Opportunities for Technology in the Self-Management of Mental Health

INTERACTION DESIGN LAB
CORNELL UNIVERSITY

Mental Health Conditions: Devastating & Prevalent

- Debilitating and life-threatening outcomes
- $300 billion per year
- 450 million people (6% of world's population)
- 4 of 6 leading causes of YLDs

What is Bipolar Disorder?
("BD")

- One of 10 most debilitating illnesses worldwide
- Permanent neurological damage with each relapse
- Poor functional outcomes
- Very high suicide rates
- 60 million people; affects men and women equally
- Chronic — progressively worsens over a lifetime

Mood is Central

Normal

Bipolar I

Depressive period

- feeling empty, worried
- inactivity
- tired
- changes in sleeping, eating
- suicidal thoughts

Balanced period

Manic period

- very high mood
- irritability
- racing thoughts
- high risk behavior
- sleeping less

Tracking (to Maintain) Stable Daily Rhythms

SRM II–5

Directions:

- Write the ideal target time you would like to do these daily activities.
- Record the time you actually did the activity each day.
- Record the people involved in the activity: 0 = Alone; 1 = Others present; 2 = Others actively involved; 3 = Others very stimulating

Date (week of): Feb 18 – 24 2013

Activity	Target Time	Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday	
		Time	People	Time	People	Time	People	Time	People	Time	People	Time	People	Time	People
Out of bed	6:30am	8:00am	0	6:15am	0	8:00am	0	6:45am	0	7:00am	0	8:07am	0	7:00am	0
First contact with other person	8:40am	9:00am	2	8:00am	1	11:00am	2	8:30am	2	11:00am	2	1:00pm	1	2:30pm	3
Start work/school/ volunteer/family care	8:40am	10:00am	2	8:10am	2	11:40am	1	8:30am	2	11:40am	1	9:00am	0	7:00am	0
Dinner	5:00pm	6:00pm	0	7:00pm	0	5:40pm	0	5:30pm	0	5:30pm	0	5:30pm	0	6:00pm	0
To bed	12:00pm	2:10am	0	3:00am	0	12:30pm	0	2:00am	0	1:00am	0	1:45am	0	12:00pm	0
Rate MOOD each day from –5 to +5 –5 = very depressed +5 = very elated		+1		0		-1		+1		-1		-1		-2	

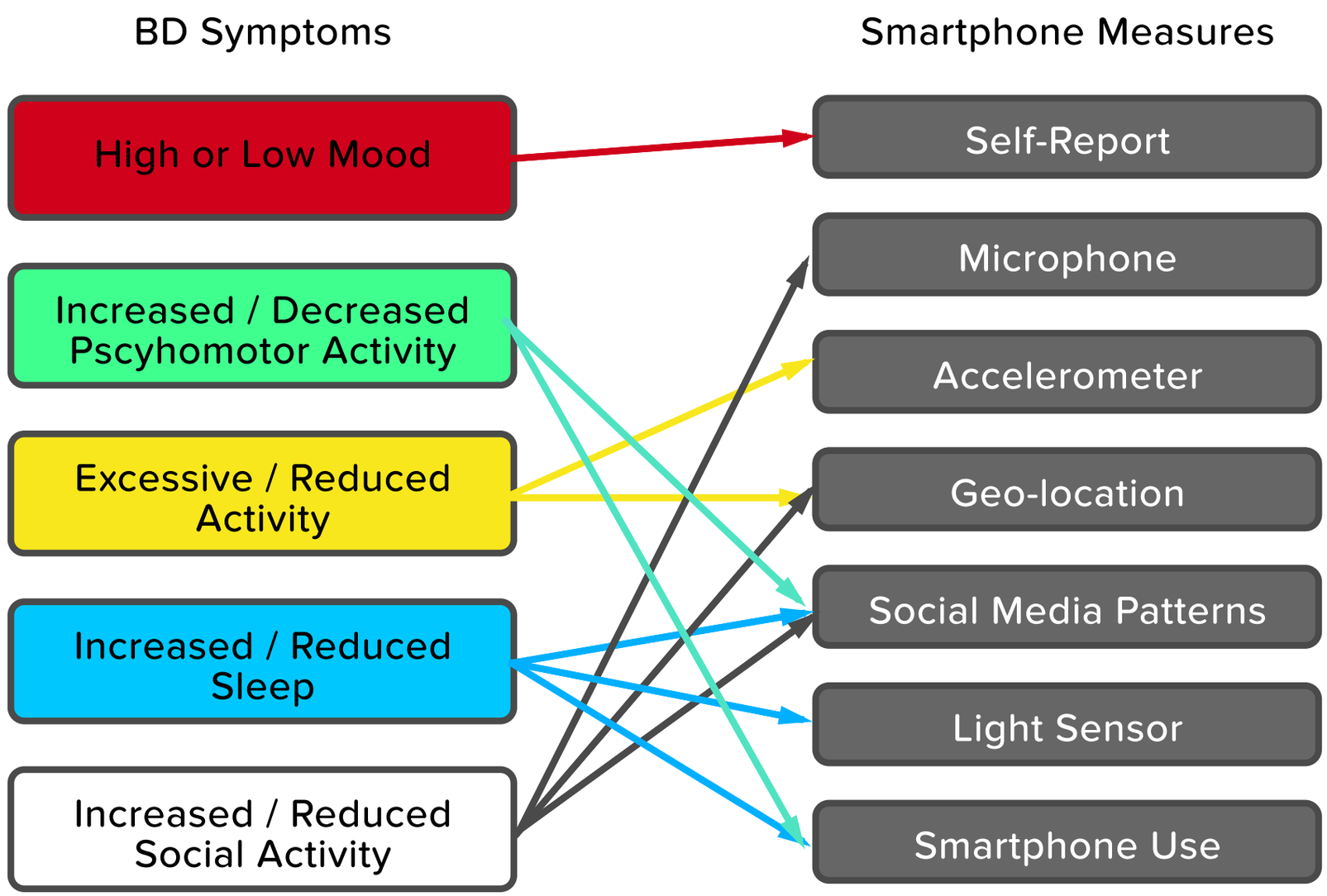
The social rhythm metric: An instrument to quantify the daily rhythms of life. Monk, T. H., Flaherty, J. F., Frank, E., Hoskinson, K., & Kupfer, D. J. (1990). Journal of Nervous and Mental Disease, 178, 120-126.

Challenges with the Paper-Based SRM

- Paper logs hinder identifying of patterns
- Unreliable retrospective recall
- Least likely to be completed when most valuable

Bipolar Disorder and Smartphone Monitoring: A Natural Match

- Individuals with BD have been early and sustained adopters of smartphone technology
- Smartphones can track (via self-report & sensing) clinically-relevant variables



MoodRhythm
Smartphone Application

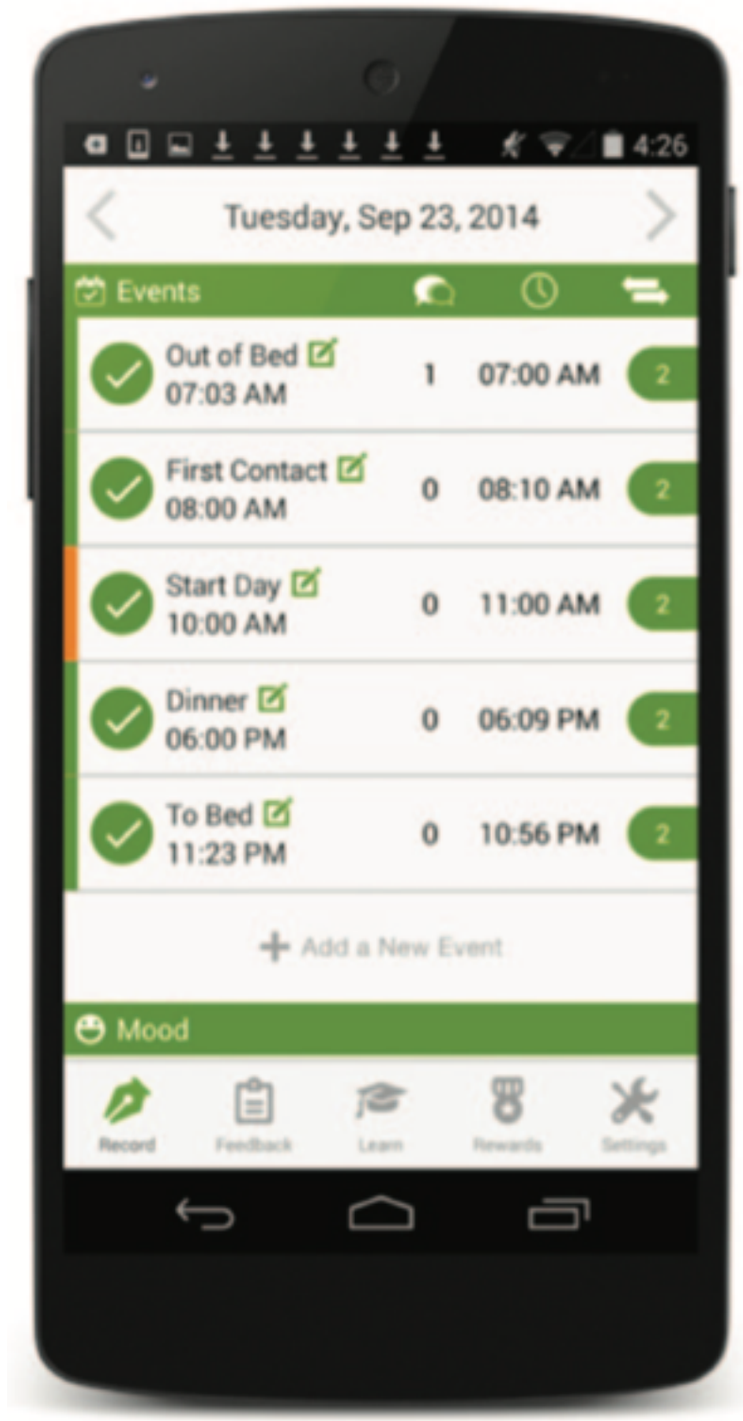
Development and Evaluation of a Smartphone-Based Measure of Social Rhythms for Bipolar Disorder.
Matthews, M., Abdullah, S., Murnane, E., Voida, S., Choudhury, T., Gay, G., & Frank, E. (2016). Journal of Assessment.

In situ design for mental illness: Considering the pathology of bipolar disorder in mHealth design.
Matthews, M., Voida, S., Abdullah, S., Doherty, G., Choudhury, T., Im, S., & Gay, G. (2015). In Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services (pp. 86-97). ACM.

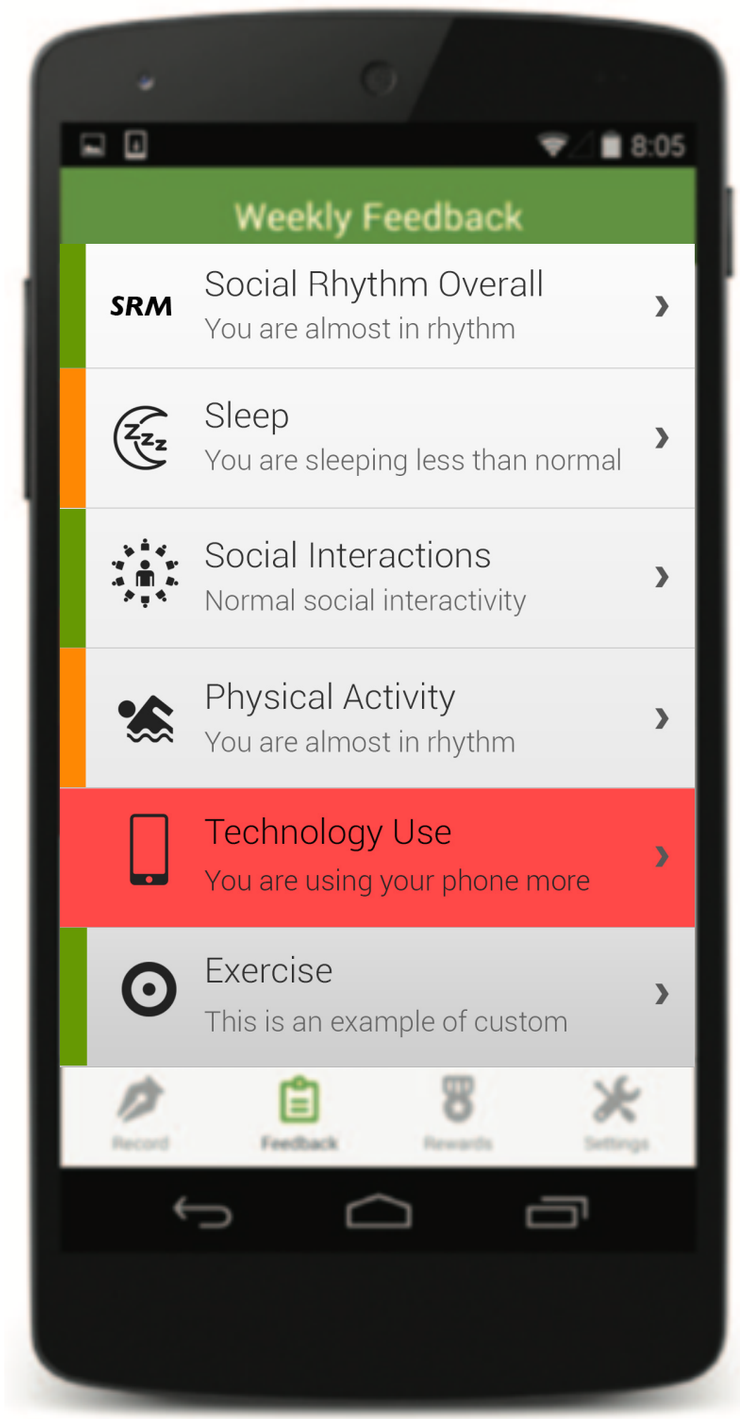
Participatory Design

- Individuals with BD
- Clinicians
- Professional psychological researchers

MoodRhythm's Self-Report Screen



MoodRhythm's Feedback Screen



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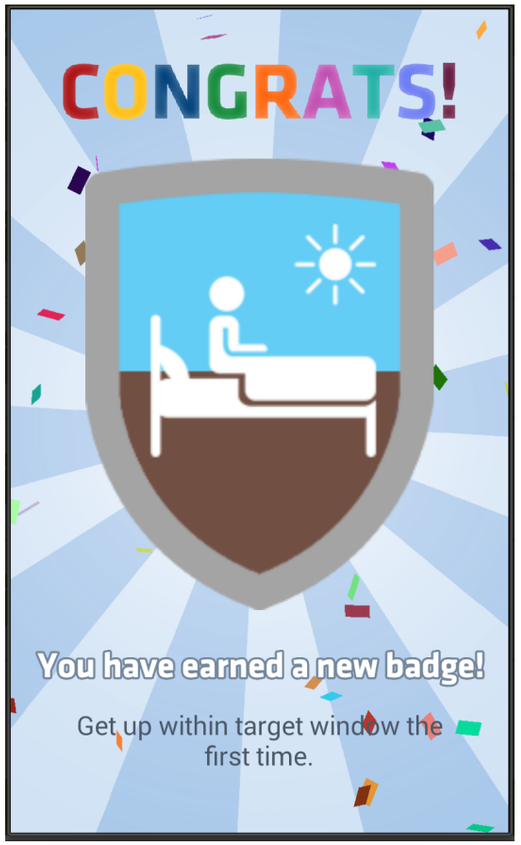
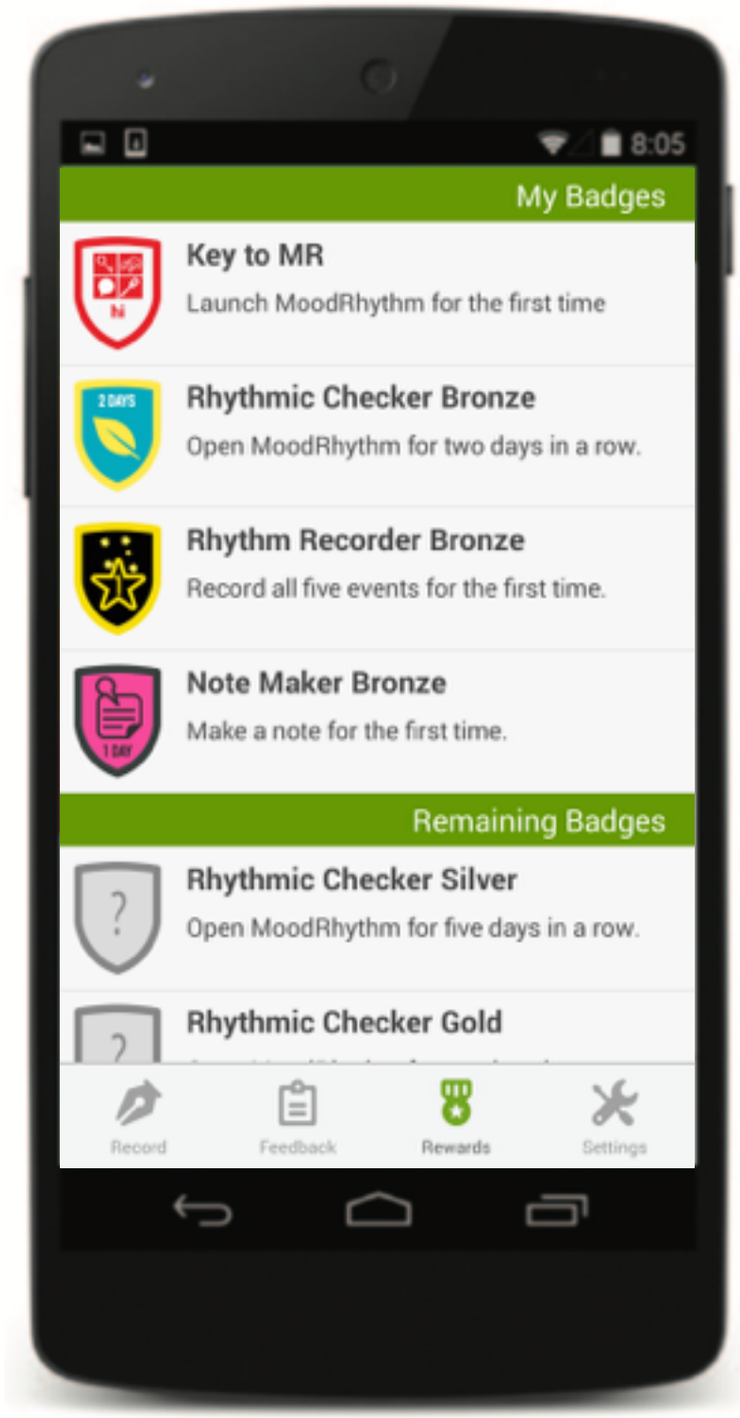




"I like the rewards"

"I think the badges are kind of cool"

"Yes, I LOVE badges"

"I got the badges. It gives me personal satisfaction that I have completed something. And, that's good. It keeps motivating."

…

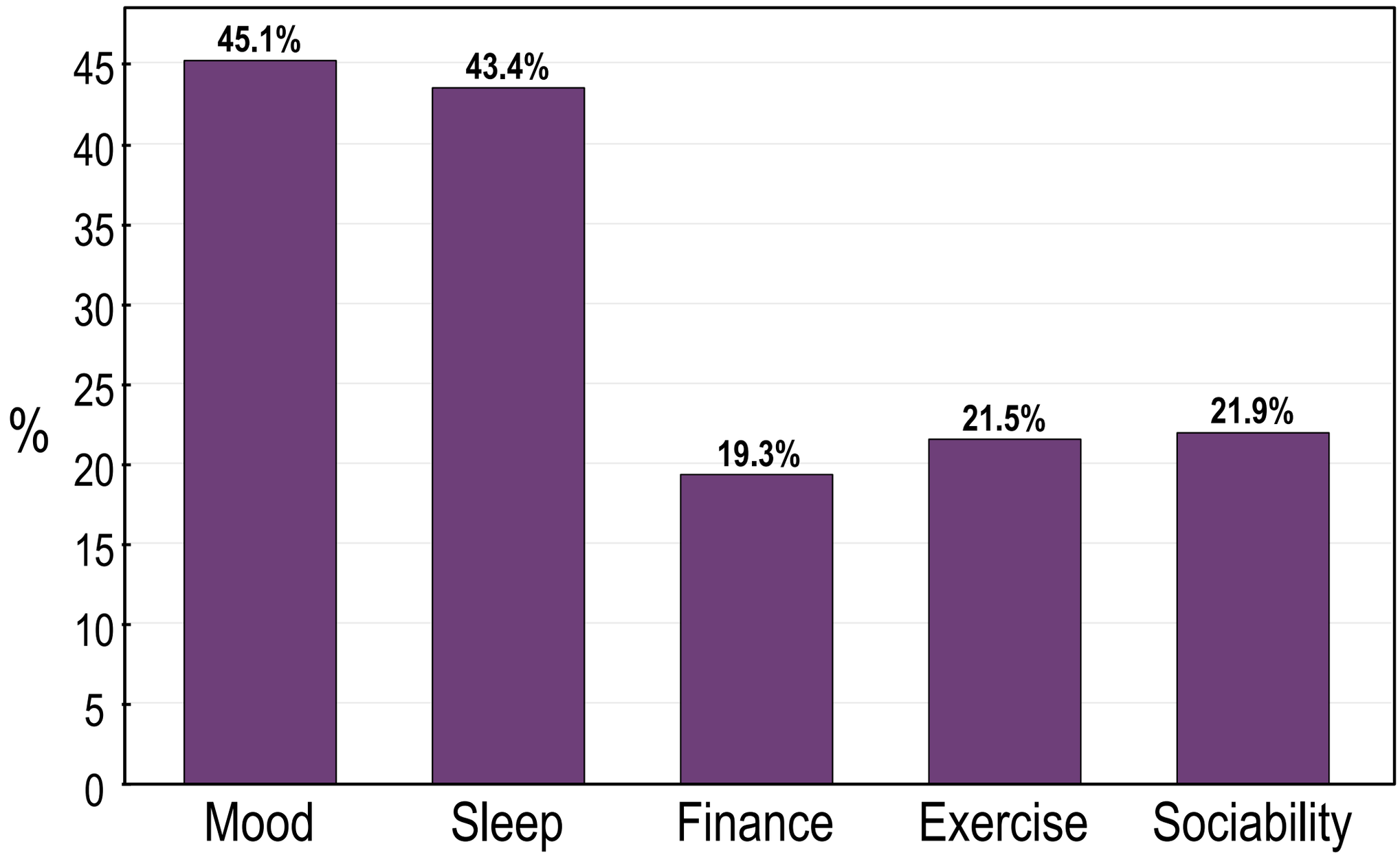
Informing Design from Extant Practices & Lived Experiences

- Indicators, tools, motives
- Perceived benefits & challenges
- (Un-met) needs

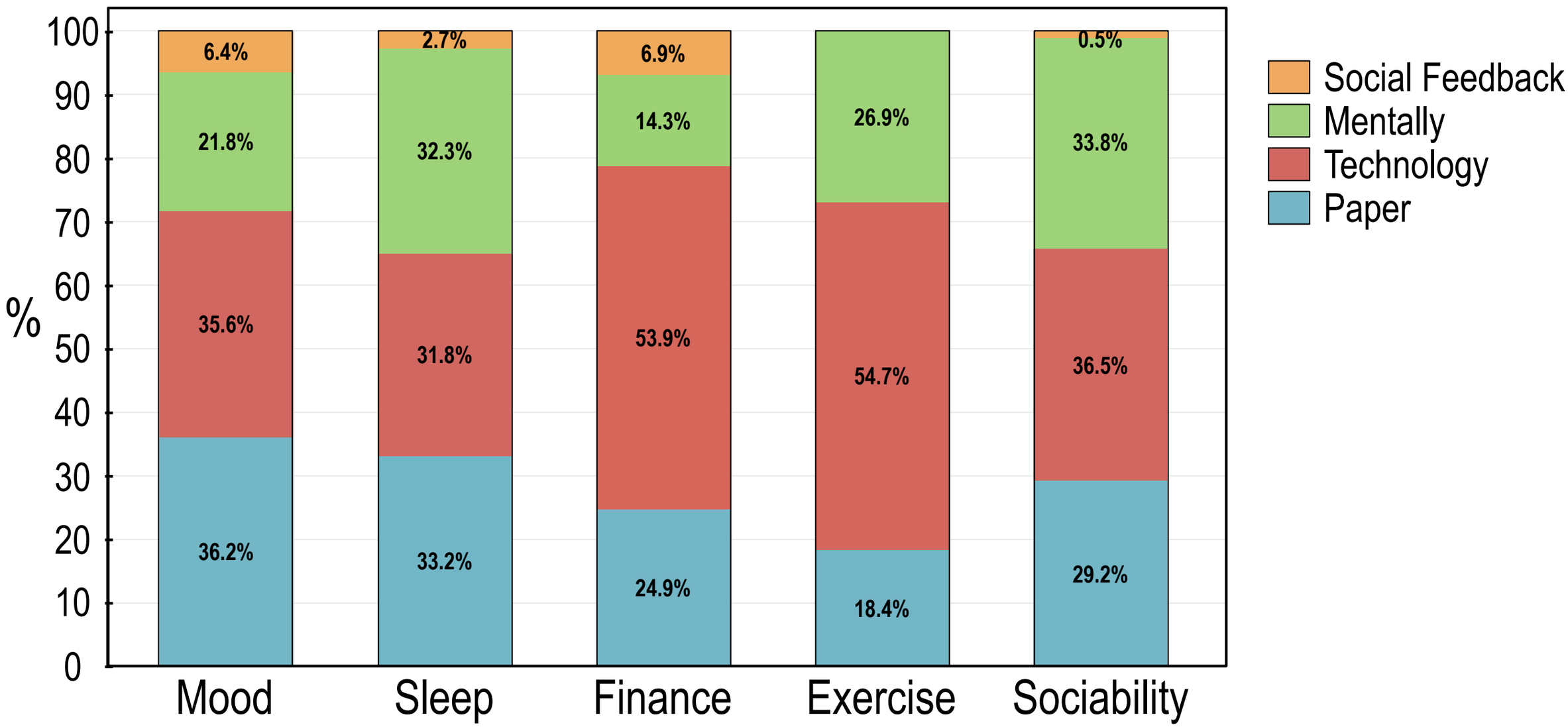
Self-Monitoring Practices, Attitudes, and Needs of Individuals with Bipolar Disorder: Implications for the Design of Technologies to Manage Mental Health*. Murnane, E. L. Cosley, D., Chang, P., Guha, S., Frank, E., Gay, G., & Matthews, M. (2016). Journal of the American Medical Informatics Association (JAMIA), 23(3), pp. 477-484.*

Quantifying the Changeable Self: The role of self-tracking in coming to terms with and managing bipolar disorder. *Matthews, M, Murnane, E. L. & Snyder, J. (2017). Under revision in Journal of Human-Computer Interaction.*

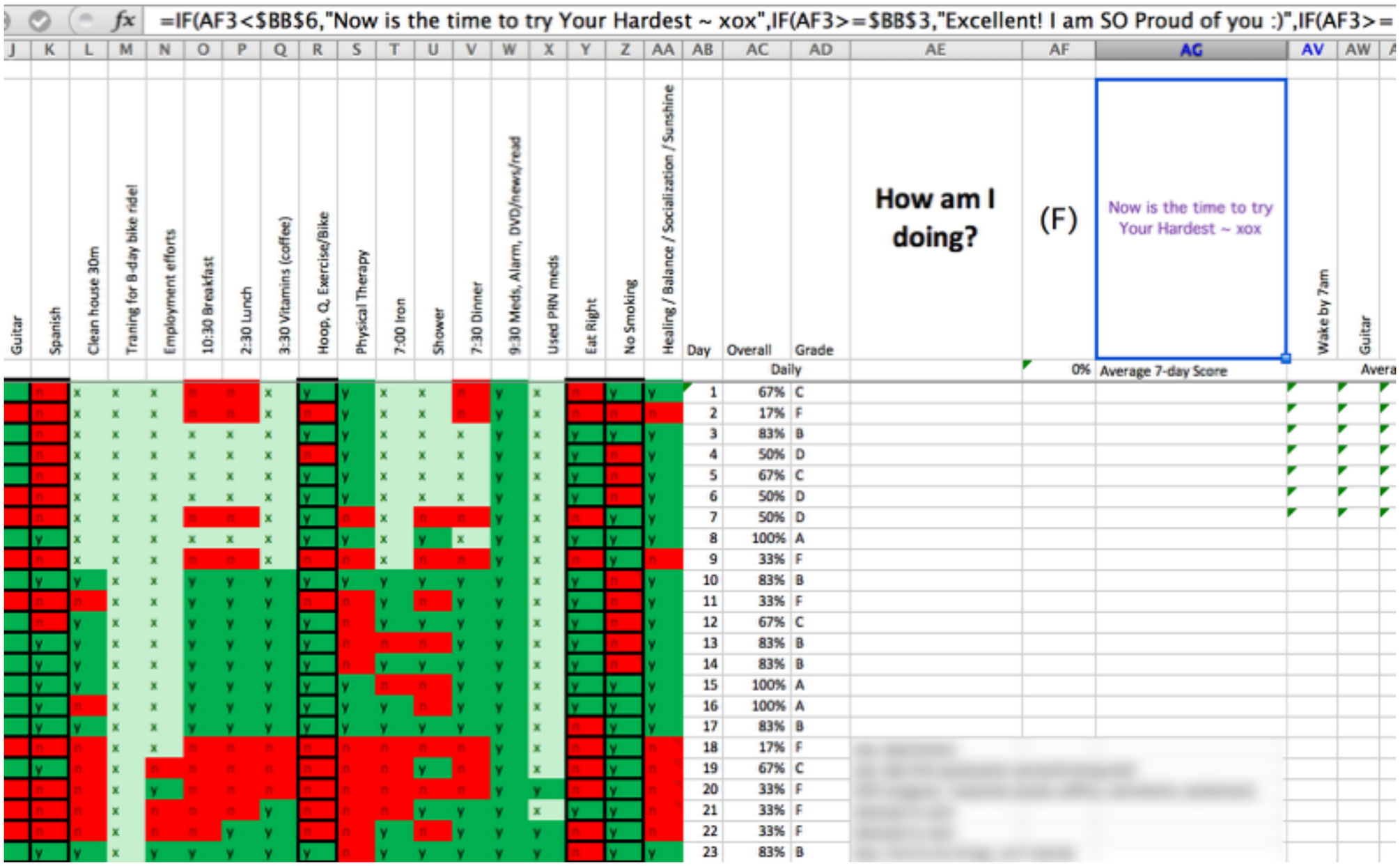
What are people tracking?



How are people tracking?



Custom Tracking Setups



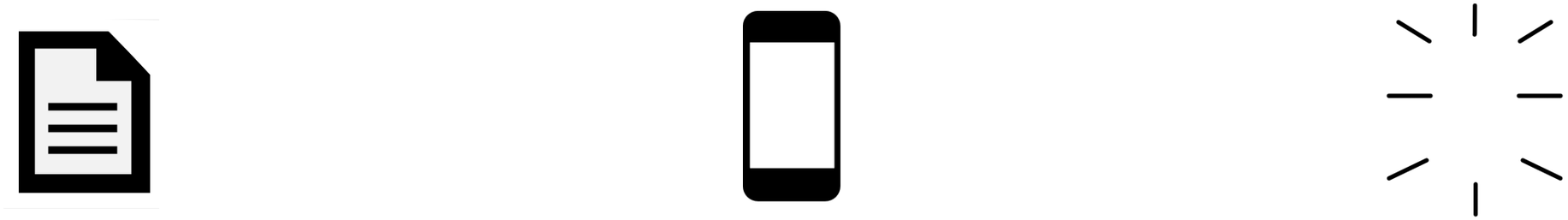
Why are people tracking?

- Fosters clinical interactions
- Promotes self-awareness, reflection, empowerment
- Enables pro-active condition management

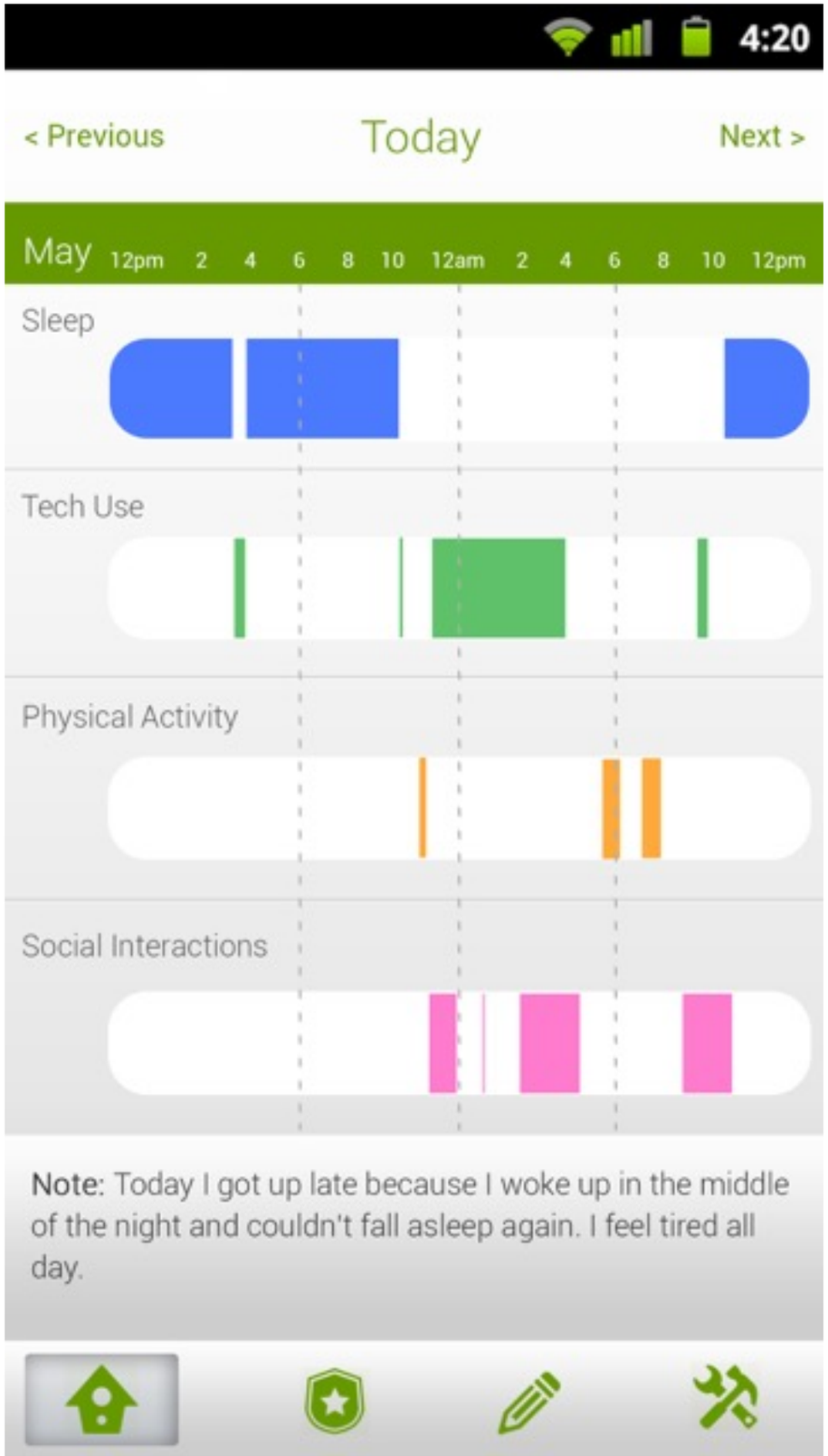
Design Guidelines

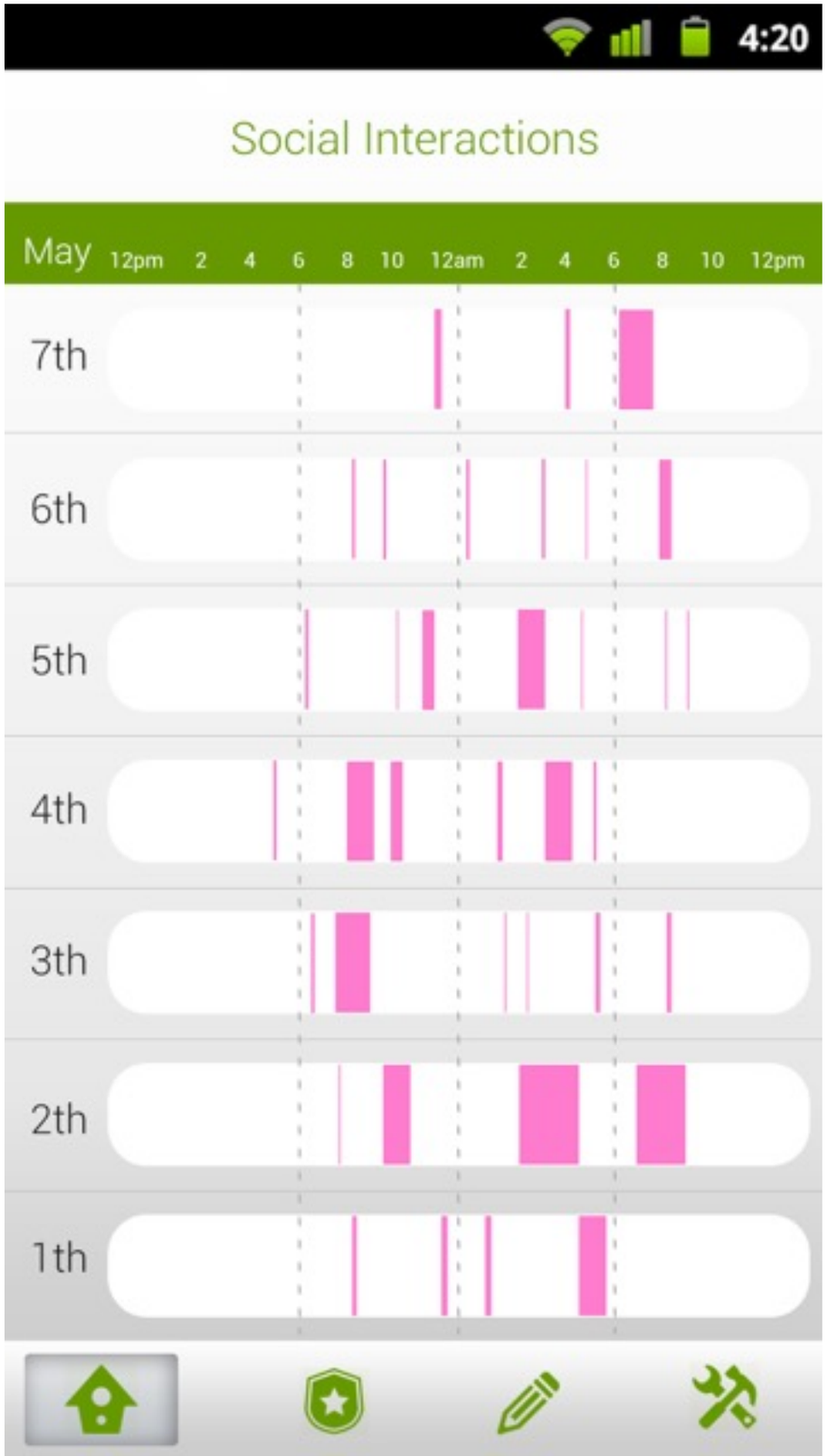
Design Implications	Needs Addressed	Representative Quotes
Deploy software across platforms, devices, and operating systems	Pervasive accessibility	"The easier it is to access the program the more likely I am to use it." "I like typing on my work computer but use my iPad and iPhone at home."
Deliver proactive notifications	Promotes adherence to self-monitoring and behavioral regularity	"I also just found emoods for my smartphone. I am just now starting to like it but I need to set an alarm to do it." "I am so chaotic I find it difficult to keep track of anything without help and prompting."
Synthesize data and highlight patterns	Increases self-awareness and reflection	"It has helped me see general patterns and to recognize personal triggers. And the more aware I am of the symptoms, the more I can do proactively."
Provide encouragement messages and rewards or (after non-compliance) flexibility and forgiveness	Provides mastery experiences and cultivates self-efficacy and self-compassion	"My first few episodes I felt intensely guilty about failure. It was this intense guilt that made me feel suicidal. Recognizing symptoms of depression has allowed me to be much more forgiving during episodes."
Integrate with clinical care while respecting	Facilitates improved acceptance, transmission,	"I find that the reports succinctly provide my doctors with a more accurate picture over time that what I can recall at

From
Paper to Smartphone to Sensor



- Social activity (built-in microphone)
- Physical activity (accelerometers)
- Location (GPS + WiFi + Cellular)


4:20
< Previous
Today
Next >
May
12pm 2 4 6 8 10 12am 2 4 6 8 10 12pm
Sleep
Tech Use
Physical Activity
Social Interactions
Note: Today I got up late because I woke up in the middle of the night and couldn't fall asleep again. I feel tired all day.


4:20
Social Interactions
May
12pm 2 4 6 8 10 12am 2 4 6 8 10 12pm
7th
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1th

Symptoms Manifest through Usage Patterns

Indicator	Manic Manifestations	Depressive Manifestations
Computer-mediated communication (email, phone, texts, tweets, blog posts)	Repetitively (re)reading and sending messages -- to the point it may be construed as spam; writing an excess of online content	Avoidance of email; dodged phone calls and texts
Social networks (e.g., Facebook, Twitter)	Checking social news feeds repeatedly	Avoidance of social media
Web searching and browsing	Consumed with performing web searches, and they manage and rapidly switching among multiple browser windows and tabs	Non-use or idle use (e.g., reading websites
Streaming media (e.g., Netflix, Hulu)	"Binge watching"	Non-use or "zombie-like" watching
E-commerce	Compulsive online shopping	Non-use
Gambling, gaming	Obsessively gambling; playing games on computers or phones for hours -- including multiple games, social games, high-action games	Non-use or solitary, "calming" games (e.g., solitaire)
Digital calendars	Excessively booking activities	Diminished
Typing and audio	Faster, more careless (e.g., more typos, more garbled speech)	Slower
Tech-mediated risky behavior	Increased visitation of dating or pornography sites, sending x-rated photos, using more inappropriate and aggressive language in written content; more risk-oriented web searches (e.g., to find tattoo parlors or research exuberant vacations)	None reported
Usage timing and frequency	Late night usage; excessively checking phone notifications; paranoidly checking partner's emails, social media accounts, or cellphone logs)	Diminished

The Double-Edged Sword: A Mixed Methods Study Of The Interplay Between Bipolar Disorder and Technology Use. *Matthews, M., Murnane, E. L. ,Snyder, J., Guha, S., Chang, P., & Doherty, G., Gay, G. Under review in Computers in Human Behavior.*

Evaluation and Acceptability

- Generalized model predicts SRM score (range 0-7) with Root Mean Square Error (RMSE) = 1.40
- Personalized models: RMSE = 0.92
- Classification (stable vs. unstable): precision = 0.85, recall = 0.86

Automatic detection of social rhythms in bipolar disorder. *Abdullah, S., Matthews, M., Frank, E., Doherty, G., Gay, G. & Choudhury, T. (2016). Journal of the American Medical Informatics Association (JAMIA), 23(3), pp. 538–543.*

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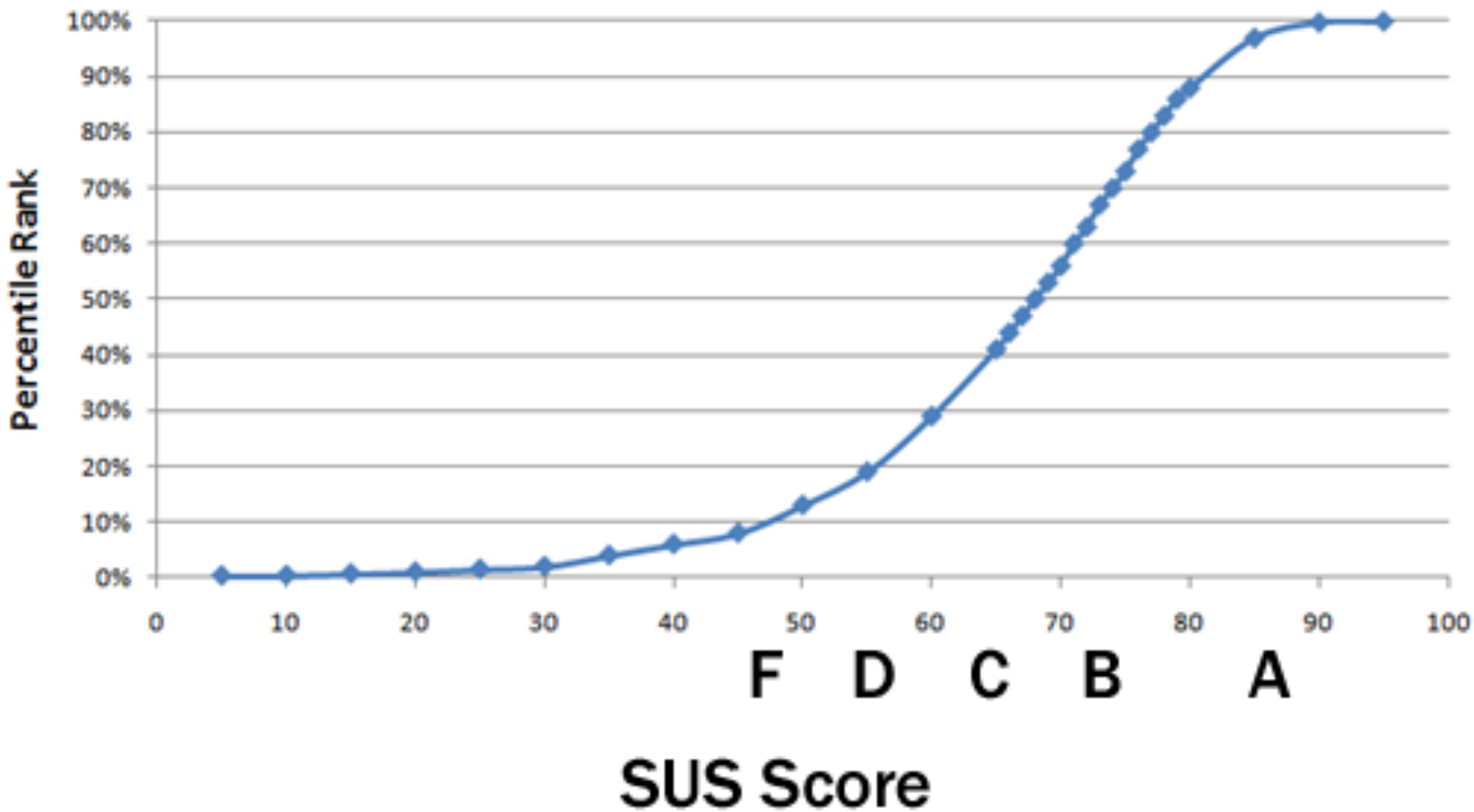
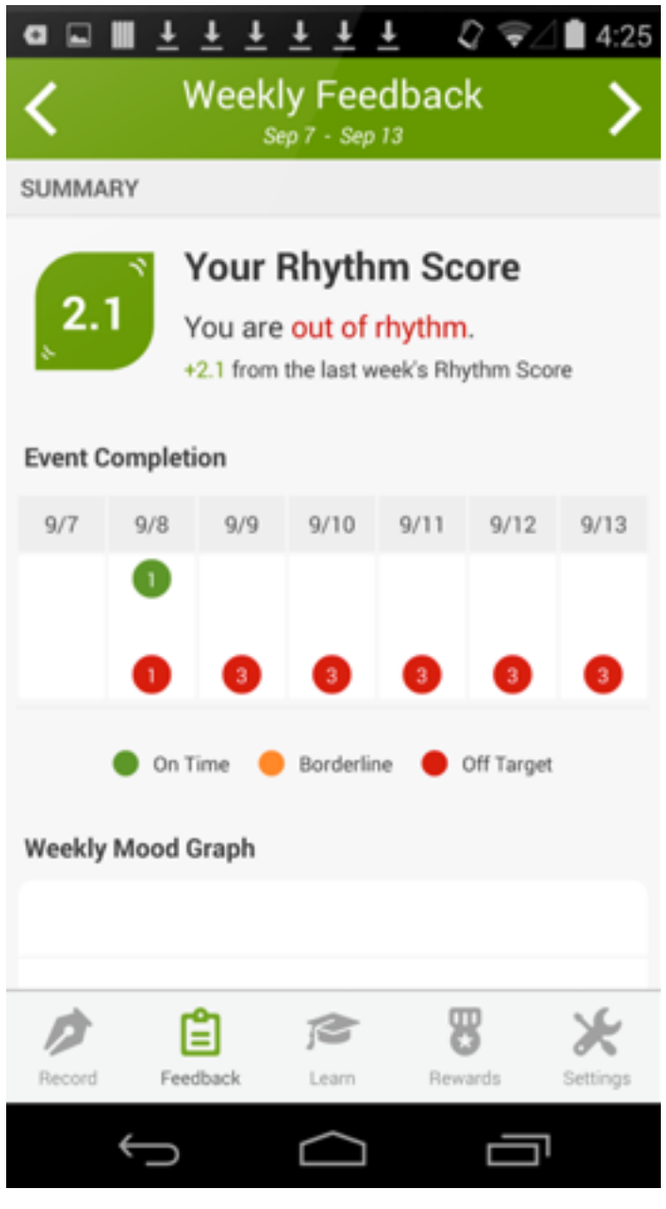
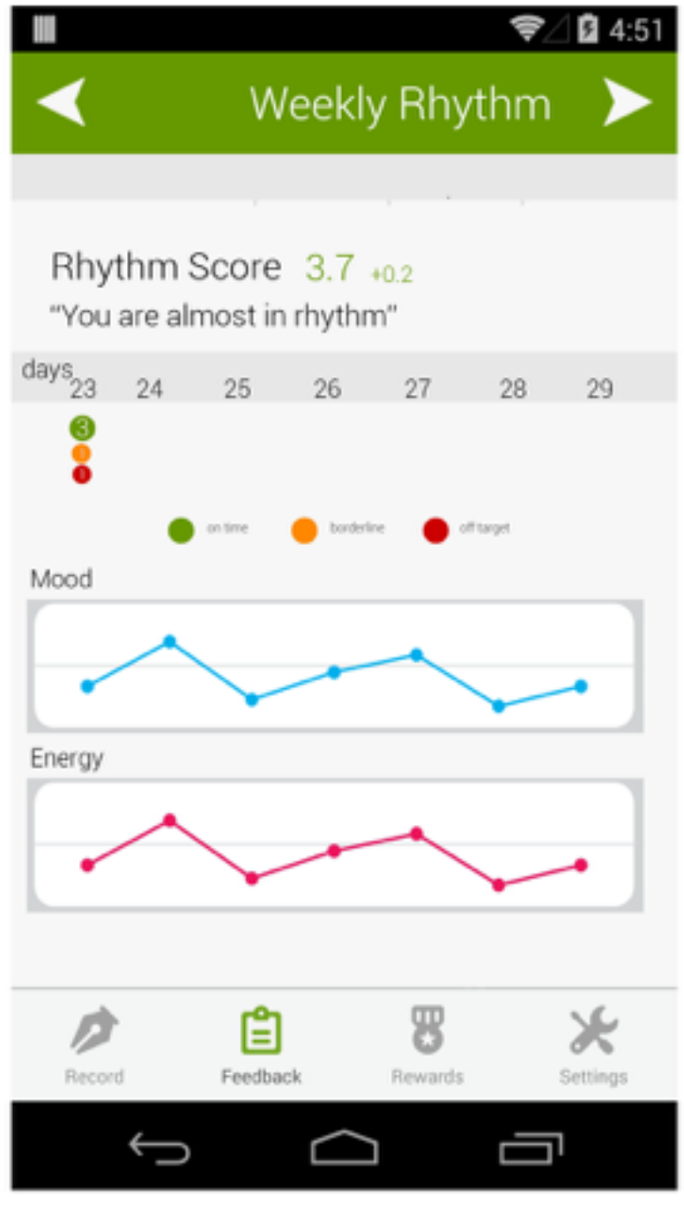
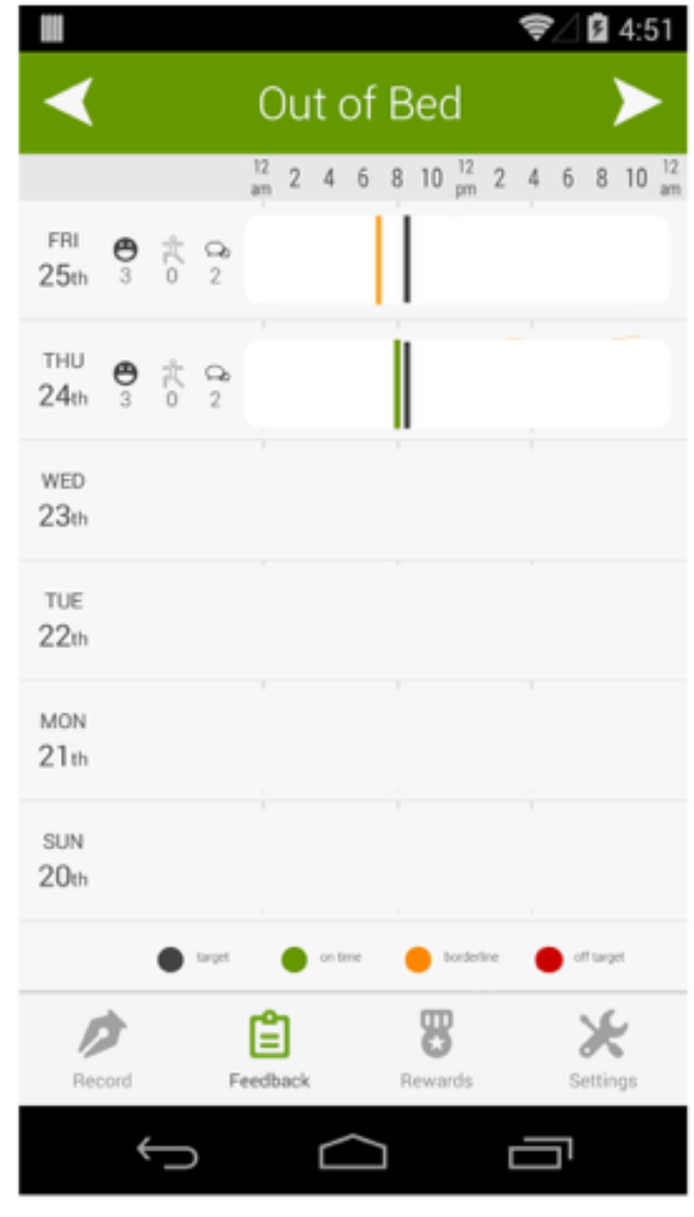


Closing the Loop: Feedback & Intervention







Take-Aways & Considerations

- Characteristics of mental illness and patient experience can have an important impact on the design of digital interventions
- Smartphone solutions for self-tracking, passive sensing, and tailored intervention
- Weigh design tensions & take a “do no harm” approach

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Thank You! Questions?

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