The Future of Mental Health Care

(is sitting in your pocket)

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University of Washington
Disclosures

Dr. Ben-Zeev has financial interests in Merlin LLC, FOCUS technology, and CORE technology.

He has an intervention content licensing agreement with Pear Therapeutics and has provided consultation services to Trusst Health, K Health, Boehringer Ingelheim, eQuility, Deep Valley Labs, and Otsuka Pharmaceuticals.
Origin Story
Global mobile-cellular subscriptions, total and per 100 inhabitants, 2001-2017*

Note: * Estimate
Source: ITU World Telecommunication /ICT Indicators database
Mobile-cellular telephone subscriptions per 100 inhabitants, by region, 2021*

- World: 110
- Africa: 83
- Arab States: 98
- Asia & Pacific: 112
- CIS: 146
- Europe: 118
- The Americas: 119
- Developed: 135
- Developing: 105
- LDCs: 76
- LLDCs: 77
- SIDS: 87

Source: ITU
2011-12 Survey: Penetration of Mobile Devices among People with Serious Mental Illness

- Respondents:
  N=1,592
  Age: 46 y.o.
  69% AA, 41% Caucasian
  69% HS diploma or less
  73% earned $10,000 or less
Survey Results

• Ownership: 72% had mobile device
• Payment: 35% “government minutes” (Lifeline), 37% month-to-month plan, 14% prepaid cards
• Uses: 92% talk, 39% text, 33% internet

• Maryland, Massachusetts, Rhode Island, California, New Hampshire, Michigan: 82%-97%
  (Aschbrenner et al., Brunette et al., 2019; 2018; Carras et al., 2014; Noel et al., 2019; Torous et al., 2014; Young et al., 2020)

• India: 72%-92%
  (Jain et al. 2015)

• USA: 92% of people who hear voices recruited via Facebook own smartphones
  (Crosier, Brian, Ben-Zeev, 2016)
Young Adults with Early Psychosis

- n=77
- Average Age: 23.68
- 22% Male, 59% Female, 18% nonbinary, 10% Transgender
- Transgender: 8 (10.4%)
- 67% White/Caucasian, 9% Multiracial, 8% Black/African-American
- Latino/Hispanic: 5.2%

- 97.4% owned a smartphone

Young Adults with Early Psychosis

• High interest in psychosis-specific digital health.
• 89.6% interested in information about medications and side effects
• 89.3% managing stress and improving mood
• 88% managing symptoms of psychosis
• 89.6% interested in content being delivered as text
• Less interest in: social features
• Those with most negative attitudes toward help-seeking had low interest in mHealth facilitating symptom disclosure

Caregivers of Young Adults with Early Psychosis

- n=43
- Average Age: 55
- 77% Female, 70% White, 65% married

- Top 5 five digital health features endorsed:
  - 95% reports of changes in their family member’s symptoms
  - 90% information about psychological treatments
  - 90% information about mental health systems
  - 86% information about medications

Caregivers of Young Adults with Early Psychosis

• 95% interest in communicating with individual therapists
• 88% with psychiatrists
• 77% researchers or experts
• 75% other caregivers

• Most popular modalities: two-way texts (88%) or phone calls (83%) with providers
• Least popular: video calls (42%) and one-way texts (32%)

UW Behavioral Research In Technology and Engineering (BRiTE) Center
Using Mobile Technology for Mental Health Care

Person-to-Person Interactions
Using Mobile Technology for Mental Health Care

Sensing, Natural Language Processing

Person-to-Person Interactions
Using Mobile Technology for Mental Health Care

- Person-to-Person Interventions
- Sensing, Natural Language Processing
- Automated Interventions
Person-to-Person: Mobile Interventionist
Mobile Interventionist Overview

- Daily Texts
- Weekly Report
- Home Visit
- Client
- Clinical Team
- MI
Hi it's Sara! How are you feeling Ray?

hi sara. voices talking about me

Mobile Interventionist

That's stressful. You are not alone! Lots of people hear voices.

They say something bad if I take the bus

I have a trick that can help you feel calm, even when voices are loud on the bus… wanna hear about it?

maybe.

what is it?

Mobile Interventionist

Mobile Interventionist: Therapeutic Alliance

- Working Alliance Inventory (WAI):
  “We agree on what is important for me to work on”
  “I am confident in my clinician’s ability to help me”
  “My clinician and I trust each other”
  “I believe my clinician likes me”

WAI ratings:

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<thead>
<tr>
<th></th>
<th>In-person</th>
<th>MI (texting)</th>
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<tr>
<td></td>
<td>50.4 (SD=12)</td>
<td>56.7 (SD=9)</td>
</tr>
</tbody>
</table>

Mobile Interventionist: Randomized Controlled Trial

- 61% people with schizophrenia/schizoaffective disorder, 24% with bipolar disorder, 14% with MDD

- All receiving Assertive Community Treatment (ACT) team care

- Age: 45 years old, 55% male, and 52% White, 26% Black/African-American, 17% multiracial.

- Average lifetime hospitalizations: 3

Mobile Interventionist: Randomized Controlled Trial

Persecutory Ideation (GPTS)

Mobile Interventionist: Randomized Controlled Trial

Depression (BDI-II)

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<td>Treatment as Usual</td>
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<td>18.5</td>
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Mobile Interventionist: Randomized Controlled Trial

Illness Management and Recovery (IMRS)

What about HIPAA?

Director of the US Department of Health and Human Services Office for Civil Rights (OCR), the HIPAA enforcement agency (March 2018):

Health care providers may share Protected Health Information (PHI) with patients through standard text messages. Providers must first warn their patients that texting is not secure, gain the patients’ authorization, and document the patients’ consent.

https://www.emrandhipaa.com/mike/2018/03/06/texting-patients-is-ok-under-hipaa-as-long-as-you/
Helpful Reviews: Clinical Texting


Sensing, Natural Language Processing, Signal Detection

Data Capture
- Self-Report
- Device Use
  - APPS
  - SMS
- Behavioral Sensing
  - GPS
  - Microphone

Analytics
- Servers

Remote Monitoring
- System Reports

R01MH103148 (Ben-Zeev), R01MH112641 (Ben-Zeev), R42MH123215 (Kopelovich), R37MH066031 (Barch)
Natural Language Processing (NLP): Thought Coherence

### Natural Language Processing (NLP): Thought Distortions

<table>
<thead>
<tr>
<th>Distortion</th>
<th>SHAP Explainer</th>
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<tr>
<td>mental filter</td>
<td>ys distracted within myself thoughts daydreaming wishing things didn’t turn out the way they did in my life and with myself always asked God what is it and why</td>
</tr>
<tr>
<td>jumping to conclusions</td>
<td>Maybe they really don’t like me</td>
</tr>
<tr>
<td>catastrophizing</td>
<td>Feeling unsure of myself right now. Desperate. Idk if I can handle my money or tackle my goals of saving for a rainy day.</td>
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<tr>
<td>shoulding &amp; musting</td>
<td>Yes, but I’ve got to be able to make better decisions for myself and not let people use my issues for their personal shit</td>
</tr>
<tr>
<td>Over-generalizing</td>
<td>I’ve never been able to rest in my life the way I wanted to</td>
</tr>
</tbody>
</table>

Tauscher, Lybarger, Ding, Chander, Hudenko, Cohen, Ben-Zeev (Under Review).
GPS
(Geospatial Activity):
Distance Covered

Ben-Zeev, Wang, Abdullah, Brian, Scherer, Mistler, Hauser, Kane, Campbell, Choudhury (2016)
Psychiatric Services.
GPS
(Outdoor Geospatial Activity): Time Spent at Location

Ben-Zeev, Wang, Abdullah, Brian, Scherer, Mistler, Hauser, Kane, Campbell, Choudhury (2016)
Psychiatric Services.
Bluetooth Beacons (Indoor Geospatial Activity): Time Spent at Location

Hours

Standardized score

0

0,1

0,2

0,3

Inpatient: Men’s corridor

TV room

Accelerometer (Physical Activity): Walking/Running/Cycling

Standardized score

Accelerometer (Physical Activity): Sedentary Time

---

Microphone (Speech): Conversation Frequency

Microphone (Speech): Conversation Duration

Ben-Zeev, Wang, Abdullah, Brian, Scherer, Mistler, Hauser, Kane, Campbell, Choudhury (2016)
Psychiatric Services.
Device use + Light + Sound+
Movement: Sleep Model

Ben-Zeev, Wang, Abdullah, Brian, Scherer, Mistler, Hauser, Kane, Campbell, Choudhury (2016)
*Psychiatric Services.*
Remote Monitoring and Notification

Ben-Zeev et al. (2017). *Psychiatric Rehabilitation Journal*
Remote Monitoring and Notification

Ben-Zeev et al. (2017). *Psychiatric Rehabilitation Journal*
Remote Monitoring and Notification

Ben-Zeev et al. (2017). *Psychiatric Rehabilitation Journal*
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Remote Monitoring and Notification
Remote Monitoring and Notification

Individual User:
Feedback
Mobile interventions
Prompts to initiate contact
Remote Monitoring and Notification

Treatment Team:
- Outreach
- Telehealth/home visit
- Medication
- Wrap-around care

Individual User:
- Feedback
- Mobile interventions
- Prompts to initiate contact
Mobile RDoC: Using Smartphones to Understand the Relationship Between Auditory Verbal Hallucinations and Need for Care

Dror Ben-Zeev 1, Benjamin Buck 1, Ayesha Chander 1, Rachel Brian 1, Weichen Wang 1, David Atkins 1, Carolyn J. Brenner 1, Trevor Cohen 1, Andrew Campbell 1, and Jeffrey Masson 1

CrossCheck: Integrating Self-Report, Behavioral Sensing, and Smartphone Use to Identify Digital Indicators of Psychotic Relapse

Dror Ben-Zeev, Rachel Brian, Rui Wang, Weichen Wang, and Andrew T. Campbell
Dartmouth College

Marta Hauser and John M. Kane
Northwell Health, Great Neck, New York, and Hofstra Northwell School of Medicine

Emily A. Scherer
Dartmouth College

Predicting Early Warning Signs of Psychotic Relapse From Passive Sensing Data: An Approach Using Encoder-Decoder Neural Networks

Daniel A. Adler 2, BSc; Dror Ben-Zeev 1, BA, MSc, PhD; Vincent W-S Tseng 2, BSc; John M Kane 1, MD, BA; Rachel Brian 1, MPhil; Andrew T Campbell 1, BSc, MSc, PhD, Marta Hauser 1, PhD, Emily A Scherer 1, PhD, Tanzeem Choudhury 1, BSc, MSc, PhD

Assessing the relationship between routine and schizophrenia symptoms with passively sensed measures of behavioral stability

Joy He-Yesya 1, Benjamin Buck 1, Andrew Campbell 1, Tanzeem Choudhury 1, John M Kane 1, Dror Ben-Zeev 1, and Tim Althoff 1

The Centroid Cannot Hold: Comparing Sequential and Global Estimates of Coherence as Indicators of Formal Thought Disorder

Weizhe Xu, BS 1, Jake Portanova, BA, BS 1, Ayesha Chander, MRes 2, Dror Ben-Zeev, PhD 1, Trevor Cohen, MBChB, PhD 1
Helpful Reviews: Sensing, Natural Language Processing


Automated Interventions:

FOCUS
A Smartphone App for People with Serious Mental Illness
User-Centered Development Process

Stage 1: Needs Assessment
• Client survey (n=904)
• Practitioner interviews (n=18)
• CMHC leaders

Stage 2: Intervention Development
• Assemble multidisciplinary team
• Technology selection
• Content development
• Programming

Stage 3: Usability testing
• Usability cycle 1
• Intervention adaptation
• Usability cycle 2
• Intervention refinement…
FOCUS: Intervention Description

- 3 Daily prompts
- “On-demand” resources
- Native app
- 5 targets: voices, social, meds, sleep, mood

FOCUS: Prompt

- System prompt:
  3 times daily

- Patient launched:
  On demand 24/7
FOCUS: Clinical Status Assessment

- 6th Grade reading level
- Simple geometry
- Low working memory load
- Intuitive
FOCUS: Cognitive Assessment

- Multiple wording variations
- Common dysfunctional beliefs
FOCUS: Intervention

Voices may sound like they know everything, but they don’t.

Can you think of when the voices may be right?

How about when they were sure something was going to happen, but it didn’t?

If the voices got it wrong once, they probably don’t know everything, right? Think about it.

Continue
Bringing the “Pocket Therapist” to Life: FOCUS AV

24/7 Web-Based Provider Dashboard

Summary

PAST WEEK  PAST MONTH

Social
- Improved
- Poor to Good

Voices
- Improved
- Poor to Great

Sleep
- Improved
- Poor to Great

Mood
- Improved
- Poor to Great

Medications

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Toolbox Videos Watched

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<tr>
<th>TOTAL</th>
<th>MOOD SUPPORT</th>
<th>SOCIAL BOOST</th>
<th>THOUGHT CHALLENGES</th>
<th>RELAX</th>
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</table>
FOCUS: Comparative Effectiveness Trial (12 Week RCT)

No Difference in Clinical Outcomes or Satisfaction Ratings Between Conditions
FOCUS: Engagement Over Time

FOCUS: Depression
(12 Week RCT)

**FOCUS: Depression Transdiagnostic Effects**

![Graph showing changes in BDI-II scores from baseline](image)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Depression Symptoms</th>
<th>Psychosis Symptoms</th>
<th>Antidepressant Medication</th>
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<td>Schizophrenia/Schizoaffective</td>
<td>Minimal/ Mild</td>
<td>Absent</td>
<td>None</td>
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<tr>
<td>Bipolar Disorder</td>
<td>Moderate/ Severe</td>
<td>Present</td>
<td>1 or more</td>
</tr>
<tr>
<td>Major Depressive Disorder</td>
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</tbody>
</table>

Ben-Zeev et al. (2019) *JMIR Mental Health.*
FOCUS: Recovery (12 Week RCT)

FOCUS: Treatment Satisfaction
(12 Week RCT)

FOCUS costs **HALF** of Group Intervention

- $256 vs $520 per client, per month

Ben-Zeev et al. (2021). *Psychiatric Services.*
FOCUS: Peer-Reviewed Evidence Base
Statewide Implementation
Helpful Reviews: Intervention Apps


Technology-Assisted Life of Recovery
Annie: A day in the life
1 in 3 Americans seek mental health information online.

Fox & Duggan, 2013
Predictive value for online psychosis screening is better than in-clinic screening.

Brodey et al., 2019
Natural Language Processing (NLP) helps predict psychotic risk.

Bedi et al 2015; Rezaei, Walker & Wolf 2019
Web-based support tool enhances shared decision-making practices

van Der Krieke, Emerencia, Aiello & Sytema, 2012
RECEIVE PERSONALIZED DIGITAL HEALTH DASHBOARD

ORIENTATION OF HEALTH TOOLS

PRIMARY TELEHEALTH APPOINTMENT
Text message medication reminders are feasible and usable.

Community-based case managers use texting to effectively support daily activities

Ben-Zeev, Kaiser & Krzos, 2014

Computer-based cognitive remediation training improves ability to focus

McGurk, Twamley, Sitzer, McHugo & Mueser, 2007; Wykes, Huddy, Cellard, McGurk & Czobor 2011
App-connected supported employment specialist provides on-the-job guidance

Nicholson, Wright, Charlisle, Sweeney & McHugo, 2018

VR job interview trainings improve job attainment in randomized control trials

Smith et al, 2015
FOCUS mHealth Intervention

Usable

Engaging

Feasible

Clinically Effective

Ben-Zeev et al, 2013; 2014; 2018; 2019; 2020
Web-based family and client online psychoeducation

Feasible & Acceptable
Glynn, Randolph, Garrick & Lui, 2010

Improves symptom management and knowledge about schizophrenia
Rotondi et al, 2010
Virtual Reality (VR)
Cognitive Therapy

Reduction in paranoid belief conviction and distress

Freeman, 2008; Freeman et al., 2016
Satisfaction with two-way video conferencing as clinical services

Hulsbosch, Nugter, Tamis & Kroon, 2016; Niendam et al, 2018; Delgadillo et al 2017
Voices Avatars

Computerized treatment designed to engage in dialogue with representations of hallucinations

Leff, Williams Huckvale, Arbuthnot & Leff, 2013; Criag et al, 2018; du Sert et al, 2018
Substance Use Recovery Support

GPS DETECTS HIGH RISK LOCATIONS

PROVIDES INFORMATION AND SUPPORT

Gustafson et al, 2014
YouTube

- Primary source of information
- Virtual community support system

Lal et al, 2015; Naslund, Grande, Aschbrenner, & Elwyn, 2014
An Ideal?
The transformation I want to see is...

- Mental health promotion
- Parenting support e-community
- Targeted online forums
- Analyses of social media content and behavior
- Gaming
- Bio-behavioral markers
- Parents
- At risk or prodromal period
- Relapse prevention
- Wellness/recovery
- 1st Episode
- Tailored and adaptive
- Multi-User/Crowdsourcing
- Multi-Modal
- Rehab (functional, vocational)