instances of conversations about technology-mediated support for managing BD. This section describes how we created our corpus, as well as the searching and screening processes that we used to identify people's use of technologies for managing BD, from the Reddit platform. We also detail our qualitative analytic approach for making sense of these conversational mentions of technology support for BD.

3.1 Why Reddit?

Reddit has been an important, distinguished, convenient, and popular online community to share mental health-related experiences and "surprisingly high quality" information compared to other social media platforms like Facebook and Twitter [26]. For example, studies show that people do not usually post sensitive information like mental health information on Facebook because of low visibility control and challenges of personal impression management (e.g., being concerned about

disclosing health information even within their close networks) [27, 60]. Additionally, other online health communities (e.g., PatientsLikeMe) are more clinical-oriented communities, centering on the discussions of treatment [34]. The discussions about technologies in such communities could be less comprehensive than those on Reddit, which is insufficient to answer our research questions.

In contrast, Reddit is a widely used platform serving more than 100,000 active communities (subreddits) and millions of people[1]. There are about 10 BD-related subreddits, with an average of 35,000 members in each, which enables us to understand the experiences of a large number of people using technologies to manage mental health conditions in their day-to-day lives. Moreover, Reddit provides a detailed historical record of relevant posts, allowing us to examine the changes, if any, of the technologies used over a certain period of time. In sum, Reddit provides a valuable, large-scale data source to understand people's *in situ* technology use experience qualitatively. Therefore, we chose Reddit as the data source to answer our research questions.

3.2 Data Collection and Sampling

Initial corpus collection. The first author searched "bipolar disorder" using the Reddit search feature, a feature which searches for sub-reddit communities and content within those communities related to the search terms. This search resulted in the identification of 10 BD-related subreddits. To further narrow the data sources for our corpus, we identified the three most active subreddits among these—those with the most active online users and number of new posts per day. We scraped the most recent four years of posts and comments from these three communities using the Pushshift API PASW[2], working backwards from the date of our initial data collection (see Table 1). We collected data from over a four-year period because we were also interested in seeing the changes in technology types across time for RQ1. The collected data included post/comment ID, post/comment content, post time, score, and the number of comments.

Table 1. Descriptive statistics of corpus in the three active BD subreddits

Time range	# Posts	# Comments	Pseudonym of subreddits
Oct.16, 2017–Oct.16, 2021	133,537	1,114,418	r/[BPC#1]
	29,233	269,957	r/[BPC#2]
	30,279	344,053	r/[BPC#3]

Identifying keywords. After collecting the initial corpus, we cleaned the data by excluding null, removed, and deleted posts and comments. To identify as many technology-related keywords as possible about the kind of technologies involved (RQ1), we simultaneously applied two approaches: manual coding (manual premise-keyword identification, see Figure 1) and topic modeling (algorithmic premise-keyword identification, see Figure 1). For manual coding, we first randomly sampled 100 posts from each year, resulting in 500 threads (500 posts and corresponding comments) for open coding. First, the three authors involved in the coding process met to agree on the criteria of technologies—that is, we reached agreement to consider "technologies" as a broad concept including hardware, software, platforms, among others. Also, we only considered technologies that relate to bipolar disorder management such as positively or negatively impacting conditions and/or condition management.

[1] https://www.redditinc.com/
[2] https://psaw.readthedocs.io/en/latest/

The first, second, and third authors then split the 500 posts and independently coded the assigned threads to extract technology- ***and*** condition-related keywords. Through this step, we identified 99 keywords identifying specific technologies, such as Daylio, Facebook, and Spotify, as well as general classes of technology, such as computer, phone, and AI (see Table 4 for a complete list). It is worth noting that during manual coding we found that people often mentioned technologies in comments responding to technology-irrelevant posts. Thus, we decided to consider posts and comments independently, rather than to use threads as our unit of analysis. During the annotation of comments, we visited original posts if more contextual information was needed.

Our computational topic modeling analysis used NMF (Non-negative Matrix-Factorization) [48] on Gensim[3], a widely used topic modeling tool, to extract topics with ranked keywords for the same purpose as manual coding—that is, to identify technology- and condition-related keywords. Unlike manual coding, topic modeling was applied to all posts and comments. Among collected keywords generated from topics spanning from five to thirty, only three were found to be related to technologies (i.e., "app", "track", "post"). These three high-level keywords were also identified with more detailed information through manual coding. For example, we manually found several specific mood tracking apps (e.g., Daylio), uncovering more detailed information compared to the algorithmic-identified keyword—that is, "track." Together, the two approaches generated a total of 102 technology-related keywords.

Next, we iteratively examined the extracted keywords among the first three authors and excluded some keywords based on the following exclusion criteria: (1) the keyword has multiple meanings (e.g., "show", "app" (abbreviation of "appointment" in many posts and comments)), and (2) the keywords refer to the same object (e.g., "sub reddit" and "subreddit"). After screening and standardization (e.g., converting all keywords to lowercase), we arrived at a list of 73 technology-related keywords (Table 4 in the findings section).

Technology-related corpus extraction. To gain a deeper understanding of RQ1 regarding the changes in technology types across time and to collect data in support of RQ2 about the roles of technologies, we filtered all the posts and comments that included any of the 73 keywords from our initial corpus, resulting in 19,842 posts and 177,009 comments related to technologies.

Sorting and percentage sampling. We sampled 2% of the extracted posts and comments for qualitative analysis, respectively, resulting in 425 posts and 3,562 comments. In order to select high-quality posts for this qualitative coding process, we ranked posts according to a *Computed Importance Score* (CIS) (Formula 1) and ranked comments according to the score feature in the initial dataset, which is computed with the number of upvotes and downvotes. (Reddit releases score instead of the number of upvotes and downvotes recently). We applied this ranking strategy because we found that posts with concrete contents (e.g., suggestions, tips, encouragement) typically got upvotes while vague or BD-irrelevant posts usually got no upvotes or downvotes. Although we do not argue that our sampled corpus is representative, with practical consideration [36], sampling and sorting corpus for qualitative analysis has been employed and validated by previous HCI and CSCW studies (e.g., [30, 36]). For example, Eschler et al. [30] sorted and sampled Reddit corpora (N = 47 threads) based on upvotes and downvotes. Garg et al. [36] sampled the top 4% of ranked Reddit posts according to the number of comments.

$$CIS = \frac{\text{Score of a post}}{\text{Max score in the corpus}} \times \frac{\text{Number of comments}}{\text{Max number of comments in the corpus}} \quad (1)$$

For presenting the technologies used each year, we used percentage sampling to sample our ranked corpus by month and year for thematic analysis. Specifically, we calculated a *targeted sample size*

[3] https://radimrehurek.com/gensim/

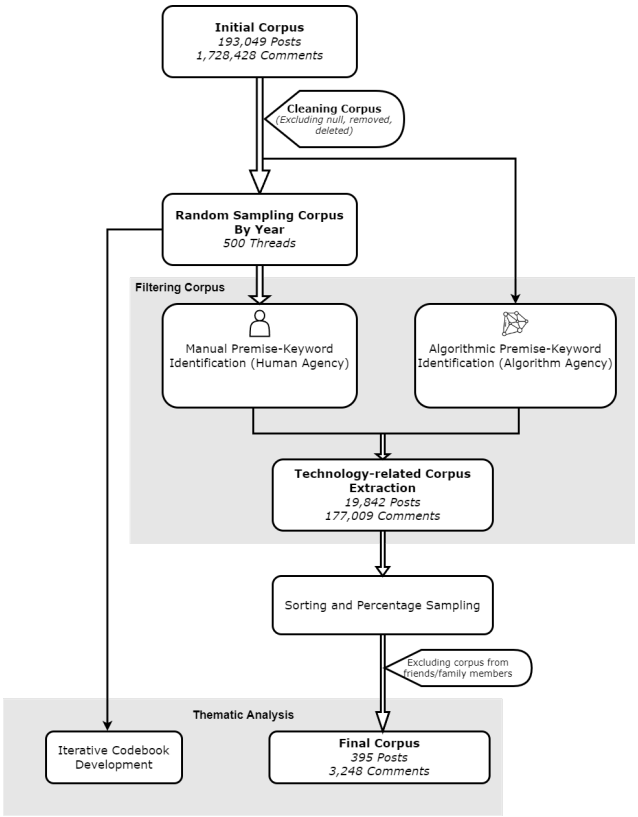

Fig. 1. Filtering corpus and thematic analysis process

(TSS) of posts and comments, which are 2% of extracted posts and comments. We then calculated the percentage of every month's posts and comments in each year. Last, we multiplied *TSS* and calculated the percentage, giving the number of posts and comments we should sample from each month each year (see Formula 2). For example, in 2017, November's posts occupy 0.35% of the extracted posts. In percentage sampling, we should extract around two top posts ranked according to *CIS* for the final sampled corpus.

$$\text{Number of Items in Sampled Corpus per Month} = TSS \times \frac{\text{Number of posts/comments per month}}{\text{Total number of extracted posts/comments}} \quad (2)$$

With percentage sampling, our final corpus contained 425 posts and 3,562 comments. The first author read all sampled posts to identify what technologies and how they were used. We then excluded irrelevant data (e.g., the posts and comments posted by caregivers or friends and about general technology discourse), resulting in 395 posts and 3,248 comments for data analysis (see more details in Table 2).

3.3 Data Analysis

Our keyword identification and extraction process comprehensively identified the various technologies people with BD discuss using when managing their mental health conditions (RQ1).

Table 2. Descriptive statistics of extracted and final sampled corpus

Extracted corpus		**Final sampled corpus**	
# Extracted Posts / # Unique authors	*# Extracted Comments / # Unique authors*	*# Sampled Posts / # Unique authors*	*# Sampled Comments / # Unique authors*
19,842 / 13,090	177,009 / 32,333	395 / 381	3,248 / 2,584

We conducted an inductive thematic analysis [16] to analyze technologies' roles in people's BD condition management in everyday life (RQ2). Specifically, the first three authors independently coded the 500 sampled threads in the open coding stage, as mentioned above. We then held regular meetings to refine the sub-pattern themes iteratively, followed by clustering these sub-themes via discussions, generating three high-level technological mediation patterns: ***community mediator***, ***episode mediator***, and ***information mediator***. The codes generated from our iterative thematic analysis can be found in Table 3. Later, we randomly sampled 100 posts from the final sampled corpus and the first two authors coded these items independently using the identified themes for the inter-rater reliability (IRR) check, reaching a Cohen's Kappa score of 0.80. We addressed disagreements via discussions. The IRR check validates the robustness of the identified codes and the shared understanding of the codes. The first author then coded the remaining extracted data ($N = 3,543$) using MAXQDA.

3.4 Ethics and Privacy

Research ethics in online communities is a critical area in HCI and CSCW because obtaining Institutional Review Board (IRB) approval is not required when studying online data or public data, even though such data does impose certain ethical concerns, especially users' privacy (e.g., [32, 33]). Increasingly, studies using data from online communities take action to protect users' privacy. To conform to relevant research community norms, we reviewed related studies (e.g., [3, 21, 69]) to better inform our data collection, data analysis, and paper writing practices to best protect user anonymity and privacy. The detailed practices we employed included (1) unlinking usernames from the data in the corpus before conducting analysis, (2) avoiding the use of usernames to search for users' other information during and after this study, (3) paraphrasing quotes in our paper, and (4) using pseudonyms of subreddits to further de-identify relevant communities.

3.5 Authors' Statement of Positionality

Before articulating our findings, we include a statement reflecting on the authors' backgrounds (e.g., academic background and relevant experiences with mental health) following the feminist methodology of standpoint theory [42]. All authors have academic training in HCI at United States-based research institutions. We gather together for one aim: we hope our study can contribute to the mental illness community in this fast-changing digital society. We all reflected on our observations and experiences and thought about the role that technologies played in the condition management of people with mental illnesses. The first author studies mental health informatics with a focus on bipolar disorder management. The second author has a background in design research around learning technologies for young people and had experienced and/or seen many challenges around mental wellbeing during his Ph.D. study as an international student in the United States. The third author studies mental health crisis support on social networking sites (SNS) and has a professional background in trauma-focused mental health crisis counseling. The advising author (the fourth

author) has more than ten years of experience studying mental health informatics and working with clinicians in developing support technologies for managing mental health. He is also a faculty fellow in a new interdisciplinary wellness research institute on campus[4] and has utilized mental wellness services provided by his institution while serving as a faculty member.

4 FINDINGS

In this section, we first present findings of what technologies are used by people with BD to manage bipolar disorder conditions. We further quantify a trend indicating how technology use changes—or not—over time, providing a comprehensive view of technology use. Then, we present the roles of technologies in BD people's strategies to cope with their mental health challenges.

Table 3. Technology mediation patterns in BD management

Mediation	Description	Sub-pattern	Description	Example
Community mediator	People leverage technologies to connect to mental health communities, contribute to community construction, and share mental-health-related personal conditions, emotions, as well as socialization and seek advice for improvement strategies	*Seeking and providing experiential advice*	People seek or provide advice, help, or motivation to manage mental health condition(s).	*"I thought [medicine name] should be taken in a short-time manner because of the side effects… Is this the wrong way?"*
		Connecting to community	People seek a sense of active/engaged community with/among individuals managing similar conditions and a connection for purposes such as normalizing conditions and sharing situations.	*"I can't believe I find another me here. Love the internet!"*
Episode mediator	Technologies play a role in reflecting on, redirecting attention from, or deteriorating conditions. People also leverage technologies to balance daily life and conditions.	*Redirecting attention*	People redirect their attention away from aspects of their mental health episodes such as racing thoughts and high or low emotional states (among others).	*"Finding a good podcast is what I do when I feel lonely and have racing thoughts"*
		Balancing life-episodes	People aim to maintain balance among facets of their daily lives, including managing their mental health condition, work, relationships, finance, etc.	*"I use a white noise app to segment times when I feel bad"*
		Reflecting on conditions	People reflect on conditions to gain a holistic view of condition history, seek patterns or signs of episodes, and develop coping strategies through technologies used in day-to-day life.	*"I use iMood. It gives me a chart showing [mood changes] over a day or a month."*
		Deteriorating conditions	Technology use can trigger or worsen symptoms (e.g., triggering manic episodes, aggravating technology addition in depressive episodes).	*"My major issue is impulsive online shopping."*
Information mediator	Technology is the medium to share and consume mental health-related information.	*Consuming information*	People encounter or absorb mental health-related information, which can be beneficial (e.g., improving mental health literacy) or detrimental (e.g., reinforcing stigma).	*"There's a pretty good podcast called How Bipolar Disorder Works. It helped my girlfriend to understand BD."*
		Sharing objective/educational information	People share information on condition management resources, studies about medicines, and online mental health-related communities with others having similar conditions.	*"You can check OpenFDA website or try Google Scholar to find studies about drugs information."*

[4]Renée Crown Wellness Institute, https://www.colorado.edu/crowninstitute

4.1 Technology Ecosystem

People's everyday mental health management involves multiple tools, or a *technology ecosystem*, which refers to various tools or services such as social media, personal informatics systems, music, and telemedicine services, among others [18, 27, 29]. This section presents a categorized technology ecosystem and an analysis of the trends of technology use over time by people with BD.

We identified around 200 technologies for various condition management purposes which we categorize into nine types based on their purpose (see Table 4). The categories include *communication, education/information, professional services, entertainment, self-tracking/co-tracking, online shopping, online dating, gig work,* and *general other technologies*. The *communication* category includes everyday use applications or platforms such as email, phone call, and social media platforms (e.g., Facebook, TikTok). People mainly use those technologies for connecting to the BD community or seeking advice. *Education/Information* refers to the technologies (e.g., Wikipedia, Coursera, Sci-hub) people use to gain BD-related knowledge and information, mainly aiming to understand what BD is and how to manage mental health challenges. YouTube, partially used as an information source, is also in the *education/information* category because people use it to watch either leisure or mental health education videos. *Professional services* technologies mainly include *care*-oriented tools such as online therapy and telemedicine platforms. The *entertainment* category includes technologies for leisure, for example, movies, video games, and music.

Self-tracking/co-tracking technology presents self-treatment tools that self-track or collaboratively-track facets of everyday life like mood, habit, activity, and medication. Additionally, we identified three *online dating* applications (Tinder, SCRUFF, and Recon) and four *online shopping* platforms (Amazon, eBay, Craigslist, and CVS app). *Gig work* platforms, including Uber and Amazon Turk, among others, are used mainly for managing flexible work. *General other technologies* refer to technologies like computers, mass media, and cameras, among others. We classify them as a category because people generally mentioned the impacts of this kind of technology on their conditions rather than specifically stating how they function in condition management.

Table 4. A taxonomy of technologies used in everyday mental health management by people with BD. Considering the length of the table, we combined some technologies within one subcategory. For example, WebMD, Psychoeducation, and other similar websites are combined into medical websites.

Technology type	Identified technologies
Communication	Email, messaging, phone call, video call, voicemail, Facetime, Skype, Reddit, Facebook, blog, Twitter, Instagram, TikTok, Discord, private message (Reddit), Snapchat, Groupchat, Tumblr, Imgur, Meetup, Nextdoor
Education/Information	Wikipedia, Quora, Google Scholar, Google, medical website (e.g., WebMD), Sci-hub, Coursera, YouTube, podcast, OpenFDA, audiobook
Professional services	Suicide hotline, crisis phone/text line, telehealth/telemedicine, clinical portal, online therapy (e.g., Talkspace, 7cups), Zoom
Entertainment	Movies (e.g., Hulu, Netflix), music (e.g., Spotify), video games, TV, Pokemon Go, radio, podcast, Nintendo Switch, Sony PS4, YouTube
Self-tracking/Co-tracking	Daylio, iMood, eMoods, Mango health, Habitica, Moody, Calendar, Mint, Timestamp, fasting app, Medisafe, Fitbit, UP!, Google Doc/Sheet (self-tracking/co-tracking), Word/Excel, Breeze, Notes app (phone)
Online dating	Tinder, SCRUFF, Recon
Online shopping	Amazon, eBay, Craigslist, CVS app
Gig work	Uber, Lyft, UberEats, DoorDash, Amazon Turk, Appen, Lionbridge
General other technologies	Computer, phone, mass media, internet, camera, webcam, AI/algorithm

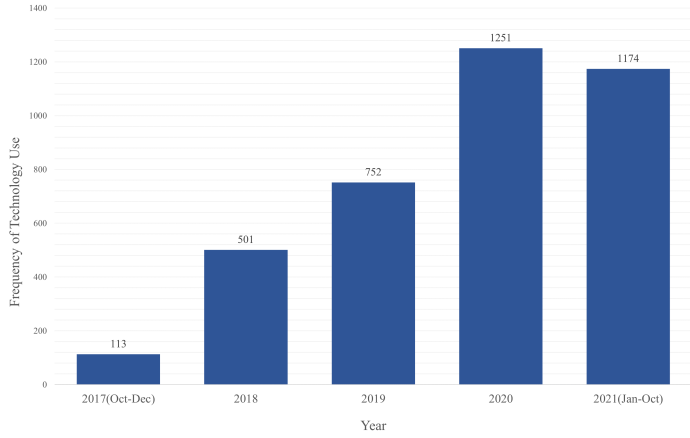

Fig. 2. Frequency of the corpus that mentioned technology use each year

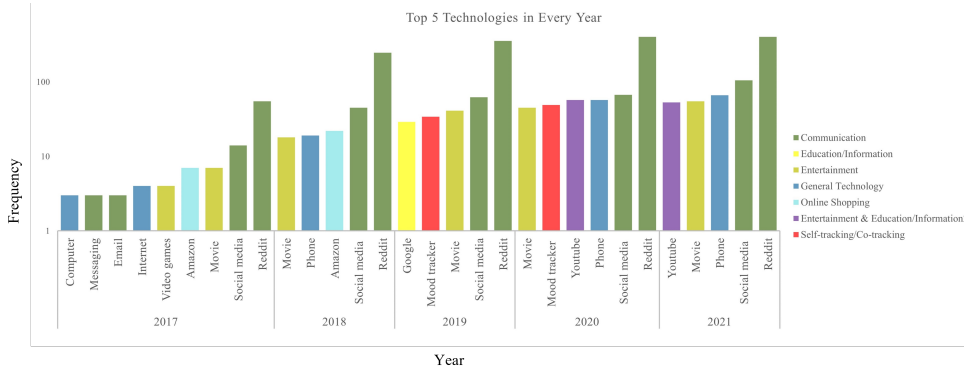

Fig. 3. Five most frequent technologies used each year (Oct.2017-Oct.2021). We use a logarithmic scale on the Y axis for readability. In 2017, three technologies tied for the first-, second-, and third-place frequency rankings. In 2020, two technologies tied for the top rank.

We also examined the frequency of the identified technologies in each year to reveal the trends of technologies used across time. We identified a significant technology-use increase in the BD community from 2017 to 2021, particularly in 2020 (see Figure 2). In Figure 3, we can see the five most frequent technologies discussed each year: *communication, education/information, entertainment, online shopping,* and *self-tracking/co-tracking* categories. Communication technologies, specifically Reddit and social media, are most prevalent over four years. Under entertainment technologies, movies are the most popular in four years but less popular than Reddit and social media. Online shopping technology (i.e., Amazon) is the second most popular tool in 2017 and 2018. In 2019, mood trackers became the top self-tracking tools, followed by education/information technology (i.e., Google). YouTube, which represents entertainment and education/information technology, is one of the most frequently used technologies in 2020 and 2021. Phone, a general technology, is the most popular technology every year except for 2017 and 2019.

4.2 Technology Mediation

In this section, we present how the identified technologies mediate the management of people's BD challenges. We classify the roles of technologies into *community mediator*, *episode mediator*, and *information mediator*.

4.2.1 Community Mediator. People leverage technologies, mainly social media or online community platforms, to connect to relevant mental health communities, contribute to community construction, share personal mental conditions and emotions, socialize, and seek advice for improvement strategies, which we frame as *"community mediator."*

Seeking and providing experiential advice. People seek advice to manage health conditions from professionals or relevant communities and provide similar support to others. The most frequent technologies people use to seek and provide advice are Reddit (673 mentions), private messages on Reddit (46), phone calls (43), email (13), and suicide hotlines (10).

Our data reveal that online communities like Reddit are essential to support many people in managing their mental health conditions. For example, people use it to connect to others and seek advice, especially for those without an offline support system, e.g., *"It is impossible to fight with BD without help. Online forums are a helpful solution for people who do not have a support system around them"* (r/[BPC#3]) and *"I know that Reddit is not a doctor… but I can't talk to my friends or family. I think Reddit can help me since I don't know what's happening on me"* (r/[BPC#1]). For those people, online communities provide the much-needed emotional support, such as *"internet hugs"* and *"comfort words"* (r/[BPC#2]). Moreover, community participants often encourage each other to live a positive life and overcome challenges, e.g., *"you posted this since you want situations to be different"* (r/[BPC#3]) and *"you are valuable"* (r/[BPC#2]). Additionally, although some individuals have an offline support network, they still prefer Reddit to seek advice from others because they believe those community participants who share similar conditions can provide more objective advice than people within a close network, e.g., *"It is nice to hear from someone who knows BD. I love my friends and family, but they cannot provide most object advice"* (r/[BPC#1]). Especially during the COVID-19 pandemic, people needed more support:

> *"COVID[-19] absolutely makes me worse, and I became suicidal. I see a therapist regularly… but I still enjoy having people support me in this subreddit. I post here because people here can better understand me than my significant other or friends." (r/[BPC#3])*

Many people seek advice about *medication* from others on Reddit. Before prescribing medication, individuals want to learn about others' experiences, particularly positive experiences. For example, *"…does anyone have positive experiences on this subreddit? I'm really nervous to start medication"* (r/[BPC#1]). Some people start medication but also sought others' experience around medication approaches: *"I'm surprised that people take long-term [medicine name]. I thought [medicine name] should be taken in a short-time manner because of the side effects… Is this the wrong way?"* (r/[BPC#1]). Even though many people ask various questions in online communities, they are cautious about providing medical advice to other people. Instead, many suggestions ask people to *"see a professional"* or *"ask a doctor"* (r/[BPC#1]) and urge advice-seekers to make decisions about medications *"under doctors' supervision"* rather than *"based on redditors' posts"* (r/[BPC#2]), partially because some people see internet advice as an unreliable resource: *"online advice can be very doubtful"* (r/[BPC#3]). Some advice-seekers accept such advice and turn to professionals, for example: *"I will definitely message a doctor"* (r/[BPC#1]).

In addition to medication advice, people posting on Reddit often ask for advice on coping strategies for managing various mental health conditions. For example, people ask for strategies to manage focus and sleep issues, e.g., *"I cannot focus even on my interests…I can't watch TV or read a*

book… How do you manage it?" (r/[BPC#2]) and *"how can I improve my sleep [quality]?"* (r/[BPC#2]). Some people struggle with feelings of paranoia that make them frantic about their life and relationships, e.g. *"I keep thinking that my boyfriend is cheating on me, which makes me panic,"* so they seek advice about *"how to deal with paranoias"* (r/[BPC#1]). Beyond advice, people also seek *motivations* from the community to keep fighting against their mental health issues. For example, some are motivated to *"keep medication"* or *"just do work"* (r/[BPC#1]) through checking BD communities on Reddit. On the other hand, people also point out that *"just relying on online forums"* leads to *"one-sided"* advice (r/[BPC#3]), and that professional advice is another important resource. People often use communication technologies such as phone calls, video chat (e.g., Zoom), and email to seek this kind of *professional advice*. Recently, particularly due to the effects of the COVID-19 pandemic, remote health care (i.e., telehealth, telemedicine) has become a common mechanism for obtaining this kind of professional help, as indicated in the 2021 nationwide trend report [71]. This is reflected in discussions of finding professional advice, as well—for example, *"I always use telehealth, which is over the internet. You can easily make an appointment. Quick, convenient"* (r/[BPC#2]) and *"affordable to those who do not have health insurance"* (r/[BPC#3]). In addition to seeking professional help through communication technologies, people also use these technologies to seek support from those in their social networks, like their friends: *"…I text my friends to let them monitor me. For example, I ask them to tell me that I have to eat"* (r/[BPC#2]).

Some challenges may arise when people seek remote help through technologies. People do not always get the needed help from professionals and others through communication technologies. First, people mention their concerns about the quality of the help they get through communication technologies, e.g., *"…I called the suicide hotline several times when I felt bad, but they just pressurized me to call the police. I don't have enough money to pay for medical fees anymore"* (r/[BPC#1]); *"I don't like my medical professional. The whole process makes me stressful"* (r/[BPC#2]); and *"my doctor takes several days to call me when receiving my message. I said I need help, but a week later, still nothing"* (r/[BPC#3]). As such, they turn to online communities for support: *"I'm so lost now. I don't know what I should do after my doctor refused to give me treatment. I'm reaching out for advice here [on Reddit]"* (r/[BPC#3]). Second, people are also concerned about identifying themselves and their conditions to other people, including medical professionals—for example, *"I feel people pointed at me"* (r/[BPC#2]) when calling a helpline. Therefore, they often anonymize themselves when seeking help through technologies. When they cannot anonymize themselves (e.g., on certain social media platforms or mobile technologies), they anonymize other aspects of their treatment. For example, they anonymize their help providers: *"I changed my pharmacy's name to 'my best friend' on my phone, so if people see it, they think I'm texting with my best friend"* (r/[BPC#1]). For some situations in which people cannot anonymize their help providers, some people choose to use the help anyway and *"always save the suicide hotline number on my phone"* (r/[BPC#2]).

In sum, people seek advice about medication and coping strategies from online communities like Reddit as well as professionals. They fluidly switch between these online and professional resources, employing a bidirectional *community-to-professional* help-seeking journey. In this journey, people are concerned about anonymity and the quality of help, both of which affect their willingness to seek help in different contexts.

Connecting to community. People seek a sense of active and engaged community with/among individuals who face similar conditions and connect with them for purposes such as normalizing conditions and sharing personal situations. The most relevant technologies are Reddit (736 mentions), social media (68), messaging (26), memes (20), and phone (18).

Many people with BD have a strong sense of and a demand for relevant online communities like Reddit groups about BD. They join such communities with clear goals because they can *"relate to a lot of people here [in the BD subreddit]"* (r/[BPC#3]) and get desired support, e.g., *"I like arts,*

but not here for it. I come to this community to give and request support", and *"...for topics about medications, mental health care system, and others' experiences"* (r/[BPC#1]). Importantly, relatability from relevant online communities makes them *"feel less alone"* (r/[BPC#1]), mainly because these communities provide a platform for many people to share similar health conditions—they share, disclose, or "vent" about mental health-related personal experiences, states, or emotions. For example, *"I had my manic episode at work, so I lost my job. I was looking for a new job and starting medication. I post my story here. You are not alone"* (r/[BPC#1]); *"I want to post something positive. After years of misdiagnosis, I finally found I am [Bipolar Type II]...Now I do gym and eat healthily again!"* (r/[BPC#1]). Sometimes, they also disclose serious moments, such as suicidal thoughts, in online communities but encounter frustration due to tensions between their desire to share these moments with their community and the platform's rules about sharing particular kinds of content: *"I am suicidal. I had a post removed because I disclosed too much about my [suicide] plans"* (r/[BPC#1]). These sharing and reading behaviors help people normalize their conditions as they can learn about other people's experiences, e.g., *"I see so many graphs of up and down, which is just like mine. It's a little comforting"* (r/[BPC#3]). Therefore, people keep connecting to these communities despite intentional lapses in participation, e.g., *"I deleted Reddit from time to time, but this subreddit brought me back"* (r/[BPC#1]).

As people share their conditions in online communities, they also care about privacy issues and prefer a safer place to share. A safer place, to many people, is Reddit, because of the *anonymity* that the platform affords. For example, *"Reddit is great because it is anonymous. But you should be very careful about other social media platforms"*; *"I can be very open about being BD on Reddit since I do not have risks of ruining my life, personal or professional"* (r/[BPC#1]). However, although anonymity on Reddit constructs a boundary that mitigates risks or harms from the real world, there is a weak boundary between the outer community and the inner community on Reddit. People's post histories create potential risks of harm from users' concurrent participation in non-mental-health subreddits. For example, *"someone looks in post history and against me using my mental health illness"* (r/[BPC#2]).

People also show agency over the communities they engage in and express different views on how the community should be maintained. Overall, they want the community to be *"more helpful and kind"* and a place *"to exchange good information"* (r/[BPC#1]). When it comes to community moderation, some people believe that *"auto-deletion"* and *"over moderation"* on some topics (i.e., drugs) are *"cold and rude"* because *"people can find what they want by themselves"* (r/[BPC#3]). However, others suggest that *"free speech doesn't work in this community since some posts are dangerous and triggering"* (r/[BPC#1]). Additionally, people are concerned about the voting system on subreddit: *"they downvote sincere and well-intended questions to boost theirs up. This is not appropriate for mental health support community"* (r/[BPC#3]). Finally, some people expressed preferences about their online communities' visual features and vibes. For example, some people highlight how artworks like memes on Reddit changed the vibe of their communities as a venue for mental health issues and can foster a happy and not-very-serious environment (e.g., *"Artwork...can make us happy"* (r/[BPC#1])) and even help people's condition management (e.g., *"at the beginning [of my diagnosis], I refused to believe it. These memes and posts made me face it, so I can actively seek help"* (r/[BPC#1])). Hence, some people explicitly share that they want more such artwork: *"We are an internet forum. Banning memes will make our community serious. I do not want this place to be a sob community without any fun allowed"* (r/[BPC#1]). Note that beyond large online communities like Reddit, people also seek connections in smaller communities such as groups in Discord[5] and

[5]https://discord.com/

Meetup[6], e.g., *"we have discord groups. There are a few chats daily but not very busy"* (r/[BPC#3]), and *"we are all around. I found meetup group in my area"* (r/[BPC#3]). In short, people not only join the community for reasons like relatability and sharing experiences, but also demonstrate agency in working to actively construct and moderate these communities.

4.2.2 Episode Mediator. In the pattern of episode mediator, technologies help people reflect on their mental health conditions, redirect their attention from episodes, balance daily life and conditions, or even deteriorate their conditions.

Reflecting on conditions. Technologies help people gain a holistic view of their condition history, reflect on their conditions, and seek patterns or signs of episodes. The most relevant technologies are: mood trackers (146 mentions), Reddit (49), social media (17), movies (13), and videos (10).

Self-tracking, also known as personal informatics systems, supports people in collecting information around the "self" to better understand themselves and conduct different levels of self-reflection [23, 49]. People mostly display a positive attitude toward self-tracking applications (e.g., *"Daylio!! I love this app so much"* (r/[BPC#1])) and recommend them to others with similar conditions (e.g., *"[I recommend to] try Daylio out"* (r/[BPC#1])). People use self-tracking systems for multiple purposes (Table 1), including tracking sleep time, light exposure, habits, medication, triggers, thoughts, and mood. People also mentioned tracking *"thoughts for therapy sessions"* and *"everything happened in life"* (r/[BPC#1]). Among these tracking behaviors, some individuals state that habit tracking is more helpful than mood tracking in understanding signs, e.g., *"I found it's convenient using habit tracker rather than mood tracker. I can recognize my low mood episode when I don't brush teeth"* (r/[BPC#3]). More importantly, we find that people rely on the interpretive and predictive features of these systems to gain self-understanding, self-confidence, and/or self-efficacy, e.g.,

> *"I always can't distinguish what is real and what is episode because of BD... so I can't really trust my subjective observations sometimes... I have to rely on data, the mood chart, to tell me I'm stable. Even my brain tells me everything is horrible... the data tells me opposite story—my life is good. I can be 'normal', so I am probably supposed to trust the decisions I made when I was stable." (r/[BPC#2])*

We further outline positive and negative user experiences (see Table 5). Some people like that self-tracking systems such as Daylio[7] are highly accessible, available in a *"free version"*, and is *"very simple"* (r/[BPC#1]). Also, the technologies log data efficiently—it *"takes several seconds to rate your day"* (r/[BPC#1]). After data collection, people like seeing patterns changing over time (*"you can see how your mood changes over a week, a month, and a year"* (r/[BPC#1])) and discovering how other factors impact mood, e.g., *"it is easy to see the correlations between your mood and weather, menstrual cycle, medication changes, and so on"* (r/[BPC#1]). People also appreciate the functions like *reminders* and *journaling* to help take medication or *"look back on"* (r/[BPC#1]). However, technology reminders or notifications could elicit anxiety in some people. For example, one post reads, *"Daylio sent me a notification saying I broke the streak, which made me insanely anxious"* (r/[BPC#1]). In this case, the notification itself triggered anxiety. Some people attribute this issue to the reason that these apps are not specifically designed for people with BD, e.g. *"Mood trackers are more designed for unipolar depression... how to log mixed episode? For example, I have high energy but very low mood...."* (r/[BPC#1]). Also, people with multiple health conditions could be marginalized in self-tracking systems. For example, manually self-logging data can be burdensome

[6] https://www.meetup.com/
[7] https://daylio.net/

for people with ADHD and BD: *"It's very hard to track my moods, medications, and everything every day. I also have ADHD, meaning I have to rely on the memories of my friends and families"* (r/[BPC#1]).

Table 5. Motivations, positive and negative experience of using self-tracking application

Motivations	Positive user experience	Negative user experience
Sleep time tracking	Seeing patterns changing over time	Trouble focusing
Light exposure tracking	Customizing variables	Time-consuming
Habit tracking	Accessibility	Non-particular-for-BD
Medication tracking	Reminder	Misleading charts
Trigger tracking	Better mood scale	Unclear day-to-day mood variations
Mood tracking	Seeing correlations between variables	Notifications causing anxiety
Thought tracking	Quick to enter	
	Journaling	

In addition to self-tracking applications, people also use Google Docs/Microsoft Word documents or the voice recording and alarm features included on a mobile phone to facilitate reflection. Interestingly, the collaboration feature of Google Docs was used to co-track conditions. For example, *"I told my husband how to manage when I get severe... I list the medication plan on Google doc and share with him"* (r/[BPC#3]).

To sum up, people often use self-tracking applications to track various aspects like habits, moods, and medication in day-to-day life to gain reflective insights on conditions. They also leverage tools with collaboration features to co-track or -manage conditions with family members.

Redirecting attention. Technologies help people redirect their attention away from aspects of their mental health episodes like racing thoughts or low emotional states (among others). The most relevant technologies are: music (45 mentions), video games (38), Reddit (32), YouTube (31), and movies (28).

People use technologies to redirect attention in four ways: journaling, gaming, sound-controlling, and learning/creating. First, people journal via audio or video to redirect attention away from racing thoughts, a symptom during manic episodes [2, 51]. For example, *"... When I'm manic, I'm so talkative. Doing an audio or video journaling could work better for me. In this timely way, I feel my creative ideas are not lost"* (r/[BPC#1]). Second, people use sound media to manage their symptoms, e.g., *"I have to turn music to maximum volume in my headphone. This is the only way to deal with racing thoughts"* (r/[BPC#1]). Some may prefer natural sounds, e.g., *"I found the meditation music and nature sounds relaxing"* (r/[BPC#2]). Third, some people want to *"play video games to help to stabilize,"* and see it as an effective coping mechanism. For example, *"video games are my NO.1 coping mechanism...I feel I live in another world. It's amazing"* (r/[BPC#1]); *"when I play video games... my brain and emotions can take a rest"* (r/[BPC#1]). This attention-redirecting approach can be frequently used without age limitation, e.g., *"I'm nearly 60 and I almost play every day"* (r/[BPC#1]). Fourth, some people redirect their attention by creating things using technologies, such as building websites and creating robots or 3D models. For example, *"Without tutorials and experience, I learned how to create 3D model over 2 months"* (r/[BPC#1]). However, attention-redirecting approaches can result in both positive or negative impacts. As a user shared, *"it can be both good or bad, depending on what [approach] it is"* (r/[BPC#1]). In brief, people mainly use entertainment technologies like sound media and video games to redirect their attention from symptoms such as racing thoughts and unstable emotions.

Balancing life and episodes. People aim to maintain balance among multiple facets of their daily lives, including managing their mental health condition, work, relationships, finance, etc. The most relevant technologies are: personal assistant apps (24 mentions), email (19), phone (16), gig work platforms (13), and online shopping platforms (12).

Notably, people use technologies to balance episodes at work. As aforementioned, people's episodes can put their careers at risk. For instance, *"I got my previous jobs when I was in manic episode but lost them when slipping down to depression"* (r/[BPC#1]). In response, some people use gig work platforms (e.g., Uber, Lyft, DoorDash) [6, 38] as the helper, which allows them to more freely manage their workload based on their mental condition. For example, *"My ups and downs last months. I drive Uber so I have time to sleep and effort to gather thoughts. I don't have the stress of go-to-work-on-time"* (r/[BPC#1]); and *"Working from home helps me a lot. Lionbridge, Appen, Amazon Turk, and transcription can help. Solo work without direct supervisors"* (r/[BPC#2]). People also use technologies like calendars, timers, and website blockers to manage work and regulate multitasking during episodes. When facing issues brought by episodes (i.e., memory loss), some people *"use notes app or personal assistant apps to remind them to-do work"* (r/[BPC#3]). Sometimes, they plan work in a detailed manner with the help of technologies, e.g., *"I would work for half of an hour and surf online for 10 minutes"* (r/[BPC#3]). To avoid addiction to certain websites, they use *"website blocker to block websites they would be addicted to"* (r/[BPC#3]). People also use money management applications (e.g., Mint[8]) to balance money-related episodes: *"You can use money management apps on the phone... let them help you manage your money. So if you have impulsive spending, you still have money for basic life "* (r/[BPC#3]).

However, not every facet of life, such as relationships, can be balanced using technologies. We frequently encountered posts about people having difficulties balancing relationships and episodes. For example, during a depressive episode, *"I can't answer messages. My ex broke up with me because of it"* (r/[BPC#1]). Furthermore, in family relationships, family members have difficulties balancing boundaries when trying to track and monitor changes in symptoms, e.g., *"My family set up cameras in house to monitor me every moment when I was in manic episode"* (r/[BPC#1]). Overall, people mainly use apps like calendars and gig work platforms to balance multiple facets of life and episodes of BD. However, relationships are hard to balance during episodes.

Deteriorating conditions. Technology use can trigger or worsen people's symptoms—for example, triggering manic episodes or aggravating technology addiction in depressive episodes. The technologies that could deteriorate people's conditions include: social media (168 mentions), online shopping platforms (124), Reddit (112), the phone (93), and email (39).

People's technology use may result in unexpected consequences, especially triggering or worsening emotions and behaviors. Many people mention that technologies used in daily life, such as TV and radio, negatively impact their conditions, e.g., *"auditory hallucination"* (r/[BPC#1]) and *"I experienced auditory hallucinations. I heard people on the radio talking to me"* (r/[BPC#1]). Also, some people mention manic technology use. For example, when people are in a manic episode, hyperactivity could stimulate their posting behaviors, e.g., *"I can't count how many posts or comments I posted and deleted"* (r/[BPC#1]). Such behaviors, in return, give rise to negative emotions: *"posting too much information makes me feel bad... everyone lives a normal life. Facebook made me miserable"* (r/[BPC#3]). Accordingly, some people "deactivated" their accounts, e.g., *"I deactivated Facebook for months and Instagram just now. I don't miss them at all. I'm mentally exhausted of using the apps too much"* (r/[BPC#1]). This phenomenon is not uncommon and we see a trend indicating that people are retreating from Facebook or Instagram (e.g, *"I deleted Facebook years ago"* (r/[BPC#3]), and *"I deactivated Facebook. I don't trust it"* (r/[BPC#1])) and *"just stick to Reddit"* (r/[BPC#1]). Although our data show many such retreating cases, exact reasons were not mentioned. Other technologies that were mentioned as being used during manic episodes are centered around emails, shopping websites, and television. For example, *"I spent hours on Amazon to fill up cart"* (r/[BPC#1]), and *"I slept on the couch and kept watching Netflix for 18 hours"* (r/[BPC#1]).

[8] https://mint.intuit.com/

Even worse, these impulsive uses can cause real-life consequences, such as losing jobs (e.g., *"I sent an uncontrollable email, which made me lose my job"* (r/[BPC#1])) and overspending (e.g., *"$30,000 on online shopping"* (r/[BPC#1])). Finally, there are also people who intentionally avoid technology use during depressive periods, like ignoring messages, e.g., *"lots of people are struggling with answering messages during depressive episode"* (r/[BPC#1]). In sum, everyday technology use like radio and online shopping platforms can negatively impact people's conditions, such as leading to hallucinations and manic shopping behavior. These impacts can have real-life consequences like financial trouble or job loss.

4.2.3 Information Mediator. Technologies serve as the medium for people to share and consume mental health-related information.

Consuming information. People encounter and absorb mental health-related information from media and technologies, which can be beneficial (e.g., improving mental health literacy) or detrimental (e.g., reinforcing stigma). The most frequent technologies are: Google (84 mentions), Reddit (59), movies (38), Internet (31), and social media (29).

Mental health-related information from different media plays a key and complex role in condition management. On one hand, people get useful relevant information from various platforms such as medical websites (e.g., WebMD, National Alliance on Mental Illness (NAMI)) and YouTube, which helps improve their mental health literacy or self-validate their mental health conditions. Specifically, many people mention they educate themselves through searching information from various technologies after being diagnosed, e.g., *"Before being diagnosed, I knew nothing about BD. Now I'm still learning from subreddits"* (r/[BPC#2]); and *"After I got diagnosed, I watched videos on YouTube [to help me understand]…I also showed it to my mom to help her understand"* (r/[BPC#2]). Such information consumption further helps some people self-validate their conditions because it is hard for them to believe the diagnosis, with some even refusing the diagnosis. In this case, information encountered online gives them in-the-moment confirmation. For example, *"[After diagnosis] I think I was misdiagnosed. I don't have BD! Then, I read some posts in this subreddit. Oh…"* (r/[BPC#2]) and *"The videos [on YouTube] helped me to validate"* (r/[BPC#2]).

On the other hand, consuming relevant online information can generate negative impacts. First, the information can be condition-triggering. For example, *"I'm triggered by suicide prevention [content]"* (r/[BPC#3]) on social media, and *"I know it may be necessary to let people know suicide hotline, but too much such information is revolting"* (r/[BPC#3]). Second, misinformation is another challenge that can lead to devastating consequences for mental health. For example, one person shared how encountered online information influenced their medication decision: *"I didn't accept diagnosis. I thought it was a conspiracy. I also exceptionally resisted medication since I heard it would damage kidneys from a podcast"* (r/[BPC#1]). Fortunately, people acknowledge misinformation existing in online platforms and form their own thinking about different information sources. For example, some share their negative expressions about information from TikTok, e.g., *"OMG. Don't get information from Tiktok. It's full of misinformation!!!!!"* (r/[BPC#2]) and *"Tiktok is stupid. Young people fake [to be people with mental health illnesses] to gain attention or empathy"* (r/[BPC#1]).

People further raise the concern that the spread of misinformation may *"cause more stigma or stereotype"* (r/[BPC#1]), a phenomenon not just in TikTok but in broad media platforms. For example,

> *"It's tough for me to see the general misconception in popular media and the public. Whenever I read news or watch videos about someone doing dangerous, people comment and insist that this person has BD. Even worse, TV shows or movies create bad characters like bad parents and use BD to explain their awful behavior…I don't know to what extent*

the public misunderstands BD. Media just reinforce these harmful misunderstandings." (r/[BPC#3])

Even worse, this type of societal-level "misconceptions," in return, reinforce people's self-stigma. Many people share how they feel they did not fulfill their responsibilities in their everyday life well after consuming such information, e.g., *"It makes me believe I can't be a good parent or partner forever because BD is lifelong"* (r/[BPC#3]), and *"After being told BD is craziness by movies, family... most of my life, I think I should against my own stigma now. I just got diagnosed"* (r/[BPC#2]). Some people also point out that certain information is *"romanticizing mania episode of BD"*—that is, *"mania makes people productive or creative"* (r/[BPC#3]). Given all these kinds of misinformation, stereotypes, and *"incorrect mindset"* (r/[BPC#3]) about BD, people with BD call for greater awareness and understanding of the diversity of BD experiences towards this mental health challenge and urge the public to *"stop saying we [are] ALL like that"* (r/[BPC#1]). Overall, people's information consumption can be beneficial (e.g., mental health literacy improvement) or negative (e.g., self-stigma) to condition management. Misinformation is a major issue existing in everyday consumed information, spanning from social media to mass media.

Sharing objective/educational information. People share resources for condition management, studies about medicines, and relevant communities with others having similar conditions or in a social network. We noticed that people sometimes share information (e.g., medical services) in response to others' help-seeking behaviors on online communities. However, in many other cases, people simply share information related to mental health, such as articles and studies introducing a specific mental illness, that are within their knowledge voluntarily rather than responding to others' questions or needs. Therefore, we created "sharing information" as an independent category instead of merging these kinds of behaviors into "seeking and providing advice." The most frequent technologies are: Reddit (86 mentions), YouTube (56), medical studies (e.g., sci-hub, Google Scholar) (32), Wikipedia (31), and medical blogs (28).

Compared to the uneven quality of consumed information, shared information is usually from medical websites or studies. People often educate others about the mental health challenges by sharing relevant information, especially with family members or intimate people within their close social network to help them better understand about the condition. For example, *"...My spouse watched family-to-family courses on NAMI. It educated people on methods to deal with specific situations, general knowledge about mental health illnesses, and medications. She loved it and felt better about us"* (r/[BPC#2]). Additionally, people share information about condition management with others experiencing similar conditions, e.g., *"You can check this course [link to course about managing conditions during COVID-19 pandemic] on Coursera"* (r/[BPC#1]), and *"The only thing that works for me is sleep. [Link to a study about light therapy posted on Harvard Medical School website]"* (r/[BPC#1]). In sum, people not only share mental-health-education-related information to others with similar conditions, but they also share it with family members or caregivers.

5 DISCUSSION

In this section, we discuss the implications of our findings and highlight design opportunities for future technologies to better support people facing mental health challenges. We also reflect on our data analysis approach that combines machine learning with manual coding, which might serve as a methodological reference for other HCI and CSCW scholars.

5.1 Technology Use in Coping with Mental Health Challenges

Our study provides insights into technology use of BD condition management by identifying the technology ecosystem (what types of technologies are employed) that people use to manage

their conditions, and defining and describing three technology mediators (how these technologies support or undermine people's management of their conditions). Prior literature [2, 29, 51] shows that people tend to overuse technologies during manic episodes, such as online shopping platforms, messaging, social media, video games, and search engines, while reducing or avoiding use of certain technologies during depressive episodes. Our findings reinforce this existing literature, with a wide variety of non-clinical technologies mentioned, especially related to redirecting attention and managing life balance during manic episodes. This is particularly important for individuals managing BD Type I diagnoses or undergoing rapid cycling, since the levels of mania experienced by these individuals tends to be higher and more intensive.

Additionally, technologies bring both positive and negative effects. Our study reinforces these findings by providing additional empirical evidence. Simultaneously, we expand on the existing literature by identifying new technologies and mediation roles (see details in Table 3 and Table 4) that have not been revealed in previous studies. For example, we identify technologies such as *gig work platforms, mental health care tools or platforms, education/information tools,* as well as *tools for co-tracking* that play an important role in some individuals' self-management practices. These newly-discovered technologies can be ascribed to our empirical analysis on a large-scale corpus. We developed a comprehensive taxonomy of everyday use technologies in BD management. The taxonomy and our findings of technology use reveal new research gaps to be explored in the future. For example, what features of communication technologies would enable effective help-seeking during manic and depressive episodes and/or while euthymic (i.e., the state of living without mood disturbances)? Why do people facing mental health challenges choose to use certain technologies while abandoning others?

Our findings highlight the different roles of technologies in people's everyday management of their mental health challenges. We classify them into three large categories, i.e., *community mediator*, *episode mediator*, and *information mediator*. This categorization and the detailed role enactment in findings provide a *comprehensive, systematic,* and *deep* view into how technologies can mediate people's management of their mental health conditions. These findings both confirm and significantly expand studies on technology use in the mental health context. Specifically, people's behaviors of seeking and providing various support under *community mediator* align with previous findings that people prefer social media to seek peer support without the limitations of temporal and geographic constraints [3, 58, 59, 62]. Additionally, we find that online communities can facilitate professional help-seeking, resonating with Naslund and colleagues' finding that community support-seeking can encourage seeking professional support [58] but also identify instances of *collapse* in this professional help-seeking through communication technologies, such as delayed and unhelpful responses. Finally, we find that some discussions focus on medication, such as long-term medical treatment, partially because of difficulties encountered in finding appropriate medical treatment. Given the fact that medical treatment is seen in therapeutic contexts as important for long-term BD management [13, 55], we recommend that future studies further examine the nuances of information-seeking behaviors (e.g., when, how, and why these activities occur) in online communities as well as how to better support such behaviors in the context of mental illnesses.

Instances of seeking help via a suicide hotline emerged in our data. However, only a few prior studies have examined the role of suicide hotlines from an HCI perspective; Pendse et al. [65] situated the helpline examination in the context of India, suggesting that callers' needs are not met because of societal and technical barriers. Our study enriches the understanding of people's concerns about "communication safety" [65] while using the hotline, i.e., people point out the risks of involuntary hospitalization just due to suicide ideation disclosure. As demonstrated in our data, hotline services can be a critical resource for people facing mental health challenges. We highly

recommend that future studies focus more on suicide hotlines or helplines in different contexts to better design services and interventions that meet the diverse needs of those who are experiencing a crisis due to their mental health condition. Additionally, more research should focus on how to provide high-quality and safe professional support through technologies for those who need it in a timely manner.

Our findings of *community mediator* technologies also reveal an interesting trend—people with BD are retreating from Facebook to pseudonymous online communities like Reddit, resonating with Eschler et al.'s study that people with depression deleted or expressed such an intention to delete social media like Facebook [29]. People are retreating from popular social media platforms such as Facebook and Twitter and only staying in the online communities with people experiencing the same conditions. The trend could result from the issues around *context collapse* [27] when people disclose or prompt manic posting behavior on social media. We recommend further examining this potential trend in the social media ecosystem to better protect online "space" [27] for stigmatized groups.

Under the *episode mediator* category, we find that people use technologies for time management and documentation to manage work and their mental conditions, which aligns with what Eschler et al. [29] found about how people with depression use calendars and Google Docs to help plan work. We also enrich the understanding of the various balancing roles of technologies in multiple facets of people's everyday life, e.g., using gig work platforms or apps [6, 38] to balance episodes and workload. Unlike the distress and exhaustion reported among gig workers, generally [6, 38], our findings show that gig work can be an asset for people with BD. Future studies should further examine the relationship between gig-work technologies and people with mental health issues, especially how these technologies impact different aspects of their lives and how to design gig-work technologies to better accommodate these individuals' life and work needs.

Additionally, most current studies heavily focus on help-seeking behaviors [3, 58, 62] and designs of condition support technologies [10, 52, 70], while few studies have focused on the relationships between mental health and real life that were highlighted in our findings. We recommend that future studies focus on the daily lived experience of those with mental health issues, such as how mental health issues impact people's social relationships and work and how to minimize such negative influences.

Lastly, our findings of *information mediator* expand the understanding of the negative impact of media or mass media. Matthews et al. [51] found that negative content on news and TV could trigger depressive episodes. Our data reveals that media or mass media like news and TV could reinforce stigma in the community and further contribute to an individual's self-stigma. People's concerns about stigma in the community convey a demand for community impression management. Future studies can focus on studying community impression management beyond personal impression management on social media.

Regarding *information mediator*, we also observed that a considerable amount of people use voice- or video-based social media (e.g., TikTok) or podcasts to gain information, probably because of easier accessibility and readability compared to medical websites or online studies, e.g., freeing hands for podcasts; communicating rich visual information for videos. However, our findings highlight that platforms like TikTok can disseminate misinformation, leading to problematic advice-seeking outcomes. Combating misinformation on social media has been studied for years in HCI (e.g., [31, 68]), but few studies are focused on the context of mental health, with even fewer investigating how misinformation can be mitigated in new media like voice-based content. Jiang and colleagues [45] examined moderation challenges on voice-based content to combat misinformation on Discord and noted that there are no one-size-fits-all solutions for voice-based moderation. There might be a substantial difference across platforms. We suggest that future studies should research

misinformation about mental health in different technological mediums and how to combat such misinformation. For example, in what form does mental-health-related misinformation happen in different media, e.g., voice-based and video-based platforms? What are the difficulties for people facing mental health challenges to identify various forms of misinformation? And what technologies do to reduce misinformation for this vulnerable group of people?

Additionally, by analyzing the trends of the identified technologies each year, our study highlights a growing trend in technology use and identifies a soaring increase from 2019 to 2020. Such an increase aligns with the nationwide trend reported in government briefs about investment-needed mental health treatment in the U.S. in 2021 [71], reinforcing our expectation that technology plays a non-negligible role in mental health management. Among the identified technologies, social media platforms, Reddit, and phone are prevalent discourses in everyday use technologies over the past four years, revealing their close relation to condition management in people's day-to-day life. Our data also reveals an increasing trend of self-treatment and self-management started in 2019 and continues in 2020. In 2020 and 2021, YouTube became a prevalent technology in the BD community, which could be a result of two possible reasons. First, work-from-home during the pandemic increased people's entertainment technology use. For example, our qualitative data shows that people listen to music and watch fan videos via YouTube. Second, the COVID-19 pandemic may have negatively impacted people's conditions, leading them to watch more mental health education-related videos and share relevant resources in the BD community. Overall, by analyzing the frequency of technology-use discourse over time, we confirm a close relation between everyday used technologies and mental health management as well as identify an increased tendency in self-management.

5.2 Design Implications

Our findings reveal a variety of implications for designing technologies to better support people in managing their mental health challenges.

5.2.1 Designing for privacy: Anonymizing mental health-related engagement. We find that people emphasize anonymity (or pseudonymity) in mental health-related community participation and help-seeking, partially due to self-stigma [62] and potential real-world consequences. People self-disclose on Reddit because of its anonymity relative to other social media platforms like Facebook or Twitter. Nonetheless, mental health-related post history on Reddit can be a source of inadvertent disclosure about people's mental illness. Although this kind of disclosure may not directly affect real-world identity, it can still harm people's online identity. Furthermore, in professional help-seeking such as contacting pharmacy or mental health care providers via mobile phone or messaging apps, people express concern about revealing their mental illness to others in the real world. We recommend that mental health-related technologies provide the ability to anonymize their interactions with or secure access to professional help-seeking technologies, as well as an increase in privacy control functions for online communities or social media. Combating stigma is a long journey; we hope that future technologies will provide users additional privacy control of their self-presentation and self-disclosure.

5.2.2 Designing for deep care: Customizing technologies for specific mental health challenges. Our findings show that most current commercial self-tracking apps are generally not designed with features specific to supporting individuals with BD (or other mental health conditions, for that matter), although self-tracking can play an important and helpful role in managing mood disturbance and identifying opportunities for optimizing medications used and their dosages [10, 52]. As a result, even if these apps provide general-purpose functionality to track mood, they do not track mixed states or capture subtle variances in mood shifts, a common BD symptom. Additionally,

some of these apps' rewarding mechanisms are inappropriate for BD conditions and can lead to negative results such as increased anxiety, partially because the systems are built on the mood- or activity-*lift* hypothesis (that is, an assumption that users have a goal to achieve a "better" mood and more active lifestyle). All these factors compromise people's use experiences in managing their BD conditions, particularly when experiencing a manic (Type I), hypomanic (Type II), or depressive (Types I and II) mood swing. Given that every mental health challenge has its unique symptoms and coping strategies, and that a general treatment is usually not enough but requiring targeted medication, we therefore strongly suggest that designers and practitioners situate their design in a specific mental health context and consider the nuanced needs of people facing that challenge to better support their mental health management, rather than a one-size-fits-all version.

5.2.3 Designing for agency: Balancing power dynamics between users and technologies. Tracking day-to-day activity traces can be helpful for facilitating self-reflection about mental health conditions. Our data show that people rely on—and even release agency to—the system in self-tracking applications to gain self-confidence, self-understanding, self-identification, and self-efficacy. This phenomenon can be attributed to two reasons. First, system-driven agency is dominant in current self-tracking applications in the market [23]. Second, some people's feeling of "normalcy" or stability depends on the *quantified* stability presented by these systems. In some cases, this can be a helpful feature, especially when mental illness undermines an individual's ability to accurately assess their own state or wellness trends. However, standards of "normalcy" can also project bias or politics into the real world and elicit anxiety when individuals' data "diverges" from standards of "normality" [23, 41, 52]. Navigating this balance is an ongoing challenge, as there are potentially harmful consequences associated with reinforcing self-stigma. We recommend that future studies should deeply explore how, why, and when users negotiate this balance of agency in self-tracking applications as part of their mental health management or treatment. Cho et al. provide valuable suggestions about presenting data using a mixed-agency approach (e.g., allowing the system to focus on aggregating and visualizing quantitative data and providing the user with prompts to foster text-based narrative introspection) to improve self-reflection, overall [23].

5.2.4 Designing for social support: Considering close others. Our data shows that people engage in collaborative health management with those close to them—their spouses or significant others, for example, These individuals are often involved in collaborative medication and behavioral tracking. This finding resonates with Murnane et al.'s characterization of bipolar support technologies as "collective informatics" when used collaboratively within intimate social support networks [57], as well as Pina et al.'s [66] observation that parents and children with JIA (Juvenile Idiopathic Arthritis, a chronic inflammatory disease) collaboratively track factors such as medication and sleep. In light of these findings, we recommend that designers thoughtfully leverage the broader social network of users who serve to support those individuals who are experiencing mental health challenges. For example, we invite designers to consider how family members and friends can be involved, informed, and their mental health literacy strengthened to provide support as *part* of these mediating technologies.

Of course, collaborative tracking applications like these raise potential privacy concerns (see also [66, 72]). These privacy issues need to be carefully addressed—especially those raised by the kinds of information collected and shared by these systems and in light of the kinds of real-world support that the technologies are intended to facilitate. It is worth noting that existing models of personal health informatics data sharing may need to be refined in this context, as mental health-related data are quite different from (and potentially more sensitive than) other kinds of primarily physical activity data like steps or heart rate.

5.2.5 Designing for expression and redirection: Focusing attention in a positive direction. We also find that people employ technologies to redirect attention away from episodes as a coping strategy, such as playing video games, creating artifacts (e.g., creating memes, robots, artworks with AI), and listening to music. However, current studies and technologies heavily focus on the condition-focused design of personal informatics systems, such as self-tracking and condition prediction using machine learning [5, 7, 26, 52]. Significantly fewer designs aim to support people facing mental health challenges in expressing themselves and "venting out" negative emotions [25], especially in the context of BD and mental illness. We suggest that there is a missed opportunity here; that future design research might focus on creating ways for people with mental health challenges to express themselves and redirect their attention, particularly during episodes. For example, what kind of mental and physical activities can people engage in during an episode? What interaction devices can help to comfort people in the midst of a manic episode?

5.3 Methodological implications: Reflection from our combined use of machine learning and thematic analysis

Our study applied machine learning (ML) and qualitative thematic analysis (TA) to analyze people's technology use in managing mental health challenges using a large-scale corpus drawn from multiple online communities (subreddits). Thematic analysis in HCI and CSCW is often limited by small data scales, since collecting, annotating, and reflecting on data takes a large amount of time [37, 54]. As such, researchers often attempt to combine ML and thematic analysis to gain insights from large-scale data. Namely, scholars have used ML to extract relevant topics, keywords, and threads first, followed by conducting TA on the ML-extracted information (see the monochrome facets of Figure 4) [37, 54]. Our research uses a similar approach; however, our method demonstrates how this combination of ML and TA might be improved to effectively identify themes around a specific topic. We employed a method that combined human agency (manual coding) in parallel with algorithmic augmentation (automatic coding) to more robustly—but still efficiently—identify technology-related keywords from our corpus.

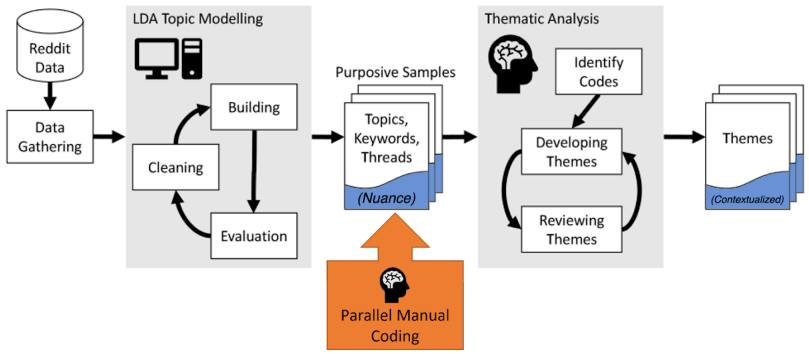

Fig. 4. The process of combining machine learning and thematic analysis, from Gauthier and colleagues' study [37] (the monochrome aspects of the figure). We suggest adding a manual coding stage as part of the process for identifying "purposive samples" (the orange addition to the diagram).

Our method demonstrates how and when hand-coding has better performance than a topic modeling algorithm—and when it does not. Human coding of topics can identify nuanced information based on contexts that could still be difficult to be revealed by current Natural Language

Processing algorithms. For example, in our data, many people shared various medical website URLs, which is important evidence for sharing information, contributing to generating the *information mediation* strategy in our code aggregation and categorization step during data analysis. In ML, due to infrequent appearance in the corpus, such information might be given less weight, leading to the loss of key themes. As such, relying solely on ML could result in the loss of nuanced and granular information that can contribute to gaining key insights. At the same time, we noted some instances in which the ML topic extraction engine detected more general topics that the human coders did not attend to in their manual coding pass (e.g., "app," "track," "post"). We suggest that future studies leveraging ML to assist with thematic analysis include a stage in which humans provide parallel validation of ML-based topic, keyword, and thread extraction (Figure 4, the orange part) to generate not only phenomenal [54] but also contextual insights.

Parallel human validation techniques have already been applied to various domains of AI applications. For example, applications that combine human input/validation with AI agents in computer vision contexts increases the AI agents' ability to learn new concepts and social norms [46]. However, human validation may not always be effective because in some contexts like mental health, human validation may bring negative impacts to the results of human–AI collaboration by adding or reinforcing certain (well-understood and cited) biases.

However, one distinct advantage of increasing targeted reliance on computational methods is that in sensitive contexts like mental health, people may not be comfortable with human coding of their data; rather, a more objective AI/ML analysis might be perceived as less invasive because the extraction of mental health-related data using AI/ML are often from larger corpuses in a even-more-anonymized way, allowing the humans to focus on the data without linking it to identifiable information contained in the post or thread. Leveraging AI/ML in this way could result in giving up a measure of context, but gain more analytic distance from identifiable individuals.

6 LIMITATIONS AND FUTURE WORK

This study has several limitations, many of which are side-effects of our decision to use Reddit as the source for our corpus. First, self-references among subreddits and over-inclusion of references to the Reddit platform as a mediating technology are biases that we expected to see in our analysis. (People who continue to post on Reddit are likely to acknowledge Reddit as a tool that they have successfully adopted into their own self-care practices.) Furthermore, our findings on technology use trends might exhibit a bias to those technologies popular among Reddit users since we did not include insights or reflections from those individuals who do not use or post on this platform. We recommend that future work should examine similar conversations taking place in other online communities or forums such as PatientsLikeMe, which might be helpful in assessing the generalizability of the findings in our research. Additionally, our research design was not able to differentiate technology uses between Bipolar I Disorder and Bipolar II Disorder unless individuals self-disclosed the details of their diagnosis (which they typically did not). We recommend that future studies further examine the differences in technology use between the types of BD (BD I and BD II), which might provide new insights into nuanced technology design implications.

7 CONCLUSION

In this study, we conducted an empirical analysis of Reddit BD communities. We identified a taxonomy of technologies used in people's everyday mental health management and summarized three broad roles that these technologies play in the management of mental illness, including *community mediator*, *episode mediator*, and *information mediator*. These findings highlight several design implications for more human-centered technologies to manage mental health challenges, spanning from balancing user-system agency in mental health-related tracking applications to

tools for fostering expression and attention management. Additionally, we provide methodological implications stressing the importance of leveraging human agency in qualitative studies that utilize machine learning to conduct thematic analysis. Ultimately, we hope our work can contribute to novel technology designs and development that can more effectively support multiple facets of the lived experience of managing and living with mental health challenges.

ACKNOWLEDGMENTS

We thank Fan Liang, Janghee Cho, Fuji Robledo, Shiva Darian, and Michael Hoefer for providing invaluable feedback and suggestions.

REFERENCES

[1] Elia Abi-Jaoude, Karline Treurnicht Naylor, and Antonio Pignatiello. 2020. Smartphones, social media use and youth mental health. *Canadian Medical Association Journal* 192, 6 (Feb. 2020), E136–E141. https://doi.org/10.1503/cmaj.190434

[2] Jorge Alvarez-Lozano, Venet Osmani, Oscar Mayora, Mads Frost, Jakob Bardram, Maria Faurholt-Jepsen, and Lars Vedel Kessing. 2014. Tell me your apps and I will tell you your mood: Correlation of apps usage with bipolar disorder state. In *Proceedings of the 7th International Conference on PErvasive Technologies Related to Assistive Environments (PETRA '14)*. ACM Press, New York, NY, USA, Article 19, 7 pages. https://doi.org/10.1145/2674396.2674408

[3] Nazanin Andalibi, Pinar Ozturk, and Andrea Forte. 2017. Sensitive self-disclosures, responses, and social support on Instagram: The case of #depression. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. ACM Press, New York, NY, USA, 1485–1500. https://doi.org/10.1145/2998181.2998243

[4] American Psychiatric Association. 2002. Practice guideline for the treatment of patients with bipolar disorder (revision). *Supplement to the American Journal of Psychiatry* 159, 4 (April 2002), 1–50. https://psychiatryonline.org/pb/assets/raw/sitewide/practice_guidelines/guidelines/bipolar.pdf

[5] Shrey Bagroy, Ponnurangam Kumaraguru, and Munmun De Choudhury. 2017. A social media based index of mental well-being in college campuses. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM Press, New York, NY, USA, 1634–1646. https://doi.org/10.1145/3025453.3025909

[6] Uttam Bajwa, Denise Gastaldo, Erica Di Ruggiero, and Lilian Knorr. 2018. The health of workers in the global gig economy. *Globalization and Health* 14, 1 (Dec. 2018), 1–4. https://doi.org/10.1186/s12992-018-0444-8

[7] Sairam Balani and Munmun De Choudhury. 2015. Detecting and characterizing mental health related self-disclosure in social media. In *Extended Abstracts of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI EA '15)*. ACM Press, New York, NY, USA, 1373–1378. https://doi.org/10.1145/2702613.2732733

[8] Ross J. Baldessarini and Leonardo Tondo. 2003. Suicide risk and treatments for patients with bipolar disorder. *Journal of the American Medical Association* 290, 11 (Sept. 2003), 1517–1519. https://doi.org/10.1001/jama.290.11.1517

[9] Jakob E. Bardram, Mads Frost, Károly Szántó, Maria Faurholt-Jepsen, Maj Vinberg, and Lars Vedel Kessing. 2013. Designing mobile health technology for bipolar disorder: A field trial of the MONARCA system. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*. ACM Press, New York, NY, USA, 2627–2636. https://doi.org/10.1145/2470654.2481364

[10] Jakob E. Bardram, Mads Frost, Károly Szántó, and Gabriela Marcu. 2012. The MONARCA self-assessment system: A persuasive personal monitoring system for bipolar patients. In *Proceedings of the 2nd ACM SIGHIT International Health Informatics Symposium (IHI '12)*. ACM Press, New York, NY, USA, 21–30. https://doi.org/10.1145/2110363.2110370

[11] Pamela Baxter and Susan Jack. 2015. Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report* 13, 4 (Jan. 2015), 544–559. https://doi.org/10.46743/2160-3715/2008.1573

[12] Courtney Beard, Alexandra L. Silverman, Marie Forgeard, M. Taylor Wilmer, John Torous, and Thröstur Björgvinsson. 2019. Smartphone, social media, and mental health app use in an acute transdiagnostic psychiatric sample. *JMIR mHealth and uHealth* 7, 6, Article e13364 (June 2019), 12 pages. https://doi.org/10.2196/13364

[13] R. H. Belmaker. 2004. Bipolar disorder. *New England Journal of Medicine* 351, 5 (July 2004), 476–486. https://doi.org/10.1056/NEJMra035354

[14] Chloe Berryman, Christopher J. Ferguson, and Charles Negy. 2018. Social media use and mental health among young adults. *Psychiatric Quarterly* 89, 2 (June 2018), 307–314. https://doi.org/10.1007/s11126-017-9535-6

[15] Julia Brailovskaia and Jürgen Margraf. 2016. Comparing Facebook users and Facebook non-users: Relationship between personality traits and mental health variables–an exploratory study. *PloS one* 11, 12, Article e0166999 (Dec. 2016), 17 pages. https://doi.org/10.1371/journal.pone.0166999

[16] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2 (Jan. 2006), 77–101. https://doi.org/10.1191/1478088706qp063oa

[17] Jane E. Brody. 2021. The challenges of bipolar disorder in young people. *The New York Times* (5 July 2021). https://www.nytimes.com/2021/07/05/well/mind/bipolar-disorder-young-people.html

[18] Eleanor R. Burgess, Alice Renwen Zhang, Sindhu Kiranmai Ernala, Jessica L. Feuston, Munmun De Choudhury, Mary Czerwinski, Adrian Aguilera, Stephen Schueller, and Madhu C. Reddy. 2021. Technology ecosystems: Rethinking resources for mental health. *Interactions* 28, 1 (Jan.–Feb. 2021), 66–71. https://doi.org/10.1145/3434564

[19] Eleanor R. Burgess, Alice Renwen Zhang, Jessica L. Feuston, Madhu C. Reddy, Sindhu Kiranmai Ernala, Munmun De Choudhury, Stephen Schueller, Adrian Aguilera, and Mary Czerwinski. 2020. Technology ecosystems: Rethinking resources for mental health. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (CHI EA '20)*. ACM Press, New York, NY, USA, 1–8. https://doi.org/10.1145/3334480.3375166

[20] Benedict Carey. 2007. Bipolar illness soars as a diagnosis for the young. *The New York Times* (4 September 2007). https://www.nytimes.com/2007/09/04/health/04psych.html

[21] Stevie Chancellor, Michael L. Birnbaum, Eric D. Caine, Vincent M. B. Silenzio, and Munmun De Choudhury. 2019. A taxonomy of ethical tensions in inferring mental health states from social media. In *Proceedings of the Conference on Fairness, Accountability, and Transparency (FAT* '19)*. ACM Press, New York, NY, USA, 79–88. https://doi.org/10.1145/3287560.3287587

[22] Yixin Chen and Yang Xu. 2021. Social support is contagious: Exploring the effect of social support in online mental health communities. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems (CHI EA '21)*. ACM Press, New York, NY, USA, Article 286, 6 pages. https://doi.org/10.1145/3411763.3451644

[23] Janghee Cho, Tian Xu, Abigail Zimmermann-Niefield, and Stephen Voida. 2022. Reflection in theory and reflection in practice: An exploration of the gaps in reflection support among personal informatics apps. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. ACM Press, New York, NY, USA, Article 142, 23 pages. https://doi.org/10.1145/3491102.3501991

[24] Saloni Dattani, Hannah Ritchie, and Max Roser. 2021. Mental health. *Our World in Data* (Aug. 2021). https://ourworldindata.org/mental-health

[25] Claudia Daudén Roquet, Nikki Theofanopoulou, Jaimie L. Freeman, Jessica Schleider, James J. Gross, Katie Davis, Ellen Townsend, and Petr Slovak. 2022. Exploring Situated & Embodied Support for Youth's Mental Health: Design Opportunities for Interactive Tangible Device. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. ACM Press, New York, NY, USA, Article 331, 16 pages. https://doi.org/10.1145/3491102.3502135

[26] Munmun De Choudhury and Sushovan De. 2014. Mental health discourse on reddit: Self-disclosure, social support, and anonymity. *Proceedings of the Eighth International AAAI Conference on Weblogs and Social Media* 8, 1 (2014), 71–80. https://doi.org/10.1609/icwsm.v8i1.14526

[27] Michael A. DeVito, Ashley Marie Walker, and Jeremy Birnholtz. 2018. 'Too gay for Facebook': Presenting LGBTQ+ identity throughout the personal social media ecosystem. *Proceedings of the ACM on Human-Computer Interaction* 2, CSCW, Article 44 (Nov. 2018), 23 pages. https://doi.org/10.1145/3274313

[28] Gavin Doherty, John Sharry, Magnus Bang, Mariano Alcañiz, and Rosa Baños. 2008. Technology in mental health. In *Extended Abstracts on Human Factors in Computing Systems (CHI EA '08)*. ACM Press, New York, NY, USA, 3965–3968. https://doi.org/10.1145/1358628.1358968

[29] Jordan Eschler, Eleanor R. Burgess, Madhu Reddy, and David C. Mohr. 2020. Emergent self-regulation practices in technology and social media use of individuals living with depression. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20)*. ACM Press, New York, NY, USA, 1–13. https://doi.org/10.1145/3313831.3376773

[30] Jordan Eschler, Zakariya Dehlawi, and Wanda Pratt. 2015. Self-characterized illness phase and information needs of participants in an online cancer forum. In *Proceedings of the International AAAI Conference on Web and Social Media (ICWSM '22, 1)*. AAAI Press, Washington, DC, USA, 101–109. https://doi.org/10.1609/icwsm.v9i1.14611

[31] Miriam Fernandez and Harith Alani. 2018. Online misinformation: Challenges and future directions. In *Companion of the 2018 World Wide Web Conference (WWW '18)*. ACM Press, New York, NY, USA, 595–602. https://doi.org/10.1145/3184558.3188730

[32] Casey Fiesler. 2019. Ethical considerations for research involving (speculative) public data. *Proceedings of the ACM on Human-Computer Interaction* 3, GROUP, Article 249 (Dec. 2019), 13 pages. https://doi.org/10.1145/3370271

[33] Casey Fiesler, Christopher Frauenberger, Michael Muller, Jessica Vitak, and Michael Zimmer. 2022. Research ethics in HCI: A SIGCHI community discussion. In *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems (CHI EA '22)*. ACM Press, New York, NY, USA, Article 169, 3 pages. https://doi.org/10.1145/3491101.3516400

[34] Jeana Frost, Sally Okun, Timothy Vaughan, James Heywood, and Paul Wicks. 2011. Patient-reported outcomes as a source of evidence in off-label prescribing: Analysis of data from PatientsLikeMe. *Journal of Medical Internet Research* 13, 1, Article e1643 (Jan.–Mar. 2011), 9 pages. https://doi.org/10.2196/jmir.1643

[35] Rachel L. Frost and Debra J. Rickwood. 2017. A systematic review of the mental health outcomes associated with Facebook use. *Computers in Human Behavior* 76 (Nov. 2017), 576–600. https://doi.org/10.1016/j.chb.2017.08.001

[36] Radhika Garg, Yash Kapadia, and Subhasree Sengupta. 2021. Using the lenses of emotion and support to understand unemployment discourse on Reddit. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW1, Article 14 (April 2021), 24 pages. https://doi.org/10.1145/3449088

[37] Robert P. Gauthier, Mary Jean Costello, and James R. Wallace. 2022. "I will not drink with you today": A topic-guided thematic analysis of addiction recovery on Reddit. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. ACM Press, New York, NY, USA, Article 20, 17 pages. https://doi.org/10.1145/3491102.3502076

[38] Paul Glavin and Scott Schieman. 2022. Dependency and hardship in the gig economy: The mental health consequences of platform work. *Socius* 8, Article 23780231221082414 (2022), 13 pages. https://doi.org/10.1177/23780231221082414

[39] Frederick K. Goodwin and Kay Redfield Jamison. 2007. *Manic-depressive illness: Bipolar disorders and recurrent depression* (2nd ed.). Oxford University Press, Oxford, UK.

[40] Iria Grande, Michael Berk, Boris Birmaher, and Eduard Vieta. 2016. Bipolar disorder. *The Lancet* 387, 10027 (2016), 1561–1572. https://doi.org/10.1016/S0140-6736(15)00241-X

[41] Shad Gross, Jeffrey Bardzell, Shaowen Bardzell, and Michael Stallings. 2017. Persuasive anxiety: Designing and deploying material and formal explorations of personal tracking devices. *Human–Computer Interaction* 32, 5–6 (Nov. 2017), 297–334. https://doi.org/10.1080/07370024.2017.1287570

[42] Sandra G. Harding (Ed.). 2004. *The feminist standpoint theory reader: Intellectual and political controversies*. Routledge, New York, NY, USA.

[43] Lamiece Hassan, Niels Peek, Karina Lovell, Andre F. Carvalho, Marco Solmi, Brendon Stubbs, and Joseph Firth. 2022. Disparities in COVID-19 infection, hospitalisation and death in people with schizophrenia, bipolar disorder, and major depressive disorder: a cohort study of the UK Biobank. *Molecular Psychiatry* 27, 2 (Feb. 2022), 1248–1255. https://doi.org/10.1038/s41380-021-01344-2

[44] Michael Jeffrey Daniel Hoefer, Bryce E Schumacher, Danielle Albers Szafir, and Stephen Voida. 2022. Visualizing uncertainty in multi-source mental health data. In *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems (CHI EA '22)*. ACM Press, New York, NY, USA, Article 397, 6 pages. https://doi.org/10.1145/3491101.3519844

[45] Jialun Aaron Jiang, Charles Kiene, Skyler Middler, Jed R. Brubaker, and Casey Fiesler. 2019. Moderation challenges in voice-based online communities on Discord. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW, Article 55 (Nov. 2019), 23 pages. https://doi.org/10.1145/3359157

[46] Ranjay Krishna, Donsuk Lee, Li Fei-Fei, and Michael S Bernstein. 2022. Socially situated artificial intelligence enables learning from human interaction. *Proceedings of the National Academy of Sciences* 119, 39, Article e2115730119 (2022), 8 pages. https://doi.org/10.1073/pnas.2115730119

[47] Emily G. Lattie, Rachel Kornfield, Kathryn E. Ringland, Renwen Zhang, Nathan Winquist, and Madhu Reddy. 2020. Designing mental health technologies that support the social ecosystem of college students. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. ACM Press, New York, NY, USA, Article 235, 15 pages. https://doi.org/10.1145/3313831.3376362

[48] Daniel Lee and H. Sebastian Seung. 2000. Algorithms for non-negative matrix factorization. In *Advances in Neural Information Processing Systems*, Vol. 13. MIT Press, Cambridge, MA, 556–562. https://proceedings.neurips.cc/paper/2000/hash/f9d1152547c0bde01830b7e8bd60024c-Abstract.html

[49] Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A stage-based model of personal informatics systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)*. ACM Press, New York, NY, USA, 557–566. https://doi.org/10.1145/1753326.1753409

[50] Mark Matthews, Elizabeth Murnane, and Jaime Snyder. 2017. Quantifying the changeable self: The role of self-tracking in coming to terms with and managing bipolar disorder. *Human–Computer Interaction* 32, 5-6 (Nov. 2017), 413–446. https://doi.org/10.1080/07370024.2017.1294983

[51] Mark Matthews, Elizabeth Murnane, Jaime Snyder, Shion Guha, Pamara Chang, Gavin Doherty, and Geri Gay. 2017. The double-edged sword: A mixed methods study of the interplay between bipolar disorder and technology use. *Computers in Human Behavior* 75 (Oct. 2017), 288–300. https://doi.org/10.1016/j.chb.2017.05.009

[52] Mark Matthews, Stephen Voida, Saeed Abdullah, Gavin Doherty, Tanzeem Choudhury, Sangha Im, and Geri Gay. 2015. In situ design for mental illness: Considering the pathology of bipolar disorder in mHealth design. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI '15)*. ACM Press, New York, NY, USA, 86–97. https://doi.org/10.1145/2785830.2785866

[53] David J. Miklowitz and Bowen Chung. 2016. Family-focused therapy for bipolar disorder: Reflections on 30 years of research. *Family Process* 55, 3 (Sept. 2016), 483–499. https://doi.org/10.1111/famp.12237

[54] Michael Muller, Shion Guha, Eric P.S. Baumer, David Mimno, and N. Sadat Shami. 2016. Machine learning and grounded theory method: Convergence, divergence, and combination. In *Proceedings of the 19th International Conference on Supporting Group Work (GROUP '16)*. ACM Press, New York, NY, USA, 3–8. https://doi.org/10.1145/2957276.2957280

[55] Bruno Müller-Oerlinghausen, Anne Berghöfer, and Michael Bauer. 2002. Bipolar disorder. *The Lancet* 359, 9302 (Jan. 2002), 241–247. https://doi.org/10.1016/S0140-6736(02)07450-0

[56] Elizabeth L. Murnane, Mark Matthews, and Geri Gay. 2016. Opportunities for technology in the self management of mental health. In *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct (MobileHCI '16)*. ACM Press, New York, NY, USA, 1093–1096. https://doi.org/10.1145/2957265.2965008

[57] Elizabeth L. Murnane, Jaime Snyder, Stephen Voida, Matthew J. Bietz, Mark Matthews, Sean Munson, and Laura R. Pina. 2018. Social issues in personal informatics: Design, data, and infrastructure. In *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '18)*. ACM Press, New York, NY, USA, 471–478. https://doi.org/10.1145/3272973.3273016

[58] J. A. Naslund, K. A. Aschbrenner, L. A. Marsch, and S. J. Bartels. 2016. The future of mental health care: Peer-to-peer support and social media. *Epidemiology and Psychiatric Sciences* 25, 2 (April 2016), 113–122. https://doi.org/10.1017/S2045796015001067

[59] John A. Naslund, Ameya Bondre, John Torous, and Kelly A. Aschbrenner. 2020. Social media and mental health: Benefits, risks, and opportunities for research and practice. *Journal of Technology in Behavioral Science* 5, 3 (Sept. 2020), 245–257. https://doi.org/10.1007/s41347-020-00134-x

[60] Mark W. Newman, Debra Lauterbach, Sean A. Munson, Paul Resnick, and Margaret E. Morris. 2011. "It's not that I don't have problems, I'm just not putting them on Facebook": Challenges and opportunities in using online social networks for health. In *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work (CSCW '11)*. ACM Press, New York, NY, USA, 341–350. https://doi.org/10.1145/1958824.1958876

[61] National Institute of Mental Health. 2022. Bipolar Disorder. Retrieved March 2, 2022 from https://www.nimh.nih.gov/health/topics/bipolar-disorder.

[62] Kathleen O'Leary, Arpita Bhattacharya, Sean A. Munson, Jacob O. Wobbrock, and Wanda Pratt. 2017. Design opportunities for mental health peer support technologies. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*. ACM Press, New York, NY, USA, 1470–1484. https://doi.org/10.1145/2998181.2998349

[63] National Alliance on Mental Illness. 2022. Mental health by the numbers. Retrieved March 2, 2022 from https://www.nami.org/mhstats.

[64] Michelle O'Reilly, Nisha Dogra, Natasha Whiteman, Jason Hughes, Seyda Eruyar, and Paul Reilly. 2018. Is social media bad for mental health and wellbeing? Exploring the perspectives of adolescents. *Clinical Child Psychology and Psychiatry* 23, 4 (Oct. 2018), 601–613. https://doi.org/10.1177/1359104518775154

[65] Sachin R. Pendse, Amit Sharma, Aditya Vashistha, Munmun De Choudhury, and Neha Kumar. 2021. "Can I not be suicidal on a Sunday?": Understanding technology-mediated pathways to mental health support. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. ACM Press, New York, NY, USA, Article 545, 16 pages. https://doi.org/10.1145/3411764.3445410

[66] Laura R. Pina, Sang-Wha Sien, Teresa Ward, Jason C. Yip, Sean A. Munson, James Fogarty, and Julie A. Kientz. 2017. From personal informatics to family informatics: Understanding family practices around health monitoring. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. ACM Press, New York, NY, USA, 2300–2315. https://doi.org/10.1145/2998181.2998362

[67] John Rooksby, Mattias Rost, Alistair Morrison, and Matthew Chalmers. 2014. Personal tracking as lived informatics. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM Press, New York, NY, USA, 1163–1172. https://doi.org/10.1145/2556288.2557039

[68] Emily Saltz, Claire R. Leibowicz, and Claire Wardle. 2021. Encounters with visual misinformation and labels across platforms: An interview and diary study to inform ecosystem approaches to misinformation interventions. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems (CHI EA '21)*. ACM Press, New York, NY, USA, Article 340, 6 pages. https://doi.org/10.1145/3411763.3451807

[69] C. Estelle Smith, Zachary Levonian, Haiwei Ma, Robert Giaquinto, Gemma Lein-Mcdonough, Zixuan Li, Susan O'Conner-Von, and Svetlana Yarosh. 2020. "I cannot do all of this alone": Exploring instrumental and prayer support in online health communities. *ACM Transactions on Computer-Human Interaction* 27, 5, Article 38 (Aug. 2020), 41 pages. https://doi.org/10.1145/3402855

[70] Stephen Voida, Mark Matthews, Saeed Abdullah, Mengxi (Chrissie) Xi, Matthew Green, Won Jun Jang, Donald Hu, John Weinrich, Prashama Patil, Mashfiqui Rabbi, Tauhidur Rahman, Geri Gay, Ellen Frank, and Tanzeem Choudhury. 2013. MoodRhythm: Tracking and supporting daily rhythms. In *Adjunct Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing (UbiComp '13 Adjunct)*. ACM Press, New York, NY, USA, 67–70. https://doi.org/10.1145/2494091.2494111

[71] White House Council of Economic Advisors. 2021. Reducing the economic burden of unmet mental health needs. Retrieved July 2, 2022 from https://www.whitehouse.gov/cea/written-materials/2022/05/31/reducing-the-economic-burden-of-unmet-mental-health-needs/.

[72] Naomi Yamashita, Hideaki Kuzuoka, Keiji Hirata, Takashi Kudo, Eiji Aramaki, and Kazuki Hattori. 2017. Changing moods: How manual tracking by family caregivers improves caring and family communication. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM Press, New York, NY, USA, 158–169. https://doi.org/10.1145/3025453.3025843

Received July 2022; revised January 2023; accepted March 2023