# Developing a Smart Phone App to Monitor Mood, Social Rhythms, Sleep and Social Activity: Technology to Support Effective Management of Bipolar Disorder

Ellen Frank[1], Mark Matthews[2,3], Tanzeem Choudhury[2], Stephen Voida[2], Saeed Abdullah[2]

[1] University of Pittsburgh, [2] Cornell University, [3] Trinity College Dublin
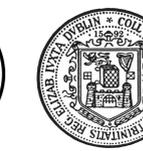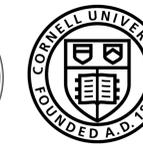
Abstract

Serious mental illnesses, including bipolar disorders (BD), account for a large share of the worldwide healthcare burden—estimated at $62.7B in the U.S. alone. Bipolar disorders represent a family of common, lifelong illnesses associated with poor functional and clinical outcomes, high suicide rates, and huge societal costs. Interpersonal and Social Rhythm Therapy (IPSRT), a validated treatment for BD, helps patients lead lives characterized by greater stability of daily rhythms, using a 5-item paper-and-pencil self-monitoring instrument called the Social Rhythm Metric (SRM). IPSRT has been shown to improve patient outcomes; however, maintaining adherence to self-monitoring remains a major challenge in implementing the treatment. As part of the MoodRhythm development program, we sought to create a system combining smartphone-based self-report with robust, privacy sensitive automated sensing to help patients maintain stable social rhythms and moods. Specifically, in the development of the MoodRhythm app we aimed to: (1) design interaction techniques that help patients to assess and reflect on trends or changes in their daily rhythms, social interactions, and mood and motivate them to incorporate the system into their self-care; (2) remind patients to engage with the system on a daily basis; (3) augment the data traditionally collected through patient journaling; (4) reduce the burden of self-report while dramatically enhancing the validity of the data collected; and (5) explore mechanisms for connecting smartphone data with other health data systems as part of ongoing treatment and a means for alerting clinicians when significant changes in a patient's mood or behavior are detected. Our current prototype for MoodRhythm is able to use the phone's onboard sensors to automatically track sleep and social activity patterns. It also facilitates patient self-report of the 5 SRM items, as well as the creation of individually-tailored patient-specific items and provides reminders to complete them. Initial feedback from experienced IPSRT clinicians and from a small cohort of patients with whom MoodRhythm has been tested has been uniformly positive.

IPSRT & The Social Rhythm Metric

Interpersonal and Social Rhythm Therapy (IPSRT), developed by Ellen Frank, Ph.D., is a highly specific behavioral intervention designed to regulate daily routines which, in turn, is hypothesized to entrain underlying circadian rhythms. IPSRT targets activity patterns as well as sleep timing and duration, factors that are assumed to mediate treatment outcomes. The Social Rhythm Metric-5 (SRM) is a validated five-item self-report assessment measure of the regularity of daily routines. The SRM helps to record and quantify the regularity of social routines that has been used as a both a research and a therapeutic self-monitoring tool in evidence-based psychosocial interventions for affective illness.

Development Process

Clinicians and patients worked in a Participatory Design process with the research team to create, revise and finalize the initial implementation of the MoodRhythm system. Our goal in developing MoodRhythm was to use smartphones to provide a combination of active and passive methods to track daily rhythms, to relay this information to clinicians, and to provide feedback to patients to enable them to improve their moods by establishing more regular daily rhythms.

MoodRhythm App

MoodRhythm is a cross-platform mobile app, compatible with both Android and iOS, and a website. The app helps patients become more aware of their daily patterns and adhere to their therapeutic goals. MoodRhythm uses the onboard sensors on patients' phones to automatically and conveniently track sleep and social activity patterns. This work draws on several years of peer-reviewed algorithm design and empirical research with inference accuracies approaching 85%–90% with minimal intervention on the user's part [1,2]. The aim is to support

patients who find self-tracking challenging and to increase the quantity of this clinically valuable daily routine information. This approach is both cost effective and broadly applicable since it targets devices and sensors that patients already own.

Initial Results

To assess the impact of MoodRhythm, three patients and three clinicians used the system. They provided both iterative and summative feedback (see below).

Usability	The "nice, clean and easy-to-use interface...is inviting and says, "I can use this even if I am not a computer person." (Patient)
Feedback	"Getting the visual feedback when my day worked within the targeted times gave me more confidence that I could meet my doctor's expectations." (Patient) "The prompt feedback that patient's receive via the device (i.e. items turn green when a task is completed "on time") will be much more effective versus receiving the feedback only when they are with their therapist." (Clinician)
Convenient	"First and foremost, it was convenient, which meant that I remembered to note when activities actually occurred and how I felt (instead of trying to remember two days later)." (Patient) "It was right there for me with the rest of the utilities I use every day on the phone. I never had to look for it or a pen." (Patient) "It fits my needs nicely. It's always with me" (Patient)
Clinical Support	"I think that this app could be a significant contribution to the treatment of mental health conditions and specifically bipolar disorder due to the illness' proven sensitivity to life's rhythms." (Clinician) "I truly feel that having access to such info could greatly improve patient care."(Clinician)

In addition, three patients completed a usability measure based on a 1 ("Strongly Disagree") to 7 ("Strongly Agree") scale. Participants found the app easy to learn and use, attractive and trustworthy (see Table below).

Question	Mean	SD
The way MoodRhythm works overall is consistent	6.5	0.5
It is easy to learn to use MoodRhythm	6.4	0.8
	6.4	0.8
This app is attractive	5.2	2
I like using the interface of this app	6.2	1.3
Interacting with MoodRhythm requires a lot of mental effort	1.6	0.5
The characters on the screen were easy to read	6.4	0.8
I felt comfortable using the system	6.2	1
Overall, I am satisfied with how easy it is to use this app	6	1

Next Steps

MoodRhythm aims to make recording daily routine information easier for individuals with bipolar disorder and provide more clinically relevant information to the clinician. The next steps in the MoodRhythm development process include: (1) running participatory design workshops involving focus groups of members of local BD support groups, researchers, and clinicians to identify improvements to the prototype and articulate new scenarios of use; (2) creating long-term opportunities for patients and clinicians to serve as co-designers by supporting their use of robust system prototypes on their own devices, allowing us to elicit feedback on an ongoing basis; and (3) formally evaluating the system's effectiveness against existing interventions using the paper-based IPSRT instrument (SRM-5).

By empowering patients to more easily monitor social rhythms and interpersonal interactions and giving them tools to motivate long-term adherence and encourage self-reflection on emerging mood and social rhythm trends, MoodRhythm could substantially lower the public health impact of bipolar disorders. Finally, given the fact that circadian regulation is important in a range of disorders including cancer, diabetes and obesity, MoodRhythm has broad potential for improvement of public health.

References

1. Lane, N.D., et al. BeWell: A smartphone application to monitor, model and promote wellbeing. in 5th International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth2011). 2011.

2. Wyatt, D., T. Choudhury, J. Bilmes, and J.A. Kitts, Inferring co-location and conversation networks from privacy-sensitive audio with implications for computational social science. ACM Transactions on Intelligent Systems and Technology (TIST), 2011.2(1):p.7.