Digital Phenotyping and Mental Health: Hype, Hope, and Hard Work Ahead

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Conflicts of Interest

• Investigator Initiated Study on Abilify MyCite Supported by Otsuka
Outline

• State of Smartphones and Mental Health

• Smartphones Digital Phenotyping

• App Evaluation

• Informed Consent in the Digital Age
Finding Focus in Digital Mental Health

Device Category

Mobile
- Wearables
  - Continuous wear
  - Heart rate, sleep count
  - Small touchscreen
- Smartphones
  - Mobile communication
  - Ubiquitous
  - Robust, open-source marketplace for apps
- Tablets
  - Large, user-friendly touchscreen
  - Home and office usage
  - Connectivity with mobile devices
- Telehealth
  - Connect virtually with clinician
  - Frequent monitoring
- Virtual Reality
  - Immersive cognitive therapy
  - Adapt to unique virtual settings
- Video Games
  - Fun, high engagement
  - Adaptable across cognitive domains
- Smart Homes
  - Interact with patients passively
  - Assist in daily life

Image by Ryan Hays, BIDMC Digital Psychiatry
Audience Question #1

The largest breakthrough in smartphone based digital mental health will be in

1- Diagnosis
2- Relapse Monitoring
3- Delivering Peer Support
4- Real Time CBT Based Interventions
State of Smartphones and Mental Health in US

• Number of Mental Health Apps: 10,000

• Number of FDA Approved Mental Health Apps: 1

• Industry Studies ->


State of Smartphones and Mental Health


Study: Majority of mental health patients would consider giving clinicians access to phone behaviors, locations

A small study published in JMIR Mental Health found that 84 percent of surveyed patients living mental illness were willing to use apps that would collect and share biomarkers.

By Laura Lovett | September 04, 2018
State of Smartphones and Mental Health

State of Smartphones and Mental Health

Nicholas J, Shilton K, Schueller SM, Gray EL, Kwasny MJ, Mohr DC. The Role of Data Type and Recipient in Individuals’ Perspectives on Sharing Passively Collected Smartphone Data for Mental Health: Cross-Sectional Questionnaire Study. JMIR mHealth and uHealth. 2019;7(4):e12578.
### State of Smartphones and Mental Health

- **Screen**
  - Seen as one of the less invasive ways of seeing interaction patterns and daily routines. Worrries about false positives (e.g. screen on due to movement or notification).

- **Keyboard**
  - Highly unacceptable to record keys clicked. Participants do not want their messages or searches tracked. Keyboard events (key press counts etc.) rather than content more acceptable.

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<p>| | |</p>
<table>
<thead>
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<th></th>
<th></th>
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<td>P12</td>
<td>&quot;interesting to see if there are correlations between how much screen-time you get versus your ability to sleep and your ability to relax and put it away, because the screen being on and the screen being off, it doesn’t bother me for privacy issues.&quot;</td>
</tr>
<tr>
<td>P1</td>
<td>&quot;That’s a scary one... I definitely don’t want them to see what I Google.&quot;</td>
</tr>
</tbody>
</table>
State of Smartphones and Mental Health

https://github.com/BIDMCDigitalPsychiatry/LAMP-start
Smartphones -> New Longitudinal Symptom Data

Smartphones -> New Longitudinal Symptom Data

Survey Responses for U2847148753

Domains
- Sleep
- Psychosis
- Anxiety
- Depression
Smartphones -> New Longitudinal Symptom Data

Figure by Philip Henson, BIDMC Digital Psychiatry
Smartphones -> New Longitudinal Symptom Data
Smartphones -> New Functional Data

Active and Passive (n= 1 example)

SurveyID: 56fe99da1206f74995a83f71
SurveyID: 56e6facc1206f735d849088b
SurveyID: 56e6fa3e1206f735d8490880

# missed calls
Call duration
Total length of texts received
# texts received
Total length of texts sent
# texts sent
Circadian routine
# Significant locations visited
Max distance from home
Distance travelled
Home time
GPS amount recorded

Week 1
Week 2
Week 3
Week 4

Image by Ian Barnett PhD, UPenn
Active and Passive (n= 1 example)

Image by Ian Barnett PhD, UPenn
Data Quality

Towards Sleep
Smartphones -> New ‘Cognitive’ Data

Smartphones -> New ‘Cognitive’ Data
Smartphones -> New New Data
Prediction of Future Clinical State

- Anxiety Stable
- Psychosis Stable
- Anxiety Elevated
- Psychosis Elevated

Transition probabilities:
- 0.78 from Anxiety Stable to Psychosis Stable
- 0.28 from Psychosis Stable to Anxiety Stable
- 0.46 from Anxiety Elevated to Psychosis Elevated
- 0.54 from Psychosis Elevated to Anxiety Elevated
Towards Population Level Mental Health
Towards Global Mental Health

1. LAMP creates a baseline digital phenotype for users based on active + passive data. New data to improve phenotyping will be added to the model.

2. LAMP monitors users’ digital phenotype at all times for anomalies in surveys, behaviors, cognition, and activity patterns, and identifies relapse risk.

3. LAMP prompts users to complete intervention activities to reduce relapse risk. Intervention will be based on published evidence and created via co-design at all study sites.
Towards Digital Skills Groups

**Session 1: Smartphone Fundamentals and Your Health Goals**
- Learn how apps may help you towards your health goals
- Learn about mental health apps and other digital resources
- Access and download apps
- Keep your personal data secure
- Remove harmful apps
- Use alarms, maps, and reminders on the phone available for

**Session 2: Smartphones for Health and Wellness**
- Set up mental health apps
- Collect your own data on mood, anxiety, sleep, and steps
- Learn to use wearables and smartwatches
- Learn to explore and discover local services via apps
- Learn how to connect with peers and family with apps (without a data plan)

**Session 3: Smartphones for Personal Health**
- Access and learn from your personal data
- Learn how to share your data with who you want and how to protect what you don’t want to share
- Customize apps to your needs
- Develop a digital mental health toolkit to support your recovery
- Evaluate apps that may be of help

**Session 4: Smartphones for Your Recovery**
- Develop insights into your recovery with digital data and smartphone tools
- Finalize your digital toolkit
- Help peers with technology
- Use apps to access community resources and services
- Action planning with apps
- Identify barriers and solutions to technology use
Towards Digital Skills Groups

Session 2: Capturing Lived Experience

In this session, group members will explore the ways in which smartphones technology can be used to illuminate connections between behavior, symptoms, and mood. Participants will be introduced to the LAMP app as a tool for monitoring depression, anxiety, happiness, and mood. They will be guided through the process of installing and using the app, and will be encouraged to reflect on how their experiences correlate with their mental health.

Materials needed:
- LAMP app
- Large screen and projector

Appendix C

Session 3: Understanding lived experience and enhancing self-management strategies

Data Visualizations

LAMP Assessments

- Now we'll split into small groups and help each other to download the app.
- Please try to make sure everyone understands what the app does.
- Record participant names and email addresses.
- Tip: If participants are not able to install the LAMP app, they can assist them with locating the app on their smartphones.
- This feature is located within the 'Healthcare applications' for iPhone and within the Google Play application for Android.

Action planning and wrap-up

- Set goals for the LAMP app.
- Assign points or checkoff sheet.
- Create digital poll and print/sticker instructions for participants.

Feedback:
- What worked? What didn't work? What will you change?
- What did you expect to happen?
- How do you feel about your experience?

Next steps:
- Next week, we’ll go back to groups that will show you how we’ve been doing each day of the week.

- The more you use the LAMP app, the more data we can analyze.

- If you have any questions or concerns, please feel free to ask me at any time.
Towards a Digital Clinic

Evidence Based Digital Mental Health Care to Augment and Extend Services

- Physical Activity
- Environmental Stressors
- Real Time Surveys

App

- Relapse Risk Algorithm
- Digital Clinic Staff

Personalized Care Plan

Towards New Questions

Digital Pills <-> Digital Phenotyping
Towards Digital Pills
Smartphone Apps Today

- Estimate to be over 10,000 mental health related apps

Informed Decision Making Around Apps

Audience Question #2

How comfortable would you be using a digital phenotyping app that captured GPS, call/text logs, accelerometer, and surveys from your personal smartphone. (1 star = not, 5 stars = very comfortable)
Informed Decision Making Around Apps

Mental Health Apps

The expanding use of mobile health (mHealth) technologies is unprecedented in the history of medicine. Every month, companies and researches release new smartphone apps, smart watches, and sensor technologies for the healthcare market. Psychiatry has been no exception to this trend. There has also been growing patient, clinical, government, and payer interest in the potential of mHealth technologies for psychiatric clinical care. Psychiatrists, clinical psychologists, psychotherapists, and other mental health clinicians are increasingly faced with questions regarding the efficacy and risks of mobile and online apps.

APA is helping Psychiatrists and other mental health professionals navigate these issues to ensure all important factors are considered and ultimately determine whether an app works for you and your patients. The material provided here covers why it is critical to rate an app, how best to evaluate an app and an opportunity to seek additional guidance on apps and/or the evaluation process.

Why Rate Mental Health Apps?

Learn why it is important to rate mental health apps for you and your patients.
Up to 48% of NHS mental health patients are re-admissions - don't be one of them.

In 2014 the National Audit Office reported that each year the NHS deals with one million emergency readmissions within 30 days of discharge, costing an estimated £2.4 billion.

What can you do to change this?

Dedicate yourself to your own healing, and thereby avoid being readmitted.

This will help save the NHS some of the £2.4 billion, which they urgently need to help others like you.

Help others by helping yourself.

Be your own NHS.
Informed Decision Making Around Apps: Level 1

In about four months’ of data reviewed by The Times, her location was recorded over 8,600 times — on average, once every 21 minutes.

Informed Decision Making Around Apps: Level 1
Informed Decision Making Around Apps: Level 2

<table>
<thead>
<tr>
<th>Search term</th>
<th>Identified in searches (n=1435)</th>
<th>Screened (n=350)</th>
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<tbody>
<tr>
<td></td>
<td>Android</td>
<td>iOS</td>
</tr>
<tr>
<td>Anxiety</td>
<td>249</td>
<td>200</td>
</tr>
<tr>
<td>Depression</td>
<td>250</td>
<td>200</td>
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<tr>
<td>Schizophrenia</td>
<td>250</td>
<td>32</td>
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<tr>
<td>Self-harm</td>
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<td>29</td>
</tr>
<tr>
<td>Substance use</td>
<td>131</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>965</td>
<td>470</td>
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</table>

<table>
<thead>
<tr>
<th>Coding element</th>
<th>n (% of apps)</th>
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<tbody>
<tr>
<td>3. Positive claims</td>
<td>59 (81%)</td>
</tr>
<tr>
<td>3.a. Claims of effectiveness</td>
<td>47 (64%)</td>
</tr>
<tr>
<td>3.a.i. Detection or diagnosis</td>
<td>7 (10%)</td>
</tr>
<tr>
<td>3.a.ii. Improvement in symptoms or mood</td>
<td>22 (30%)</td>
</tr>
<tr>
<td>3.a.iii. Improvement in self-management</td>
<td>26 (36%)</td>
</tr>
<tr>
<td>3.b. Claims of acceptability</td>
<td>33 (45%)</td>
</tr>
<tr>
<td>4. Technical expertise</td>
<td></td>
</tr>
<tr>
<td>4.a. Scientific language</td>
<td>32 (44%)</td>
</tr>
<tr>
<td>4.a.i. Specific technique described</td>
<td>24 (33%)</td>
</tr>
<tr>
<td>4.a.ii. Evidence from study using app</td>
<td>2 (2.7%)</td>
</tr>
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<td>4.a.iii. Citation to scientific literature</td>
<td>1 (1.4%)</td>
</tr>
<tr>
<td>4.b. Technical expertise</td>
<td>23 (32%)</td>
</tr>
<tr>
<td>4.b.i. Certification or accreditation</td>
<td>0</td>
</tr>
<tr>
<td>4.b.ii. Prizes or awards</td>
<td>2 (2.7%)</td>
</tr>
<tr>
<td>4.b.iii. Credible developers</td>
<td>18 (25%)</td>
</tr>
<tr>
<td>4.b.iv. Credible endorsements</td>
<td>3 (4.1%)</td>
</tr>
<tr>
<td>4.c. Lived experience design</td>
<td>10 (14%)</td>
</tr>
<tr>
<td>4.c.i. Lived experience involvement</td>
<td>6 (8.2%)</td>
</tr>
<tr>
<td>4.c.ii. Lived experience developer</td>
<td>5 (6.8%)</td>
</tr>
<tr>
<td>4.d. &quot;Wisdom of the crowd&quot;</td>
<td>14 (19%)</td>
</tr>
<tr>
<td>4.d.i. Download, usage or popularity statistics</td>
<td>11 (15%)</td>
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Informed Decision Making Around Apps: Level 2

Meta-analysis of Smartphone Apps for Anxiety

Firth & Torous et al., April 2017

9 RCTs for Anxiety:
1,837 participants

Eligibility Criteria
(i) RCTs in any population
(ii) Smartphone-based psychological interventions
(iii) Assessed changes in anxiety/depression

<table>
<thead>
<tr>
<th>Effects on Anxiety</th>
<th>Hedge’s (g)</th>
<th>P-value</th>
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<tbody>
<tr>
<td>All RCTs</td>
<td>0.33</td>
<td>&lt;0.001</td>
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<tr>
<td>Smartphone vs. Waitlist</td>
<td>0.45</td>
<td>&lt;0.001</td>
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<tr>
<td>Smartphone vs. Active Control</td>
<td>0.19</td>
<td>0.003</td>
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Meta-analysis of Smartphone Apps for Depression

Firth & Torous et al., October 2017

18 RCTs for Depression:
3,414 participants

<table>
<thead>
<tr>
<th>Effects on Depression</th>
<th>Hedge’s (g)</th>
<th>P-value</th>
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<tr>
<td>All RCTs</td>
<td>0.38</td>
<td>&lt;0.001</td>
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<td>Smartphone vs. Waitlist</td>
<td>0.56</td>
<td>&lt;0.001</td>
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<tr>
<td>Smartphone vs. Active Control</td>
<td>0.22</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Informed Decision Making Around Apps: Level 2

Arean PA, Hallgren KA, Jordan JT, Gazzaley A, Atkins DC, Heagerty PJ, Anguera JA. The Use and Effectiveness of Mobile Apps for Depression: Results From a Fully Remote Clinical Trial. J Med Internet Res 2016;18(12):e33
Informed Decision Making Around Apps: Level 2

Noone and Hogan. A randomised active-controlled trial to examine the effects of an online mindfulness intervention on executive control, critical thinking and key thinking dispositions in a university student sample. BPJ Psychology. 2018
Informed Decision Making Around Apps: Level 3

PTSD: National Center for PTSD

Mobile App: PTSD Coach

PTSD Coach has now been downloaded over 100,000 times in 74 countries around the world.

The PTSD Coach app can help you learn about and manage symptoms that often occur after trauma. Features include:

- Reliable information on PTSD and treatments that work
- Tools for screening and tracking your symptoms
- Convenient, easy-to-use tools to help you handle stress symptoms
- Direct links to support and help
- Always with you when you need it
Informed Decision Making Around Apps: Level 3

Owen et al. mHealth in the Wild: Using Novel Data to Examine the Reach, Use, and Impact of PTSD Coach. JMIR Mental Health. Dec 2015
Informed Decision Making Around Apps: Level 3

Evaluating Usability: Criteria Types and Methods

<table>
<thead>
<tr>
<th>Type of Evaluation Criteria Utilized</th>
<th>Number of Studies</th>
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<tbody>
<tr>
<td>Survey</td>
<td>6</td>
</tr>
<tr>
<td>Survey + Interview</td>
<td>4</td>
</tr>
<tr>
<td>Interview</td>
<td>4</td>
</tr>
<tr>
<td>Usage Data</td>
<td>2</td>
</tr>
<tr>
<td>Survey + Usage Data</td>
<td>12</td>
</tr>
<tr>
<td>Interview + Usage Data</td>
<td>10</td>
</tr>
<tr>
<td>Survey + Interview + Usage Data</td>
<td>8</td>
</tr>
</tbody>
</table>

Subjective
Objective
Combination
Informed Decision Making Around Apps: Level 4
Informed Decision Making Around Apps: Level 4

Review

Digital mental health apps and the therapeutic alliance: initial review

Philip Henson, Hannah Wieniawski, Chris Hollis, Metcheri Keshavan and John Torous

Background

As mental healthcare expands to smartphone apps and other technologies that may offer therapeutic interventions without a therapist involved, it is important to assess the impact of non-traditional therapeutic relationships.

Aims

To determine if there were any meaningful data regarding the digital therapeutic alliance in smartphone interventions for serious mental illnesses.

Method

A literature search was conducted in four databases (PubMed, PsychINFO, Embase and Web of Science).

Results

There were five studies that discuss the therapeutic alliance when a mobile application intervention is involved in therapy. However, in none of the studies was the digital therapeutic alliance the primary outcome. The studies looked at different mental health conditions, had different duration of technology use and used different methods for assessing the therapeutic alliance.

Conclusions

Assessing and optimising the digital therapeutic alliance holds the potential to make tools such as smartphone apps more effective and improve adherence to their use. However, the heterogeneous nature of the five studies we identified make it challenging to draw conclusions at this time. A measure is required to evaluate the digital therapeutic alliance.

Keywords

Smartphone, alliance, individual psychotherapy.

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Informed Decision Making Around Apps

Informed Decision Making Around Apps:

Step 1. Background Info
- Business Model
- Technical

Step 2. Privacy/Security
- Data Collected
- Personal Health Information
- Security Measures in Place
- Deleting Personal Data
- Privacy Policy

Step 3. Evidence Based
- First Impressions
- Impressions After Using
- Clinical Validity
- User Feedback Supporting

Step 4. Ease of Use
- Specific to Users / Accessability
- Short Term Usability
- Long Term Usability

Step 5. Data Integration
- Data Ownership/Access/Export
- Clinically Actionable
- Therapeutic Alliance

Beth Israel Deaconess Medical Center
The FDA To the Rescue in the US?
Informed Consent in the Digital Age
Thank You

Digitalpsych.org ; jtorous@bidmc.harvard.edu