



SilverCloud

The Next Generation of Digital Therapeutics for Mental Health

Keynote Fireside Chat

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Agenda

- Project Talia – AI for improved mental health
- Background and prior work
- Machine Learning for outcome prediction
- Considerations for model deployment
- Research on ML prediction model
- Key takeaways



Project Talia -AI for improved mental health

Multidisciplinary Research collaboration

- Expertise in Machine Learning
- Expertise in Digital Mental Health

Leverage SilverCloud's user base
2018-ongoing

Microsoft®
Research

Background

- Digital Mental Health Interventions (DMHI) have great potential for dissemination of evidence-based mental health care
- 166 individual studies on DMHI included in the review
- Effective and cost-effective for depression and anxiety through multiple studies



In Review Series Article

Internet Interventions for Adults with Anxiety and Mood Disorders: A Narrative Umbrella Review of Recent Meta-Analyses

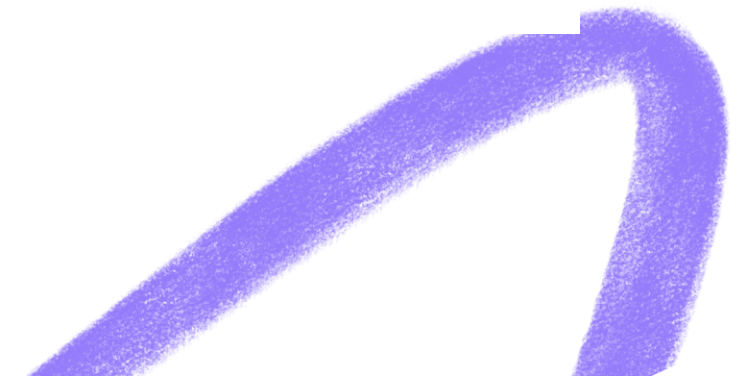
Interventions par Internet pour des adultes souffrant de troubles anxieux et de l'humeur : une revue d'ensemble narrative des récentes méta-analyses

Gerhard Andersson^{1,2}, Per Carlbring^{3,4}, Nikolai Titov^{5,6}, and Nils Lindefors²

Abstract

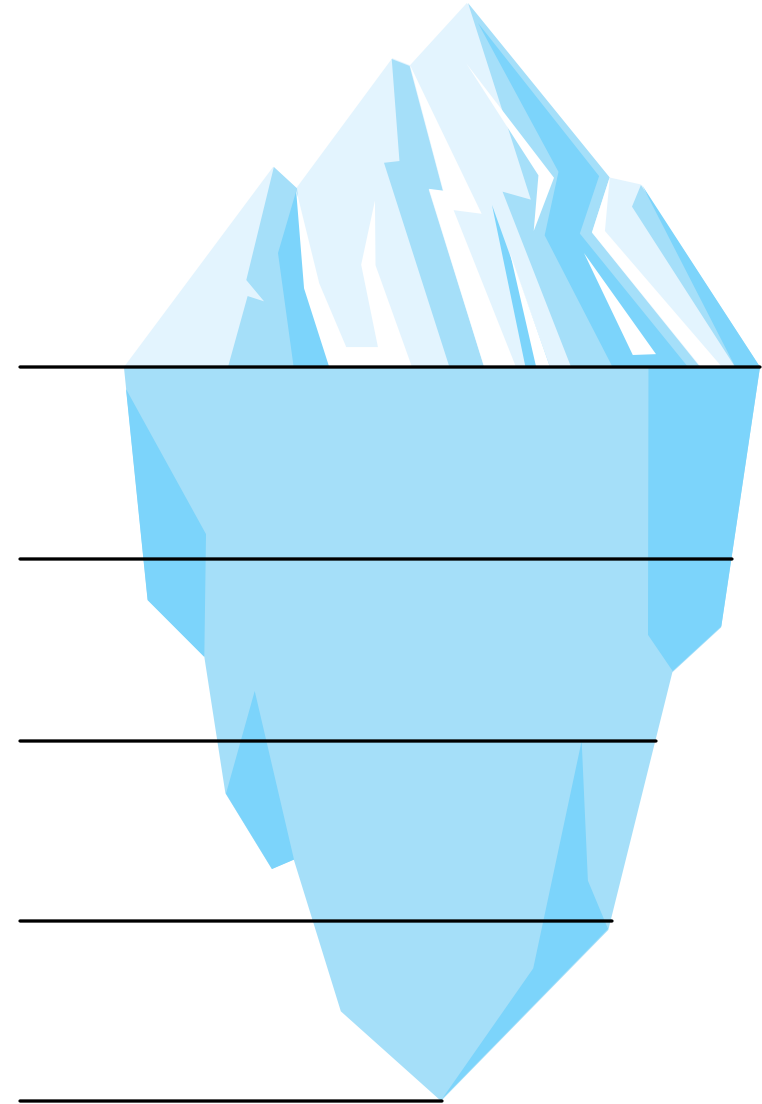
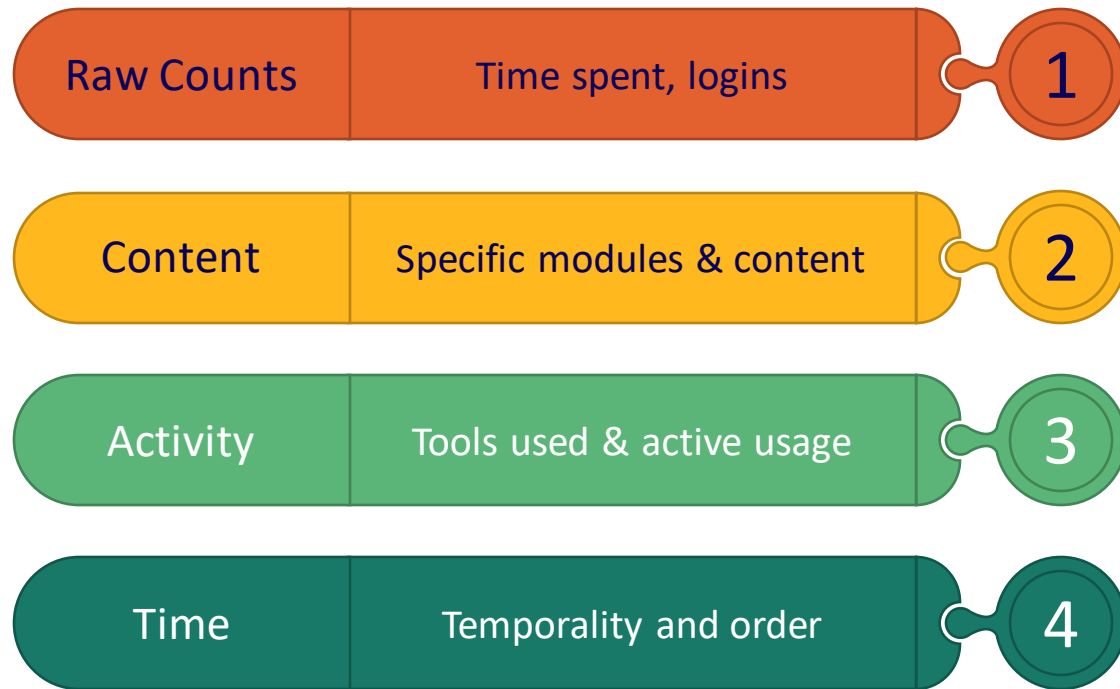
Internet-delivered cognitive behaviour therapy (ICBT) has existed for 20 years and there are now several controlled trials for a range of problems. In this paper, we focused on recent meta-analytic reviews of the literature and found moderate to large effects reported for panic disorder, social anxiety disorder, generalized anxiety disorder, posttraumatic stress disorder, and major depression. In total, we reviewed 9 recent meta-analytic reviews out of a total of 618 meta-analytic reviews identified using our search terms. In these selected reviews, 166 studies were included, including overlap in reviews on similar conditions. We also covered a recent review on transdiagnostic treatments and 2 reviews on face-to-face v. internet treatment. The growing number of meta-analytic reviews of studies now suggests that ICBT works and can be as effective as face-to-face therapy.

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Background

DMHIs have been largely treated as a black box



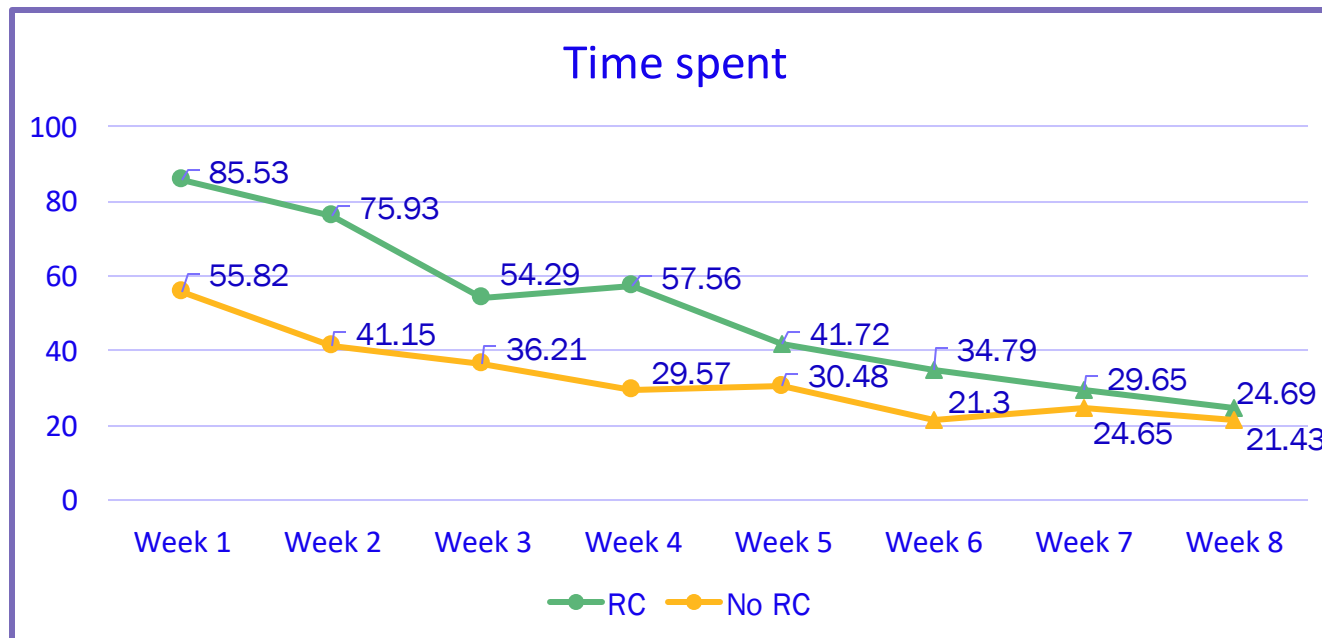
Background

Original Paper

Exploring the Relationship Between Usage and Outcomes of an Internet-Based Intervention for Individuals With Depressive Symptoms: Secondary Analysis of Data From a Randomized Control Trial

Angel Enrique^{1,2}, PhD; Jorge E Palacios^{1,2}, MD, PhD; Holly Ryan², MSc; Derek Richards^{1,2}, PhD

- High-level granularity
- RCT data (n= 216 participants)
- More usage is associated to better outcomes



Background



- **Aim:** Identify behavior patterns based on how people engage with a DMHI program for depression and anxiety
- De-identified dataset (54,604 users)
- Supported by clinicians
- Naturalistic setting (14 weeks of usage)
- Deep level of granularity
- Include all analytic events
- Unsupervised deep learning models

JAMA Network | **Open**[™]



Original Investigation | Psychiatry

A Machine Learning Approach to Understanding Patterns of Engagement With Internet-Delivered Mental Health Interventions

Isabel Chien, MEng; Angel Enrique, PhD; Jorge Palacios, MD, PhD; Tim Regan, PhD; Dessie Keegan, MSc; David Carter, PhD; Sebastian Tschatschek, PhD; Aditya Nori, PhD; Anja Thieme, PhD; Derek Richards, PhD; Gavin Doherty, DPhil; Danielle Belgrave, PhD



Space from Anxiety & Depression

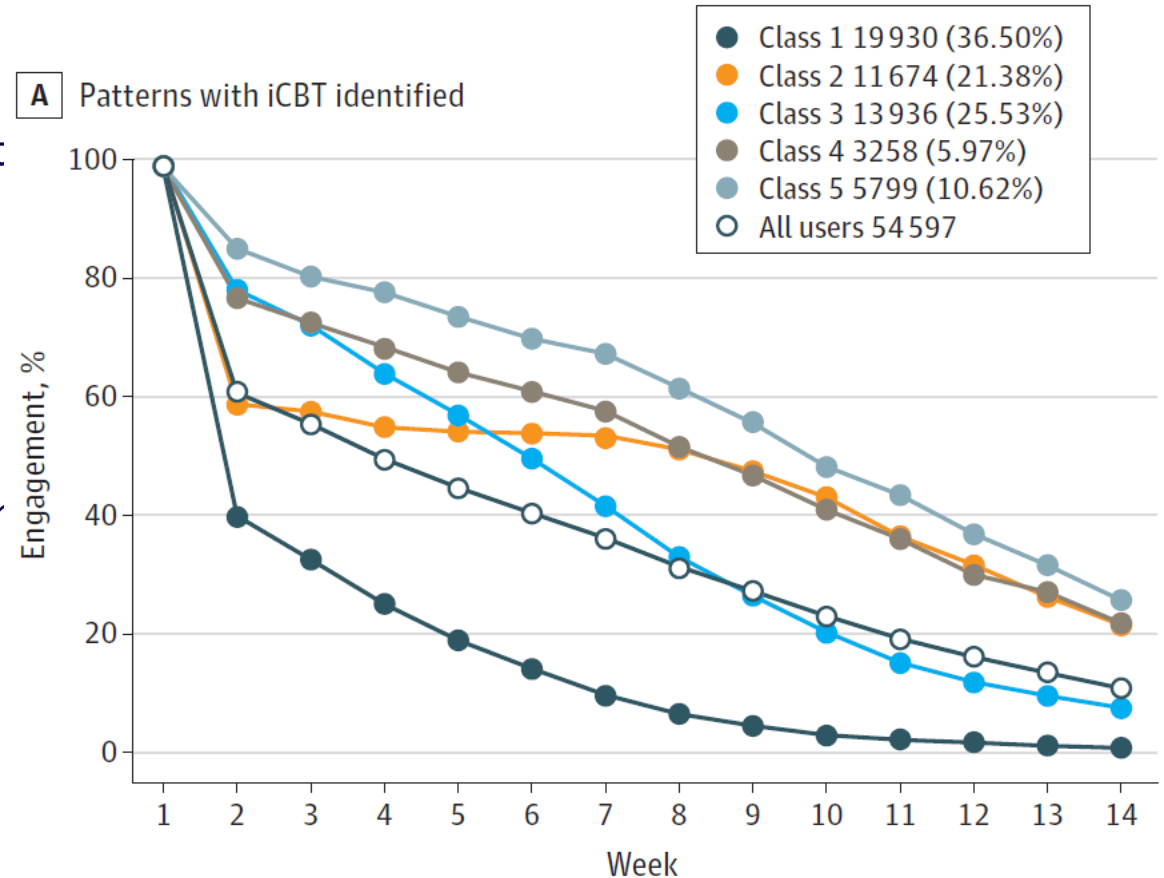
Background



Original Investigation | Psychiatry
A Machine Learning Approach to Understanding Patterns of Engagement With Internet-Delivered Mental Health Interventions

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- 5 classes of engagement patterns
 - class 1 (low engagers),
 - class 2 (late engagers),
 - class 3 (high engagers with rapid disengagement)
 - class 4 (high engagers with moderate decrease)
 - class 5 (highest engagers)
- Differences in the quantity and type of content seen
- Diverse and complex patterns difficult actionable steps



Background

- Aim: Understand how different support strategies correlate with clinical outcomes.
- Study: 234,735 supporter messages to clients
- ML methods to:
 - (i) clustering supporters based on client outcomes;
 - (ii) extracting and analyzing linguistic features from supporter messages;
 - (iii) identifying context-specific patterns of support

Understanding Client Support Strategies to Improve Clinical Outcomes in an Online Mental Health Intervention

Prerna Chikersal¹, Danielle Belgrave², Gavin Doherty³, Angel Enrique⁴, Jorge E. Palacios⁴, Derek Richards⁴ and Anja Thieme²



Background



Findings

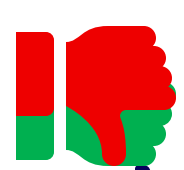
- Concrete, positive and supportive feedback from supporters are strongly associated with better outcomes
- Identifying Effective Context-Specific Support Strategies
 - supporter messages that typically achieve higher client outcomes contain more words that are positive, supportive, related to social behaviors, and less abstract;
 - tend to be shorter than less successful messages
- Difficulty to infer causality or the direction of the associations

CHI 2020 Paper

CHI 2020, April 25–30, 2020, Honolulu, HI, USA

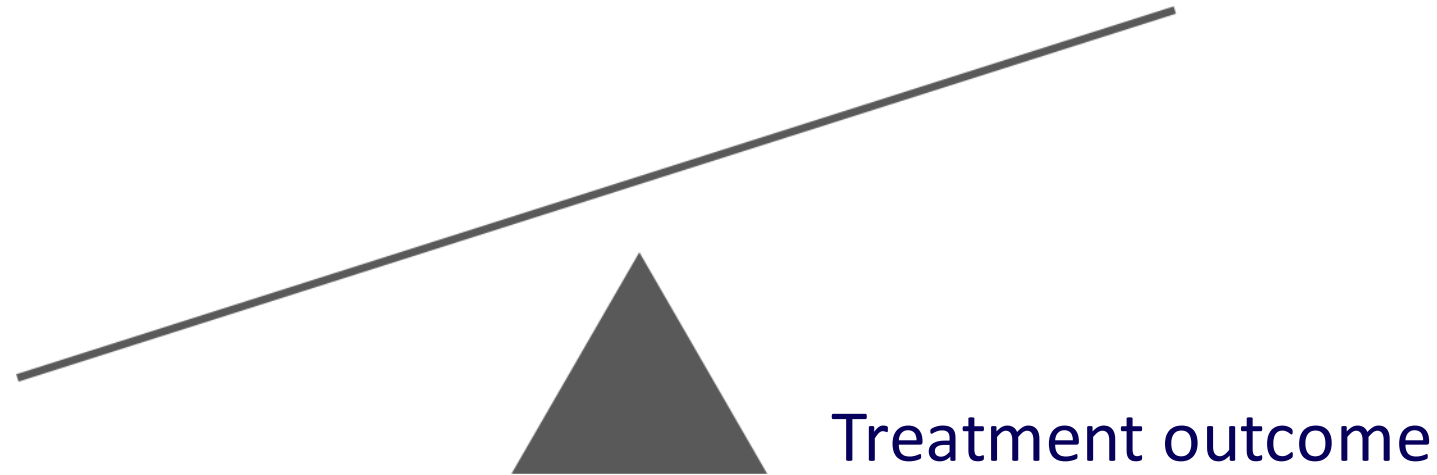
Understanding Client Support Strategies to Improve Clinical Outcomes in an Online Mental Health Intervention

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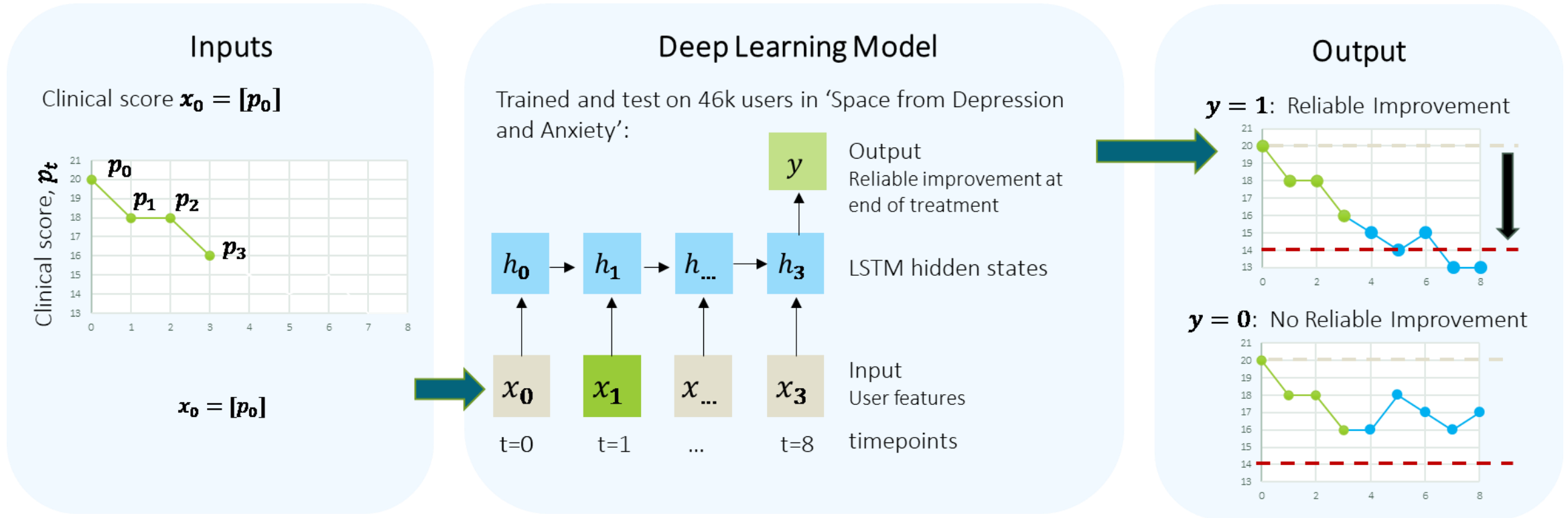


Machine Learning for Outcome Prediction

State-of-the-art deep learning model to predict **Reliable Improvement** in symptoms of depression (PHQ-9) and anxiety (GAD-7)



Machine Learning for Outcome Prediction



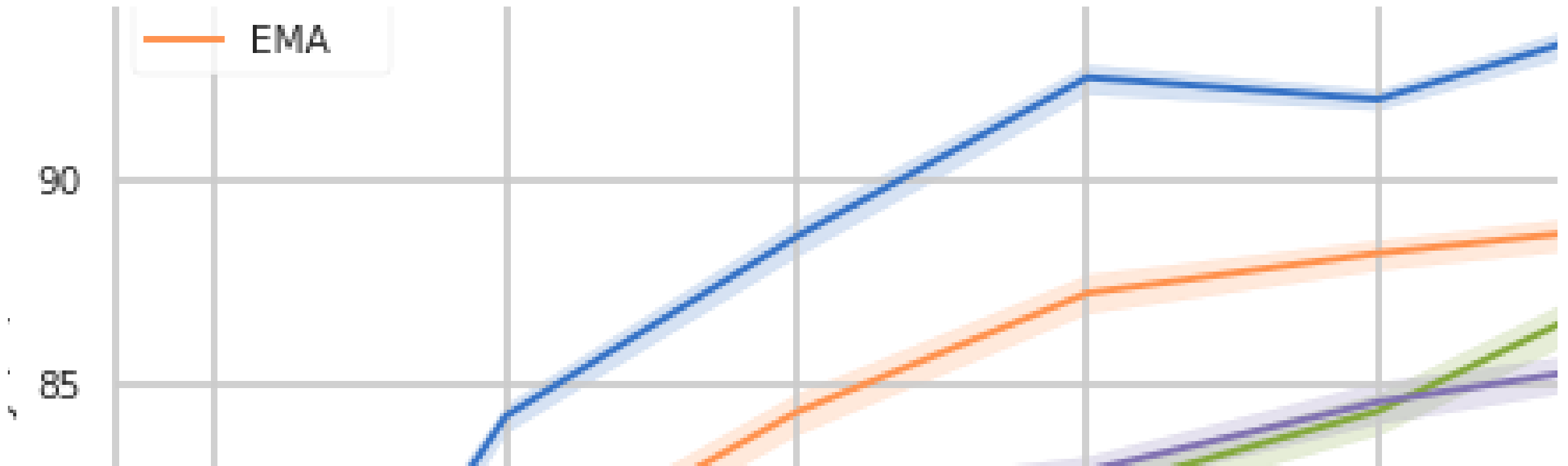
Data split 70:20:10 (training, validation, testing)

3-layer RNNs with a 50-dimensional hidden layer with LSTM units to encode client features at different treatment time points

Machine Learning for Outcome Prediction

PHQ-9: Predictive Accuracy

GAD-7: Predictive Accuracy



Prediction accuracy >87% for PHQ-9 and GAD-7 after three measures

Considerations for Real-World ML Application

Specific use scenario + work practices of iCBT coaches
Challenges for integration within routine clinical care

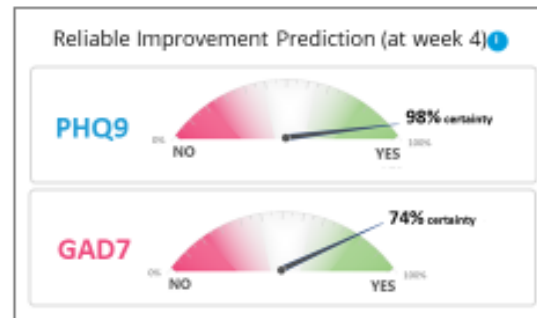


Considerations for Real-World ML Application



Design mock-ups illustrating various prediction output ideas for user research

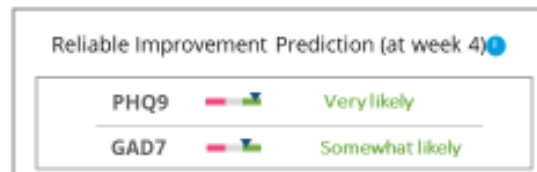
I Wheel Indicator



II Multiple Outcomes Table

Treatment Outcome Predictions	PHQ	GAD
Mental Health Trend	Improving	Improving
Chance of Reliable Improvement	Very likely	Likely
Chance of Reliable Recovery	Likely	Likely
Chance of Reliable Deterioration	Very Unlikely	Unlikely

III Visual Cue + Text



IV Population Comparison



V Dashboard Feedback



Considerations for Real-World ML Application



Navigation: Clients | Coaches | Invites | Programs | Tools | John | Help

Mary Democlient

CURRENT PROGRAM: Space from GAD
ACTIVITY: ✓✓✓
REVIEW STATUS: Review is now due - see below
PREDICTED OUTCOME: ⓘ

We have used Machine Learning to identify "patterns" in client mental health progression, based on their questionnaire scores. This research was done using 54,604 previous SilverCloud clients. These predictions, based on the patterns, have been shown to be 87% accurate with 3 sets of questionnaires results.

The measurements below show the chance that this client will achieve reliable improvement, defined as a **significant** reduction in their questionnaire score after 8 weeks. Specifically:

- 6 points for PHQ9
- 4 points for GAD7

Read this [article](#) for more information on how these predictions are calculated.

Based on **PHQ9**:

Very unlikely to improve ⓘ

[View scores →](#)

Navigation: Clients | Coaches | Invites | Programs | Tools | John | Help

Maryann Berkshire

CURRENT PROGRAM: Space from Depression & Anxiety
ACTIVITY: ✓
REVIEW STATUS: Review is now due - see below
PREDICTED OUTCOME: ⓘ

Based on **PHQ9**:

Very likely to improve ⓘ

84% chance that this client will achieve reliable improvement after 8 weeks.

Based on **GAD7**:

Very likely to improve ⓘ

[View scores →](#)

LANGUAGE: en
SILVERCLOUD ID: SC-DEM-W8SH
JOINED: 14 months ago (01/14/2020)
SIGNUP: Invited

[Note](#)

A Considerations for Real-World ML Application

Key concerns about prediction data

- Risk of over-reliance: Uncritical acceptance + trust in data insights 'as is'
- Risk of negligence of interpersonal side: treating clients 'as a number'

Responsible use of algorithms within healthcare

- Balancing data insights with clinical expertise
- Careful communications of use + purpose of ML within the interface
- Importance of staff training

The background is a solid teal color. Two thick, yellow, hand-drawn brushstroke lines are present. One line starts at the top left and curves downwards and to the right. The other line starts at the bottom left and curves upwards and to the right, meeting the first line's path. The text is centered horizontally and vertically between these two lines.

Research to test outcome prediction model

Background work:

- **Validation of model accuracy**
 - **Pilot in US site with a sample of coaches**
 - **Feedback from coaches, clinical team to design final version**
- Interviewed 6 coaches on 3 separate occasions on use of the prediction tool as an enhanced feature of the platform
 - High level of trust on accuracy (87% from 3 weeks)
 - Positive predictions reaffirmed support
 - Negative predictions led to more time spent on review to help get user on track
 - More likely to help novice coaches, experienced have routine / harder to adapt



Using a deep learning probability model to deliver feedback-informed, internet-delivered psychotherapy for depression and anxiety: A randomised-controlled trial within routine clinical practice

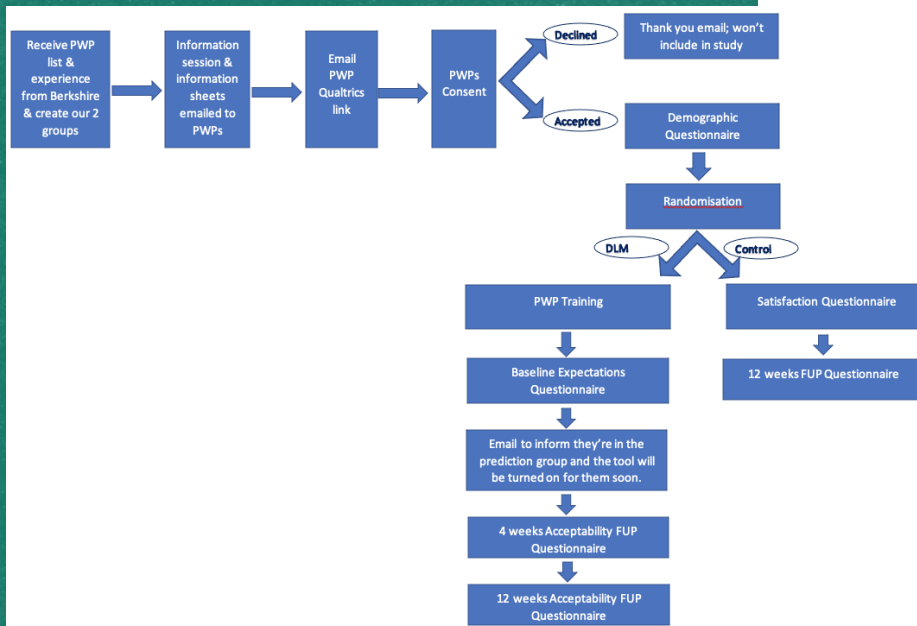
Key concepts of the study:

- Feedback-informed psychotherapy (FIT)
- Deliberate practice
- Performance of the model

RCT on DLM to deliver FIT for depression and anxiety

Methods:

- All coaches from a single health provider in UK, randomized into two groups, and split into novice and experienced coaches
- Questionnaires at baseline, 4, 12 weeks
 - Usefulness, ease of use, attitude, intention to use
 - Deliberate practice
 - Other questions on the experience of using tool



*RCT on DLM to
deliver FIT for
depression and
anxiety*

Primary objectives:

- Is there a greater percentage of reliable improvement in the clients of coaches using the prediction tool [i.e. pre-post changes in PHQ-9 and GAD-7 scores]?
- Do coaches find the prediction tool acceptable?

Secondary objectives:

- Are coaches engaging in higher levels of deliberate practice as a result of the prediction tool?

*RCT on DLM to
deliver FIT for
depression and
anxiety*

Training considerations for coaches prior to trial kick-off:

- Model description and interpretation
- Prediction scenarios
- Addressing concerns on human vs computer aspect
- Ethical responsibilities

Impact of the RCT

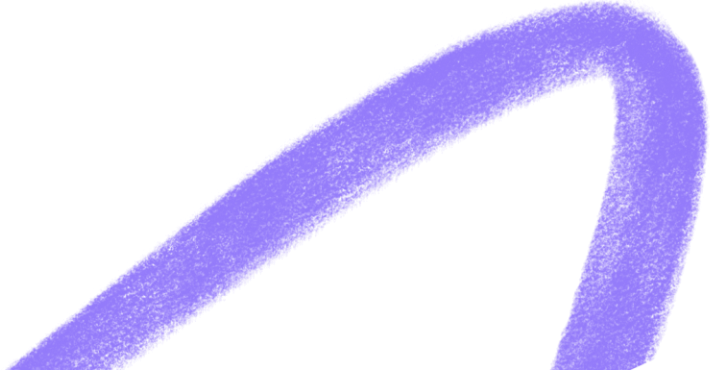
Clinical contributions

Scientific contributions



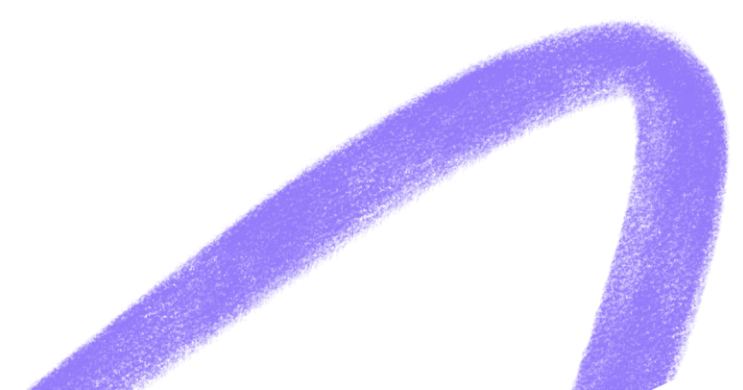
- Validation of Microsoft/SilverCloud collaboration and process
- First trial of its kind, creating FIT model for use and evidence-base generation in research
- Service level: better outcomes
- Coach level: more informed clinical decisions, prioritization
- Client level: treatment that is more tailored to their individual needs
- Leveraging ML to employ FIT and enhance digital health delivery and effectiveness

Key takeaways

- Complexity behind the questions the model is trying to answer
 - What are the meaningful data features?
 - Trade-offs: what is the ML model giving back that is clinically useful and impactful?
 - Insights generated on continual basis, from all sides (dev, product, coaches, users, etc)
 - Continuing to validate long-term
- 

What's Next

- *Digital Health Science into the future*
- *SilverCloud Research into Amwell*



**Thank you to all
those who
contributed to this
work!**



**SilverCloud: James Bligh, Gavin Doherty, Dessie Keegan,
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Regan, Usman Munir, Isabel Chien, Ryutaro Tanno,
Hannah Murfet, Junaid Bajwa, Aditya Nori**



Thank you