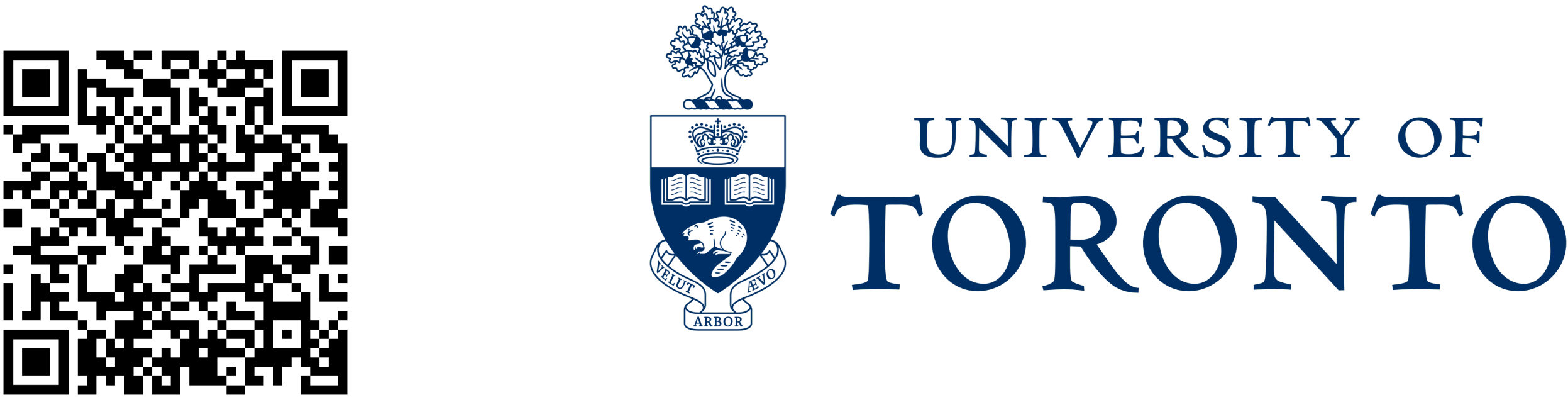# Personalizing Mental Health Interventions for Young Adults through Adaptive Text-Messaging Experiments

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Introduction

• Accessible digital mental health (DMH) interventions offer promise for **narrowing the service provision gap**, where the demand for mental health support surpasses traditional care **availability and scope**. [5]

• Text message-interventions have shown promise in promoting behavior change, with automated messaging providing a foundation for larger behavior change processes and maintaining positive mental health. [1, 3]

• However, determining engaging and effective interventions remains a challenge due to the dynamic and multifaceted nature of user experience.

Contextual Bandits

• Contextual Bandits are algorithms that utilize contextual variables to improve user engagement in web applications [2]

• They account for contextual variables to determine heterogeneity and to personalize interventions based on individual need [4]

• This is relevant for underprivileged populations, providing the tools to break the vicious circle of optimizing for the average participant.

Research Goals

• To address this, 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.
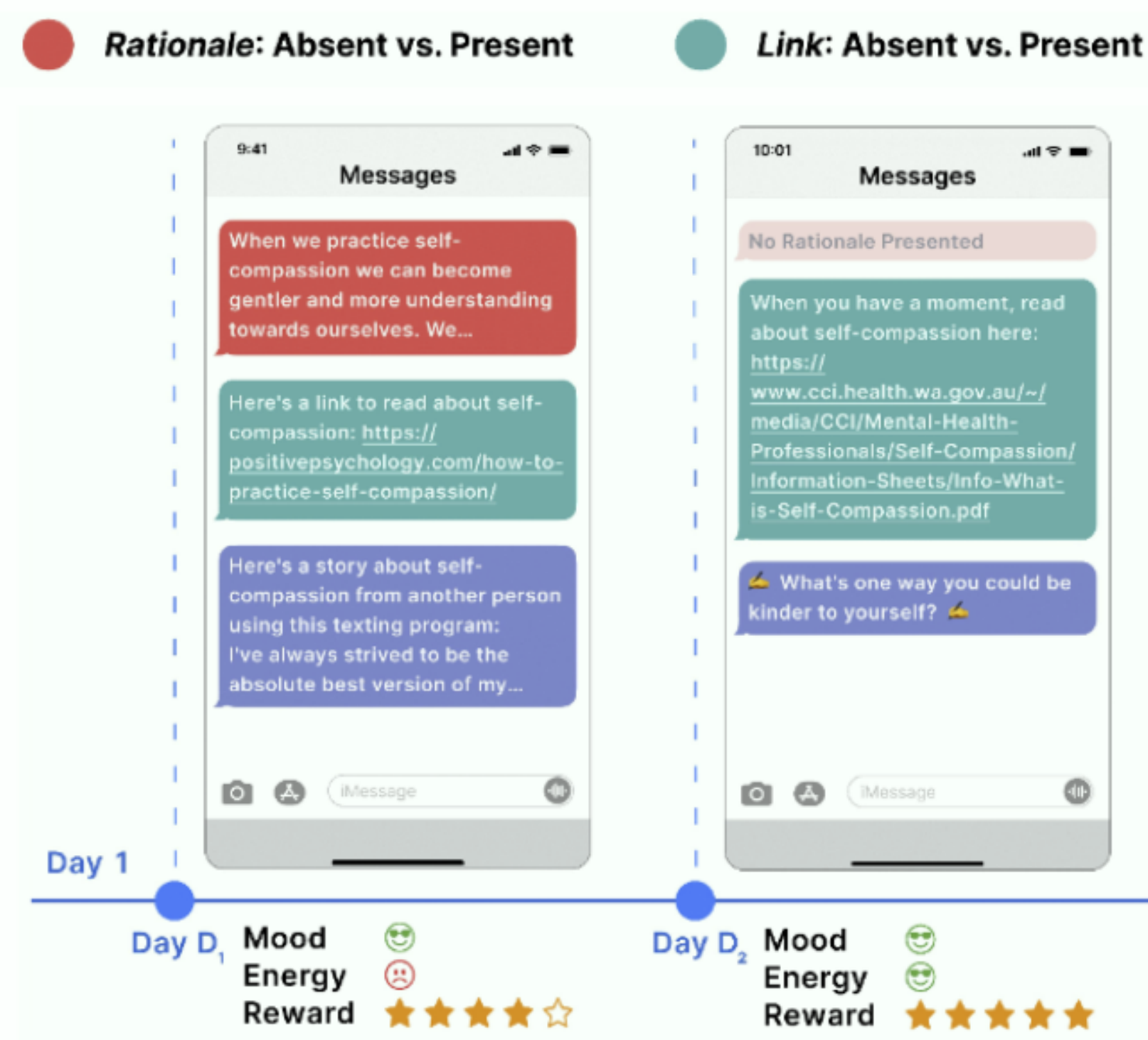

Figure 1: An example sequence of messages a user could receive within the 8-week-long intervention. Figure presents how text-message intervention changes to better suit user's need based on contextual variables like Mood and Energy during each day Di.

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).
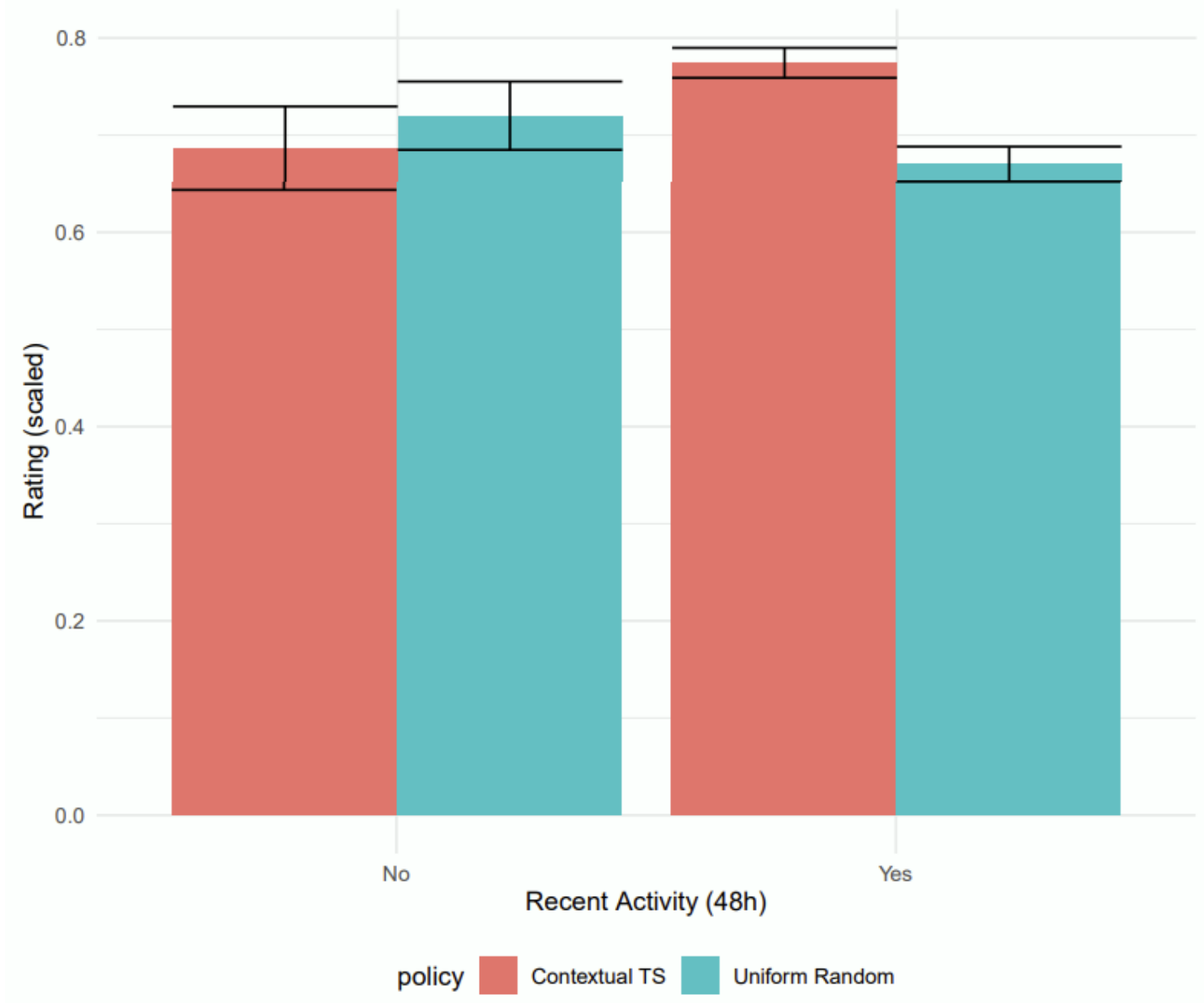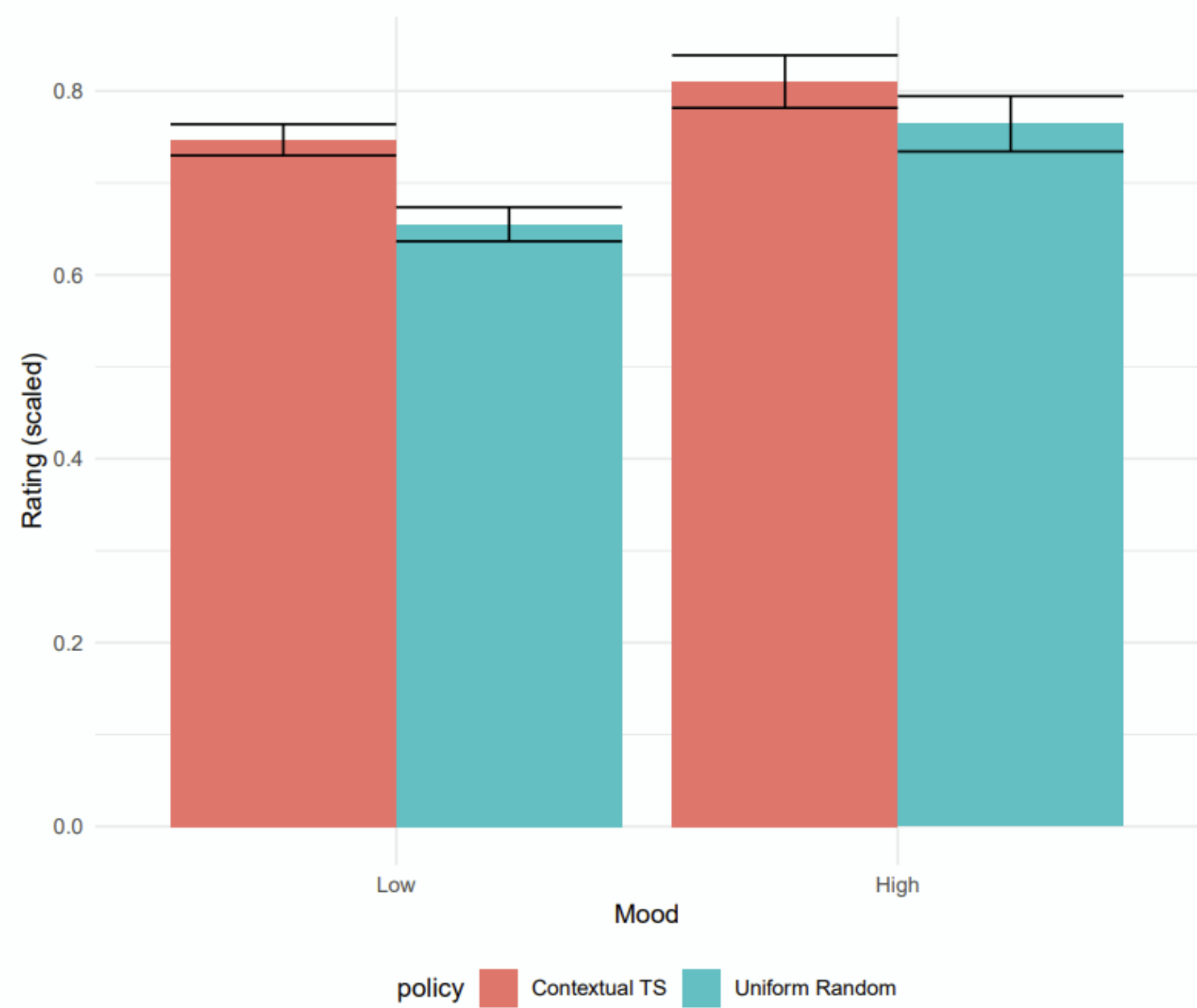

Figure 3: Overall summary including Mean and Standard Error of Mean (SEM) of the rewards collected for the two factors (Link and Rationale). We observe an increase in Mean rewards for both levels of both factors.

Factor	Contextual TS		Uniform Random	
	Present	Absent	Present	Absent
Link	N = 232	N = 175	N = 202	N = 204
	0.790 (0.018)[1]	0.716 (0.024)[1]	0.719 (0.021)[1]	0.640 (0.024)[1]
Rationale	N = 282	N = 167	N = 192	N = 171
	0.736 (0.018)[1]	0.728 (0.025)[1]	0.710 (0.022)[1]	0.703 (0.024)[1]

[1]Mean (SEM)

Discussion

• Our findings from this preliminary iteration indicates 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 adapting a heterogeneity paradigm in understanding difference in contextual behaviour interventions. [4].

Future Work

• Adaptive experimentation are dynamic in nature, thus require many iterations to determine an optimal iteration to maximize reward.

• We suggest that further experimental iteration is needed to uncover the optimal engaging and effective text message intervention for different users.

• By potential accounting for more diverse contextual variables that could help with mental health, we can better cater to underrepresented and vulnerable populations as well. [4].

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