

UC Irvine

UC Irvine Previously Published Works

Title

Mobile apps for mood tracking: an analysis of features and user reviews.

Permalink

<https://escholarship.org/uc/item/57z7f4c2>

Journal

Proceedings / AMIA ... Annual Symposium. AMIA Symposium, 2017

Authors

Caldeira, Clara

Chen, Yu

Chan, Lesley

et al.

Publication Date

2017

Peer reviewed

Mobile apps for mood tracking: an analysis of features and user reviews

Clara Caldeira, BS¹, Yu Chen, PhD¹, Lesley Chan, BS¹, Vivian Pham, BS¹, Yunan Chen, PhD¹, Kai Zheng, PhD¹

¹University of California, Irvine, Irvine, CA, USA

Abstract

Many mood tracking apps are available on smartphone app stores, but little is known about their features and their users' experiences. To investigate commercially available mood tracking apps, we conducted an in-depth feature analysis of 32 apps, and performed a qualitative analysis of a set of user reviews. Informed by a widely adopted personal informatics framework, we conducted a feature analysis to investigate how these apps support four stages of self-tracking: preparation, collection, reflection, and action; and found that mood tracking apps offer many features for the collection and reflection stages, but lack adequate support for the preparation and action stages. Through the qualitative analysis of user reviews, we found that users utilize mood tracking to learn about their mood patterns, improve their mood, and self-manage their mental illnesses. In this paper, we present our findings and discuss implications for mobile apps designed to enhance emotional wellness.

Introduction

The World Health Organization (WHO) has defined mental health as “a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community¹.” Mental disorders such as stress and depression can be burdensome and disruptive, and also increase the risk of becoming ill from other diseases such as cardiovascular disease and diabetes². Despite the importance of mental well-being, initiatives to increase mental health awareness and services have been hindered by the absence of mental health in public health agendas and the lack of integrating mental health with primary care³. Creating technology to support self-management of mental health may benefit consumers by empowering them to have a more active role over their own well-being, and making mental health resources more accessible. Along this line, both researchers and industry are increasing their efforts to develop technological solutions that enable individuals to manage their mental health. For example, Google has recently launched Verily, a healthcare lab that aims to digitalize mental health with the help of brain and behavioral sciences⁴.

Mood tracking has been investigated as an approach to help healthy individuals stay in healthy emotional states, and assist individuals with mental diseases, such as bipolar disorder and depression, in their health management⁵. Tracking health related data helps users to gain knowledge about their health, establish the correlation between the tracked data and their health conditions, and proactively engage in healthcare management¹¹. Self-tracking mood helps users increase their awareness and proactive self-regulation of their emotional well-being^{18,19}. The ubiquity of smartphones and their apps has enabled their use for a myriad of health purposes. According to a report from Statista, “health and lifestyle” is one of the most popular categories in smartphone apps⁶. Self-tracking is among the most common strategies used by health apps, including tracking preventative behavior such as exercise, as well as monitoring health indicators, such as blood pressure and mood. The latest versions of smartphones provide built-in self-tracking functions for health⁷.

Researchers have argued that many apps lack scientific- and clinical-based evidence in the feature design, and also lack evidence of consumers' empirical usage⁸. A few studies have investigated Android and iOS apps for specific health conditions, such as mental diseases⁹ and weight loss¹⁰. To the best of our knowledge, little research has investigated the features, consumers' experiences, and challenges of using mobile apps that are designed for **mood tracking**. Despite emerging sensing technologies and apps that could potentially detect users' emotions, since mood and emotions are subjective, the accuracy of such sensing technologies remain unclear¹⁵. Therefore, we investigate apps that allow users to *self-report* their mood, and we use self-tracking to refer to keeping track of mood via self-report.

Background

Emotional well-being is an essential part of mental health¹³. Positive mood can enhance cardiovascular, hormonal and immune functions, promote healthy behaviors such as better sleep and exercise¹⁴, and lead to more open-minded thinking and effective problem solving¹⁵. Self-tracking mood could facilitate gaining knowledge and awareness of one's mood patterns and thus help maintain emotional well-being. Researchers have employed various technologies to help individuals to record, analyze, and regulate mood^{16,17}. For example, MobiMood¹⁸ allows users to register their mood by selecting colors, and Aurora¹⁹ supports self-tracking by allowing users to select photos that best represent their mood. CopeSmart²⁰ users log their mood by selecting a corresponding value on a scale. Other mobile apps have elicited users' mood using emojis²¹. Besides self-tracking, apps such as Aurora¹⁹ and MobiMood¹⁸ also encourage users to share self-tracked mood data in their social networks to seek emotional support²². Study results suggest that users are willing to share their mood with their friends in social networks^{18,19}. In addition to designing self-tracking technologies for the general population, researchers have also investigated the use of mood tracking to help patients with mental diseases self-manage their conditions²³. For example, MoodZoom²⁴ helps participants with bipolar disorder to rate anxiety, elation, sadness, anger, irritability, and energy on a 7-point Likert scale. The above studies mainly investigate *one* particular app in research settings.

Since the use of mobile apps for promoting health has grown exponentially in recent years, researchers have started to systematically review apps to identify features, opportunities, and challenges for healthcare practices⁸. For example, Payne et al.²⁵ have conducted a review on the behavioral functionality of mobile apps in health interventions, and suggested that mobile apps are a feasible and acceptable means of health intervention. However, they have also called for more rigorous research and design guidelines for the functionalities and interfaces of apps available for smartphone. Other researchers have provided comprehensive analyses of the literature on mobile apps for specific health conditions, such as mental illnesses⁹ and weight loss¹⁰. These studies pointed out the limitations of evaluating mobile apps for health intervention within a limited number of participants using one specific app. Systematic reviews of health apps have identified a gap between the standards in scientific and clinical research, and the actual features in consumer products. For example, Nicholas et al.⁵ surveyed apps designed for bipolar disorder, and found that the available apps failed to provide essential information to help users assess their conditions, and argued that a new framework for mobile mental health research was essential to provide evidence-based health management. To the best of our knowledge, there has been no systematic review of mobile apps for mood tracking, how features of such apps align with healthcare research findings, and consumers' experiences with using such apps in their daily lives.

Methods

To investigate features of apps currently available for smartphones, and their users' experiences, we conducted a review on mood tracking apps, evaluated their features, and analyzed a set of consumer reviews.

App selection

In order to find a set of currently popular apps, a systematic search was conducted in the Android Play Store and the Apple App Store in January 2017. We searched for apps using the following keywords: (Mood OR emotions OR feelings OR affective OR happiness) AND (track OR log OR journal OR record OR diary). Apps were deemed eligible if they met all of the following criteria: 1) mood tracking is the main focus of the app, 2) mood is self-reported (not detected by sensors), 3) the app is in English, 4) it was last updated no earlier than 2014, and 5) it has at least 25 ratings. While consumers might provide ratings and reviews for an app, the number of ratings and reviews might differ, since users might rate an app (i.e., give it a score between 1 and 5 stars) without writing a review (i.e., a free text comment). We chose ratings as a measure of popularity because it was a comparable measure provided by both Android and iOS app stores. Criteria measuring popularity and recent updates were used to exclude apps of poor quality, which are not maintained or heavily used currently. The first two authors independently screened each app by reading its name and description, and examining any screenshots available in the app stores to decide on a set of apps for an in-depth feature and review analysis. Disagreement was dissolved through discussion.

App feature analysis

In this study, we conducted a feature analysis of mood tracking apps. For each app, two of the first four authors down-

loaded the app, extracted the main features, and then coded the features based on the stages of personal informatics tools each apps supports. To conduct the feature analysis, we used a set of key measurements based on the stage-based model of personal informatics systems¹¹ – systems that help users collect, reflect on, and gain knowledge on their personal data¹¹. We employed this model because it is a widely-adopted conceptual framework that can be used to evaluate self-tracking tools for each stage of the self-tracking process. The personal informatics model describes five stages: 1) the *Preparation* stage consists of planning that occurs before users start collecting personal data, 2) the *Collection* stage refers to when users record their data, 3) the *Integration* stage includes formatting and combining data, 4) the *Reflection* stage involves making sense of and learning from their personal data, and 5) the *Action* stage, when users act based on the insights gained through reflection. Self-tracking systems should be designed to support each stage¹¹. While there are more recent models of self-tracking practices (e.g., Epstein et al.¹²), we choose the original model for our analysis because it is more simple, and because the model by Epstein et al.¹² includes stages that do not need to be supported by self-tracking tools (e.g., deciding to track and selecting a tool).

App review analysis

In addition to reviewing system features, we analyzed reviews that users left in the app stores for the apps selected. Analyzing user reviews allows us to gain insights from the perspectives of the consumers of mood tracking apps. To do so, we downloaded all reviews from each app that were written prior to January 2017. We used two criteria to screen each review: 1) it is written in English, and 2) it is longer than 20 characters. Due to the large number of reviews, we randomly selected a subset of reviews for qualitative coding. Two independent coders read each app review and noted their themes. After reaching data saturation, we verified the remaining reviews to validate our results. Then, we used axial coding to extract themes present in the data²⁶. Because it is not possible to obtain background information on who wrote each review, we were not able to differentiate between users with different characteristics (e.g., different genders or ages).

Results

App selection

The initial search returned 249 hits on the Android Play Store and 493 on the iOS App Store. After screening and discussion between the first two authors, 32 apps were selected, including 19 Android apps and 13 iOS apps (Table 2). Most of the selected apps are designed for the general population. Only one application – eMoods Bipolar – focuses on a particular health condition. There are two explanations for this. First, apps focused on specific populations, such as those with mental illnesses, tend to place mood tracking as a secondary focus, with other functions such as medication management as the main emphasis. Since in this study we are interested in apps designed specifically for mood tracking, many apps that aim for specific mental health management were excluded. Second, mood tracking apps that focus on a particular population tend to have fewer users, which makes them less likely to have over 25 ratings than mood tracking apps for the general population. Thus, all but one of the apps included in our review are designed for a general population. For several of the apps, we included both Android and iOS versions (e.g., iMoodJournal). However, for five of them, one of the two versions did not meet the criterion of over 25 ratings, and thus they were not included in the analysis. These apps are marked with an * in Table 2.

App feature analysis

After iteratively coding features using the personal informatics stage model, we categorized the features into four stages in Table 1. For the Preparation stage, we included features that provide information to prepare users for tracking their moods, such as instructions, explanations, and other resources about the app itself or the type of mood tracking introduced in the app. The Collection stage consists of app features that support recording mood using different methods, and setting reminders for logging mood in the future. For the Reflection stage, the most common app feature is the data visualization function, which comes in various styles. Finally, the Action stage mainly includes 1) a recommendation feature in which an app provides any recommendations or resources for further actions based on the mood recorded by users, and 2) a sharing feature that allows users to share or export their mood data. We did not include the Integration stage in this analysis because all of the selected apps handled this process automatically.

We analyzed the features of each application, including their functionalities and user interfaces. In Table 2, we present

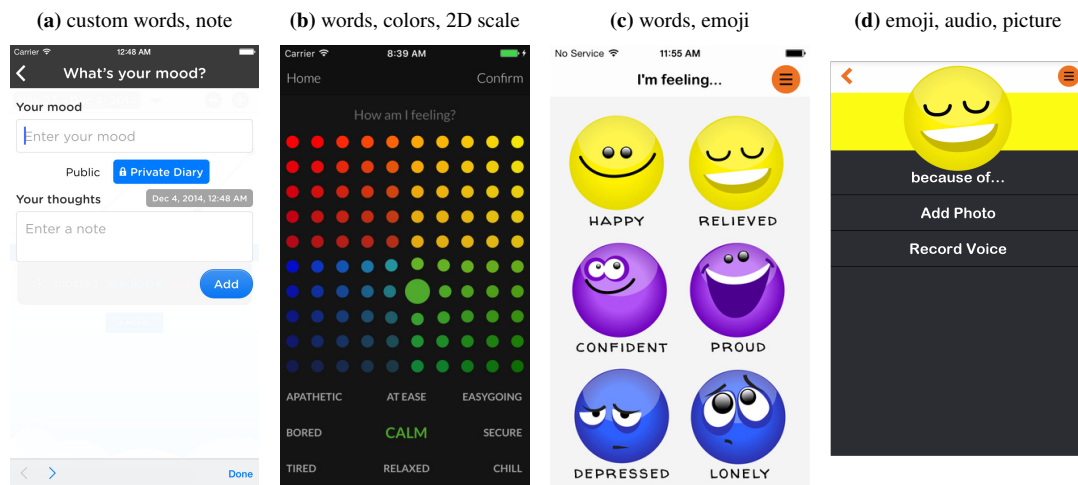
Table 1: App features mapped into stages of mood tracking based on the Personal Informatics model

Stage	Feature	Description
Preparation	instructions & explanation	information about how to conduct mood tracking
Collection	interface for collecting mood data	text, pictures, colors, emoticons, etc
	reminders	reminders for users to log mood
Reflection	visualizations	graphs, tables, lists
Action	recommendations	further actions based on data, e.g., how to improve mood
	sharing	features for users to share or export data

the features in each app that correspond to four stages of mood tracking: Preparation, Collection, Reflection, and Action.

For the Preparation Stage, we found that only a few ($N=8$) applications provided substantial information about how to track mood, or about how tracking mood can help manage and promote well-being. Other apps provided little or no such information. However, even for apps that do provide features for the Preparation stage, such information is often very limited, and usually only appears when users first launch the app. Often, this information is not shown again after the first time the app is launched.

For the Collection Stage, all apps allow users to record their mood. We have found a diverse set of tracking interfaces, including 1) pre-defined text, i.e., text provided by the app that the users can select, such as ‘optimistic’ or ‘tired’, 2) free text, i.e., text that users can type themselves, 3) colors, i.e., choosing a color to represent the current mood, 4) pictures, either taking a picture or choosing one on the app to illustrate the current mood, 5) recorded audio, 6) emojis, i.e., picking an emoji or similar image to represent the current mood, and 7) ratings, e.g., 21 apps allow users to select the intensity of a particular mood. For instance, MoodPanda users could rate their happiness on a scale from 0 to 10. A few apps also support users to add notes to their mood. Notes could include contextual information, or a more detailed description of the mood. As for reminders, about one third of the apps do not include features for reminding users to enter data. Figure 1 presents screenshots of apps with different tracking interfaces.

Figure 1: Example screenshots of the Collection stage illustrating mood collection interfaces

For the Reflection Stage, we found that most apps ($N = 29$) provide mood visualization, such as bar and pie graphs. Other visualization modalities include lists, line graphs, calendar view, map view, and mood meter. For instance, pie charts and meters can help users get an overall view of their moods; calendar view and line graphs can facilitate users to find patterns in time, and map view can assist learning association between mood and physical locations. Many apps provide visualization support in one or multiple modalities for reflection.

Table 2: Applications reviewed

	# reviews	information	words	custom words	notes	scale	color	audio	pictures	emoji	reminders	graphs or charts	calendar view	map view	recommendations	sharing features
Android																
Diary - Mood Tracker*	6857	✓	✓	✓	✓				✓	✓	✓	✓	✓			✓
Moodtrack Diary	921		✓	✓	✓	✓	✓					✓				✓
T2 Mood Tracker	710		✓	✓	✓	✓						✓				✓
eMoods Bipolar	444		✓	✓	✓	✓					✓	✓	✓			✓
iMoodJournal	419	✓	✓	✓	✓	✓			✓			✓	✓			✓
Mood Log	318	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓			✓
Moodlytics	295	✓	✓	✓	✓				✓	✓	✓	✓	✓			✓
iFeel Free*	215		✓	✓	✓			✓		✓				✓		✓
MoodDiary BETA	168		✓		✓	✓					✓	✓	✓			✓
MoodPanda	91				✓	✓					✓	✓	✓		✓	✓
Diary, mood tracker	40		✓	✓	✓					✓	✓	✓	✓			✓
Mood Tracker	37		✓		✓					✓		✓				
My Life My Voice	33	✓	✓		✓			✓	✓	✓	✓	✓			✓	
Mood Meter	22		✓		✓	✓	✓		✓	✓	✓					✓
Mood O Scope*	19		✓						✓	✓	✓	✓	✓	✓		
WINKIA EMO*	17		✓		✓	✓					✓	✓	✓			✓
Mood diary tracker	12			✓	✓					✓	✓	✓				
Schema Therapy	11		✓		✓	✓						✓				✓
Happy Meter	10				✓	✓			✓	✓			✓			✓
iOS																
iMoodJournal	1493			✓	✓	✓	✓		✓		✓	✓		✓		✓
Moodnotes	864		✓		✓	✓				✓	✓	✓			✓	✓
T2 Mood Tracker	169	✓	✓	✓	✓	✓					✓	✓				✓
Moody	102				✓	✓				✓	✓	✓				
Moodtrack Diary	101			✓	✓	✓					✓	✓				✓
MoodPanda	93				✓	✓						✓	✓		✓	✓
Moodlytics	62	✓	✓		✓				✓	✓	✓	✓	✓			✓
Happiness	59		✓		✓	✓					✓	✓				✓
Moods	43		✓	✓	✓	✓					✓	✓				✓
Mood Meter	41		✓			✓			✓		✓	✓			✓	
My Life My Voice	39		✓		✓		✓			✓	✓				✓	✓
Koko	33	✓	✓												✓	
Easy Mood Diary*	25		✓		✓	✓						✓				✓

For the Action Stage, only 7 of the 32 apps we analyzed provide features to support future actions, including recommendations for handling depression, contact information for a support hotline, strategies to avoid triggers, handle stress, and improve mood, and social features which help users look for support. Further, 25 apps have sharing features that allow users to send their mood data to their social networks for additional support, or to export the data in free text or spreadsheet format.

App review analysis

After the feature analysis, we investigated consumers' reviews of the mobile apps. In total, we obtained an initial data set of 13,736 reviews. After excluding reviews not written in English or shorter than 20 characters, 8,584 reviews remained. We then randomly selected 1,000 reviews for analysis. From the app reviews extracted from the app stores, our analysis revealed consumer experience in the following aspects: consumers' characteristics and goals in using the apps, their current app usage, and challenges they face. We summarize the findings in Table 3.

Table 3: Summary of main findings from consumer reviews

Perspectives	Aspects	Stage
Motivation	Find patterns in mood data	Reflection
	Learn about influencing factors	Collection
	For users with mental conditions to monitor symptoms	Reflection
	Make changes to improve mood based on insights	Action
Current usage	Log mood frequently	Collection, Reflection
	Add explanation to mood to facilitate reflection	Collection, Reflection
	Share data with healthcare providers	Action
Desired features	Features for specific mental illnesses	All stages
	Add contextual information	Collection, Reflection, Action
	Personalize mood input	Collection

Motivations of using mood tracking apps. Users reported that their goals for using mood tracking consist mainly of learning about their mood to find strategies to improve, cope with stress, and manage mental illnesses. For instance, users were often interested in finding patterns in their mood data to understand influencing factors, and those with mental illnesses utilized mood tracking to monitor their symptoms.

"This app is great for keeping me in check and knowing what things contribute to my emotional state. It also makes me stop and think about my day and how I've felt! Which is a great factor in being able to turn a bad day around. [...]" (Diary - Mood Tracker, Android).

"I adopted this app as a core component of my self-quantification and improvement effort. It has proven incredibly valuable in helping me analyze patterns and manage my approach to stress and increasing happiness." (Happiness, iOS).

By monitoring and learning about their own emotions, users reported feeling more in control of their mood, making informed decisions with the goal to become happier, and becoming more confident and positive in their emotional well-being.

Besides the general population, we found that users with mental illnesses also used mood tracking apps, even though the apps we selected were mainly designed for the general population. Users reported having a mental illness in approximately 10% of the analyzed reviews. The most common conditions mentioned in the app reviews were depression, bipolar disorder, and anxiety. In addition to the common mental illnesses, borderline personality disorder, obsessive compulsive disorder, attention-deficit/hyperactivity disorder, posttraumatic stress disorder, psychosis, and schizophrenia, were also cited as diseases that made users feel the need to track their mood.

"I have major depressive disorder and sometimes it is hard for me to keep track of how I feel one day to the next, especially when going to therapy. I actually heard about this app through some people on tumblr and I'm glad I tried it out. Wonderful app. [...]" (Diary - Mood Tracker, Android).

"As someone who suffers chronic physical and mental illnesses, this app is perfect to find trends in what is making me ill. [...]" (Diary - Mood Tracker, Android).

In the above review, users with mental illness also want to use mood monitoring apps because they might have other issues to track at the same time. In such cases, they might choose the app designed for the general population instead of those specifically designed for mental diseases.

Thus, user reviews indicate that the general population mainly uses the apps to learn about their mood patterns, better

manage their emotions, and make informed decisions to enhance their emotional well-being. Meanwhile, some users with mental illnesses also use the apps to monitor their mood. Some of them chose these apps instead of disease-specific apps for more flexibility and monitoring other chronic conditions together.

Current usage. We found that many users value the ability to register their mood frequently and add explanations to support reflection. Some users also share their mood data with therapists and psychiatrists. Most reviews that mentioned tracking frequency reported tracking daily, or multiple times per day. The reviews also showed that users appreciated the ability to present and share the visualized mood data with physicians, counselors, or therapists so they could monitor symptoms, or to support a possible diagnosis. A few reviews also mentioned that the app had been recommended to them by a healthcare provider. In a few cases, users with mental diseases tracked their mood alongside a family member, so both could monitor the occurrence of symptoms. These findings suggest that users collaborate with healthcare providers, caregivers, or relatives during the entire mood tracking process, or during the Reflection stage.

“[...] I have a mood disorder and the graphs make a great visual aid for sharing mood fluctuations with my doctor. [...]” (iMoodJournal, iOS).

“[...] [The app] was recommended by my therapist and I will recommend it to everyone I know. [...]” (iMoodJournal, iOS).

Based on the review, it seems that consumers could extend the logged mood data for individual usage to sharing with others. They reported leveraging mood tracking data to communicate with their healthcare providers, family members, and caregivers.

Desired features of mood tracking apps. In many reviews, users asked for additional features. The most commonly requested features were the capability to add personalized mood options, process logged data (e.g., order, search by mood/location/time), and update privacy settings (e.g., use a password to limit other people’s access to the data).

Also, while those who reported having a mental illness predominantly reported having positive experiences with the apps, they would often ask for specific features for their particular conditions. For instance, apps may assume that very positive emotions are desirable, but that might not be the case for people with bipolar disorder. For them, being too happy or optimistic might signify a manic episode. Users with mental illness also expected features such as tracking other symptoms or tracking medicine.

“[...] I’d hope to soon be able to sort my emotions by physical location. [...]” (Moodnotes, iOS).

From the consumer review above, it seems that users desire features that help them associate mood data with contextual information, such as location, to better manage their emotional well-being and their health conditions. For users who suffer from mental illnesses, sometimes they hope to have more options for mood and personalize the input.

“[...] The ability to leave notes is great and makes up a little for the lack of variety in mood choices. I also suffer from bipolar and add and find the mood choices way too simplistic when I can feel many different shades of very irritable, beyond happy into excitable and beyond that into a bit manic which might be the top end of the mood spectrum but is completely not nice. [...]” (iMoodJournal, iOS).

“[...] I suffer from a condition that makes me feel things rather intensely and only having five possible emotions to track seems lacking. However, you can add tons of activities and skills.” (Diary - Mood Tracker, Android)

Discussion

We found that mood tracking apps have many features supporting the Collection and Reflection stages of self-tracking, such as diverse forms of data collection and visualization. But the analysis revealed a lack of support for the Preparation and Action stages. Through analyzing app reviews, we found that users seek to learn about their mood patterns and improve them, and to manage emotional distress and mental illnesses. Many users pursue these goals by collecting data frequently, registering contextual information through notes, and sharing their data with healthcare providers. Still, they wish for additional features, such as the ability to personalize mood options, process their data for analysis, secure data to preserve privacy, and features specific for particular conditions.

Design app features to support Preparation, Collection, Reflection, and Action. While we found that most apps offer several different kinds of tracking options (Collection) and data visualization (Reflection), support for Action is mainly focused on sharing with social networks or exporting data. Most apps did not provide appropriate features for supporting the Preparation stage. The review analysis also indicates that apps could better support different types of users (i.e., the general population and users with mental conditions) and help them decide whether the mood tracking apps are well suited for them. Because being knowledgeable about self-tracking could help users achieve better results, it is likely that the lack of support for Preparation and Action of tracking constitutes a barrier to the effective use of mood tracking apps.

Our findings indicate that users' experiences and results could be improved by extending the support for the Preparation and Action stages of mood tracking. Providing users with more information about tracking could help them to better prepare by setting concrete goals, better plan their data collection, and gain more insights about their mood patterns. Presenting them with advice or guidelines about how to handle crises and effectively improve their overall emotional wellness based on their mood data could also improve outcomes by helping users to take appropriate action for their situation and goals. We did not observe a substantial number of requests for these features from the user reviews, which might partially explain why they are seldom present. But supporting the Preparation and Action stages better is likely to help users to become more knowledgeable about the benefits and limitations of self-tracking, and maximize how much they benefit from this practice.

Consider both the general population and users with mental conditions. The majority of the apps analyzed were designed for the general population. There is limited previous work on the benefits of mood tracking for those who do not have mental conditions, but our results show that there is substantial interest in mood tracking from the general public. Our study shows users desire to manage and improve their mood despite not having mental illnesses. Given the fast-paced and busy lifestyles in industrialized societies, mood management is an important area that could be further supported by technology. Our study points to the motivations, current preferred features and future desired features of mood tracking apps, and provides valuable insights for enhancing wellness interventions and features supporting self-knowledge and awareness.

While these popular mood tracking apps may not support the integrated needs of disease management, we found users with many different mental illnesses utilized these apps for their self-management. The diversity of conditions users reported illustrates that mood tracking could assist in the self-management of several mental illnesses. While a recent analysis of available health apps found that many conditions have few or no specific apps available²⁷, our results indicate that individuals with these conditions are utilizing apps designed for other populations. Since individuals with mental conditions might have particular needs, even those who have other options (i.e., disease-specific apps) may choose to use apps intended for the general public, due to preferring their design or features. In order to use non-disease specific apps, this population requires more flexible features to be able to track specific aspects related to their illness, such as symptoms related to manic episodes. For these users, receiving support for the Preparation and Action stages is crucial, since such support could help them to track their mood more efficiently and effectively, and to decide on how to act based on their symptoms. Based on this finding, we believe that mood tracking should be investigated as a strategy to support a wide range of mental illnesses through offering flexible and personalized mood tracking options. More effort towards investigating this population's needs and how effective mood tracking can be for individuals with each illness, could help with the development of more appropriate tools for supporting the health management needs of people with mental illnesses.

Support both individual reflection and data sharing. The app feature analysis suggests that most apps allow users to share their mood data with others. We found from consumer reviews that users share their mood data with their physicians, therapists, and counselors. Users who share the reviews with healthcare professionals are likely to be suffering from mental conditions or mental distress. Sharing mood tracking data with healthcare professionals indicates that these apps are being used not only for self-management, but also for communicating symptoms and collaborating with healthcare providers. The apps provide ways to export data and thus make it easier to share. Similar to other kinds of patient-generated data²⁸, it is likely that the kind of data visualization that is appropriate for patients might not be preferred by healthcare providers. Thus, more research is needed to investigate mood tracking apps that can facilitate data sharing between patients and healthcare providers. Further, it is important to investigate how to support

sharing data with family members, caregivers, and friends, while protecting users' sensitive information. Since family members, caregivers, and healthcare providers might have different motivations and information needs, it might be worthwhile to consider different options in different kinds of data and visualization for shared data.

Implications for clinical practice. The outcomes of this study indicate that mood tracking tools are being used by many people, including people who have mental illnesses. Our data indicate that apps should improve their support of preparation and action activities, but they also can offer benefits to users by helping them to increase awareness of their mood patterns. Health care providers may assist patients in choosing adequate mood tracking apps and using them effectively, if they are informed about which options would match patients' needs. Providing patients with information on mood tracking could compensate for the limited support for preparation and action activities from the apps.

Analyzing app reviews can reveal valuable insights about real users' experience, but there are associated limitations. First, since not every user is expected to write reviews, there might be selection bias of the user opinions we can access. Similarly, we are not able to estimate the distribution of user groups, e.g., the general population and those with mental conditions. Since not every user who wrote reviews choose to disclose their mental conditions, we cannot assume that they do not suffer from any conditions if illnesses are not mentioned in the reviews. Additionally, even though we assume that the reviews could reflect consumers' real experiences, it is difficult to determine how long they have used the app and whether they have abandoned the app.

Conclusion

A qualitative analysis on consumers' reviews of mood tracking apps showed that both the general population and consumers with mental conditions used the apps. The general population mainly used the apps to learn about their mood patterns and cope with stress, while users with various mental conditions also used the apps to monitor their symptoms. They not only tracked the data for themselves, but also used the data to communicate with their healthcare providers and share with family members.

Acknowledgements

We thank CAPES and the NSF (Grant No. 1219197) for providing funding for this work. Thanks to Brittney Katayama, Christopher Le, Fadumo Ali, Jimmy Chun-Yi, Julie Oh, Oksana Lubyana, Xiaoyu Wen, Mary Angeline Ferrer, Ngoc Tran Le, Sean Lee, Tiffany Lee, Carmela Monis, Micah Nacpil, and Kelly Pham for their contributions.

References

1. World Health Organization. Mental Health: a State of Well-being [Internet]. World Health Organization [cited 9 March 2017]. Available from: http://www.who.int/features/factfiles/mental_health/en/.
2. National Institute of Mental Health. Chronic Illness and Mental Health [Internet]. National Institute of Mental Health [cited 9 March 2017]. Available from: <http://www.nimh.nih.gov/health/publications/chronic-illness-mental-health-2015/index.shtml>.
3. World Health Organization. 10 Facts on Mental health [Internet]. World Health Organization [cited 9 March 2017]. Available from: http://www.who.int/features/factfiles/mental_health/mental_health_facts/en/index8.html.
4. National Institute of Mental Health. Dr. Tom Insel to Step Down as NIMH Director [Internet]. National Institute of Mental Health [cited 9 March 2017]. Available from: <http://www.nimh.nih.gov/about/dr-tom-insel-to-step-down-as-nimh-director.shtml>.
5. Nicholas J, Larsen ME, Proudfoot J, Christensen H. Mobile apps for bipolar disorder: a systematic review of features and content quality. *Journal of medical Internet research*. 2015;17(8):e198.
6. Statista. Market reach of the most popular Android app categories worldwide as of March 2016 [Internet]. Statista [cited 9 March 2017]. Available from: <http://www.statista.com/statistics/200855/favourite-smartphone-app-categories-by-share-of-smartphone-users/>.
7. Apple. 2017. IOS 9 Health Apple [Internet]. Apple [cited 9 March 2017]. Available from: <http://www.apple.com/ios/health/>.

8. Stoyanov SR, Hides L, Kavanagh DJ, Zelenko O, Tjondronegoro D, Mani M. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. *JMIR mHealth and uHealth*. 2015;3(1):e27.
9. Donker T, Petrie K, Proudfoot J, Clarke J, Birch MR, Christensen H. Smartphones for smarter delivery of mental health programs: a systematic review. *Journal of medical Internet research*. 2013;15(11):e247.
10. Mateo GF, Granado-Font E, Ferr-Grau C, Montaa-Carreras X. Mobile phone apps to promote weight loss and increase physical activity: a systematic review and meta-analysis. *Journal of medical Internet research*. 2015;17(11):e253.
11. Li I, Dey A, Forlizzi J. A stage-based model of personal informatics systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems 2010 Apr 10* (pp. 557-566). ACM.
12. Epstein, D. A., Ping, A., Fogarty, J., Munson, S. A. (2015, September). A lived informatics model of personal informatics. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 731-742). ACM.
13. Ryff CD, Keyes CL. The structure of psychological well-being revisited. *Journal of personality and social psychology*. 1995 Oct;69(4):719.
14. Seligman ME. *Authentic happiness: Using the new positive psychology to realize your potential for lasting fulfillment*. Simon and Schuster; 2004.
15. Calvo RA, Peters D. *Positive computing: technology for wellbeing and human potential*. MIT Press; 2014 Nov 28.
16. Calvo RA, D'Mello S. Affect detection: An interdisciplinary review of models, methods, and their applications. *IEEE Transactions on affective computing*. 2010 Jan;1(1):18-37.
17. Kanjo E, Al-Husain L, Chamberlain A. Emotions in context: examining pervasive affective sensing systems, applications, and analyses. *Personal and Ubiquitous Computing*. 2015 Oct 1;19(7):1197-212.
18. Church K, Hoggan E, Oliver N. A study of mobile mood awareness and communication through MobiMood. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries 2010 Oct 16* (pp. 128-137). ACM.
19. Gay G, Pollak JP, Adams P, Leonard JP. Pilot study of Aurora, a social, mobile-phone-based emotion sharing and recording system.
20. Kenny R, Dooley B, Fitzgerald A. Feasibility of CopeSmart: a telemental health app for adolescents. *JMIR mental health*. 2015;2(3):e22.
21. Matthews M, Doherty G, Sharry J, Fitzpatrick C. Mobile phone mood charting for adolescents. *British Journal of Guidance Counselling*. 2008 May 1;36(2):113-29.
22. Coyle D, Linehan C, Tang K, Lindley S. Interaction design and emotional wellbeing. In *CHI'12 Extended Abstracts on Human Factors in Computing Systems 2012 May 5* (pp. 2775-2778). ACM.
23. Ortiz A, Grof P. Electronic monitoring of self-reported mood: the return of the subjective?. *International Journal of Bipolar Disorders*. 2016 Dec 1;4(1):28.
24. Tsanas A, Saunders KE, Bilderbeck AC, Palmius N, Osipov M, Clifford GD et al. Daily longitudinal self-monitoring of mood variability in bipolar disorder and borderline personality disorder. *Journal of Affective Disorders*. 2016 Nov 15;205:225-33.
25. Payne HE, Lister C, West JH, Bernhardt JM. Behavioral functionality of mobile apps in health interventions: a systematic review of the literature. *JMIR mHealth and uHealth*. 2015;3(1):e20.
26. Corbin J, Strauss A. *Basics of qualitative research* 3e.
27. Singh K, Drouin K, Newmark LP, Lee J, Faxvaag A, Rozenblum R et al. Many Mobile Health Apps Target High-Need, High-Cost Populations, But Gaps Remain. *Health Affairs*. 2016 Dec 1;35(12):2310-8.
28. Berry AB, Lim C, Hirsch T, Hartzler AL, Wagner EH, Ludman E et al. Getting Traction When Overwhelmed: Implications for Supporting Patient-Provider Communication. In *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing 2017 Feb 25* (pp. 143-146). ACM.