# Personalizing Mental Health Interventions for Young Adults through Adaptive Text-Messaging Experiments

**Yi Xuan Wang, Bingcheng Wang, Harsh Kumar, Fred Haochen Song, Joseph Jay Williams**

UNIVERSITY OF TORONTO

## Introduction

- Accessible digital mental health (DMH) interventions have the potential to **narrow the service provision gap**, where the demand for mental health support exceeds the **availability and scope** of traditional care. [5]
- Text message-interventions have been shown to promote behavior change, with **automated messaging** holding promise in providing a foundation for large behavior change processes and supporting positive mental health. [1, 3]
- However, determining **engaging** and **effective** interventions remains a challenge due to the dynamic and multifaceted nature of user experience.

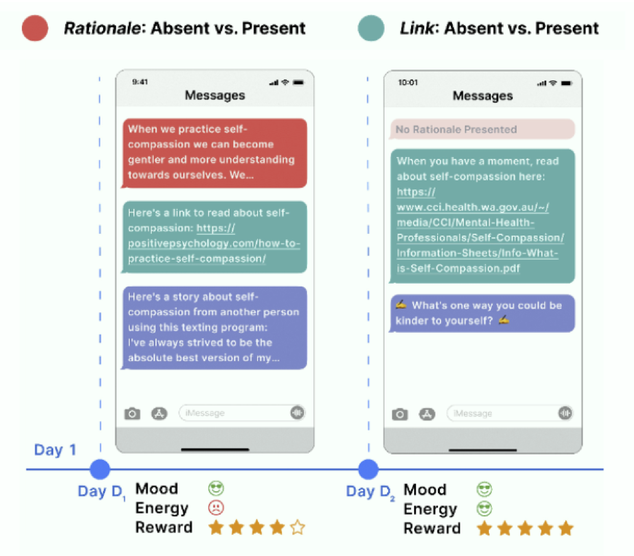



**Figure 1:** An example sequence of messages a user could receive within the 8-week-long intervention. Figure presents how text-message intervention changes to better suit user's need based on contextual variables like Mood and Energy

### Contextual Bandits

- Contextual Bandits are optimization algorithms that leverage contextual variables to balance their exploration and exploitation phases, with the goal of maximizing a certain reward function. [2]
- Contextual Bandits have been widely applied across various domains to personalize interventions based on individual need [4]
- By breaking the cycle of optimizing for the average participant, contextual bandits may help address disparities in mental health outcomes and provide more effective support for those in need

### Research Goals

- We developed a system that utilizes Multi-Armed Bandit (MAB) algorithms personalizing text-messaging interventions for improving young adults' mental health.
- **Hypothesis** : We hypothesize that the contextual bandits will have more engaging and effective message intervention compared to uniform random.

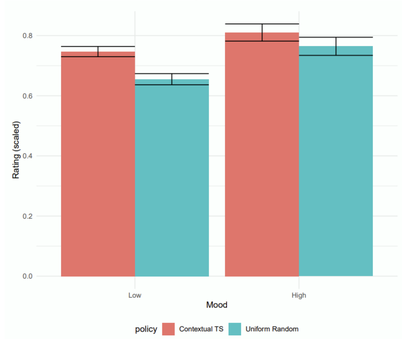
## Methods

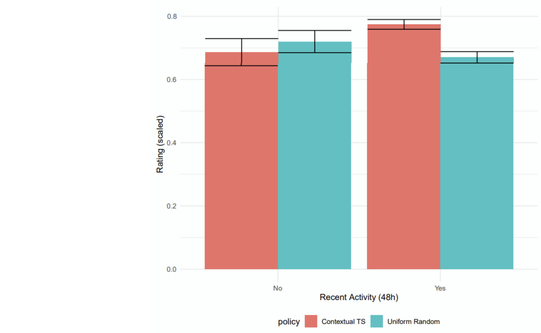
- In this preliminary iteration, young adults (n = 1100) aged 18-25 enrolled in an 8-week modular text-message-based intervention where users would receive modular messages (visually represented in Figure 1) 2-3 times a week.
- We assigned 50% of participants to contextual bandits and traditional uniform random (UR) assignment
- We structure the analysis around two independent variables of the intervention, Rationale (present vs absent) and Link (present vs absent). The goal is to decide whether or not a 'Rationale' and/or 'Link' should be provided for introducing a particular psychological strategy.
- At the end of each protocol or sequence of messages, the user were asked "How helpful were these messages? Reply with a number 1 (not at all helpful) to 5 (very helpful)". This rating is used as the reward (dependent variable) for the bandit algorithm.

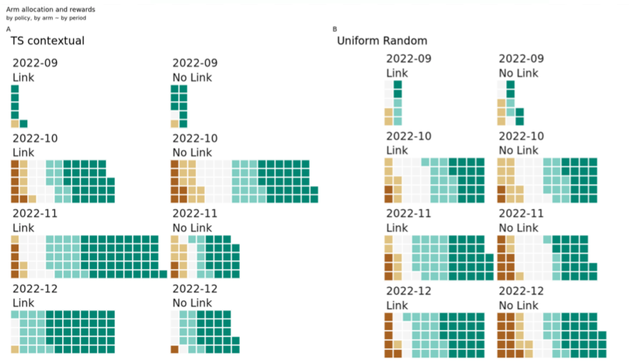
## Results

- Using contextual Thompson Sampling, we assign participants to arms based on the changing probability that these arms have better reward (the real-time reward ratings)
- In such a way, contextual bandits can quickly latch onto shifts in reward between the two arms, which results in more participants being assigned to the "better" arm and **higher mean reward**.

**Figure 2:** Average reward (rating of 1 to 5 scaled) using Contextual Bandit versus Uniform Random for "Link" rating for different levels of contextual variables. Top figure shows the distribution for contextual variable Mood (Low vs High).Bottom figure shows the distribution for Activity in last 48 hours (Yes vs No).




## Discussion

- Our findings from this preliminary iteration indicate that contextual bandits can improve reward in users with these text-message interventions (Fig. 3), by accounting for individual contextual differences between individuals.
- These findings have important implications for demonstrating the promising potential of using contextual variables for personalization.
- It also showed the importance of adopting a heterogeneity paradigm in understanding differences in contextual behaviour interventions. [4].

## References

[1] L. C. Abroms, R Whittaker, C Free, J. M. Van Alstyne, and J. M. Schindler-Ruwisch. Developing and pretesting a text messaging program for health behavior change: Recommended steps. 3(4).

[2] S Agrawal and N Goyal. Thompson sampling for contextual bandits with linear payoffs. pages 127–135.

[3] T Bickmore and T. V. Hansen. Some novel aspects of health communication from a dialogue systems perspective. pages 5–12.

[4] C. J Bryan, E Tipton, and D. S. Yeager. Behavioural science is unlikely to change the world without a heterogeneity revolution. 5(8):980–989.

[5] D. Z. Q Gan, L McGillivray, J Han, H Christensen, and M Torok. Effect of engagement with digital interventions on mental health outcomes: A systematic review and meta-analysis. 3.