THE PRIMARY CARE COMPANION FOR CNS DISORDERS

Supplementary Material

Article Title: Development and Theoretical Approach to an Adaptive Text Message Program to Promote Well-Being and Health Behaviors in Primary Care Patients

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List of Supplementary Material for the article

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Supplementary Table 1. Additional Information About Algorithm Creation and Message Delivery in This Project

Algorithm creation. Algorithms of various complexity can be used to create a customized TMI. We chose a simple reinforcement algorithm for this demonstration project. This simple algorithm utilizes the percentage “liked” of each type of message, which is calculated from the total actual number of messages “liked” and “disliked” of that type based on ratings (liked/disliked) from participants via text after each message. The algorithm then combines this information with the number of times the participant has provided feedback and with a weighting multiplier that determines how quickly the model adapts to patient feedback. By combining these three variables, the algorithm generates the probability of selecting future messages of that specific type. In this way, all message types have an identical probability of being chosen at the start of the program. However, over time a message type can become more or less likely to be chosen based on the participant’s reaction to similar messages in the past, allowing the TMI content to become curated over time to the specific preferences and needs of patients.

More specifically, though algorithms of various complexity can be used, the simple reinforcement algorithm for this project utilizes the percentage “liked” of each type of message (P), calculated from the total actual number of messages “liked” of that type (L) and the total number disliked (D). We then chose an arbitrary weighting multiplier (W) that can change how fast the model adapts, such that with a larger W there is more rapid favoring of messages with previously “liked” attributes. These values are combined to produce a modifier (B), which changes the calculated probability of selecting future messages of that specific type. In this demonstration project, for a given attribute we chose the following formula:

$B = 1 + (W \times (L/(L+D)) \times L)$. Or, simplified: $B = 1 + (W \times P \times L)$

We selected 1.5 as the arbitrary weight modifier (W) to have a moderate level of evolution of the model. Thus, in practice, this means that if a participant “likes” 4 physical activity education messages (L=4) and dislikes one (D=1), they would have liked 80% (P=0.80) of messages of this type. Using the weight modifier of 1.5 (W), they will then be 5.8 times more likely (B) to receive an activity education message in the future. In this way, all messages start with an identical probability of being chosen, but over time can become more likely to be chosen if the participant likes the attributes of that particular message. Likelihood of message selection becomes stronger with the more total previous ‘likes’ of that type of message. For instance, if a participant likes 10 PP messages in the program, over time, PP messages will be more heavily favored for the next message compared to a newer participant who has only liked two PP messages. Given that messages are selected probabilistically, messages of disliked attributes can be chosen randomly, but will be selected at a lower frequency.

While only five message types were used for this initial clinical demonstration project, the adaptive system can use a larger number of message types to be deployed based on participant feedback. Furthermore, multiple attributes (e.g., PP-based, type of health behavior) can be assigned to a single message, and the algorithm can make decisions based on these attributes instead of a single overall message type (see Figure 3). For example, a given message might encourage performing physical activity with a friend, which might mean this message is labeled as both pro-social and physical activity-related. Depending on the needs of a particular patient population, any set of message characteristics can be used with the system designed for this project.

Message delivery. For the creation of the dynamic message system, messages, message attributes, and user responses were stored in separate tables in a NoSQL database. In the initial trials we used the MongoDB service (https://www.mongodb.com/), which is widely used in industry and healthcare applications. Both the database and the adaptive messaging algorithm were hosted on Amazon Web Services (AWS)—another commonly utilized service in the healthcare and health insurance industry (https://aws.amazon.com/health/)—while the messages themselves were sent via Twilio (https://www.twilio.com/). Utilizing these three web services, this dynamic messaging system can receive participant feedback about messages in real time, incorporate this feedback into dynamically updated personal preferences, and utilize those preferences to send increasingly personalized messages to the participant.

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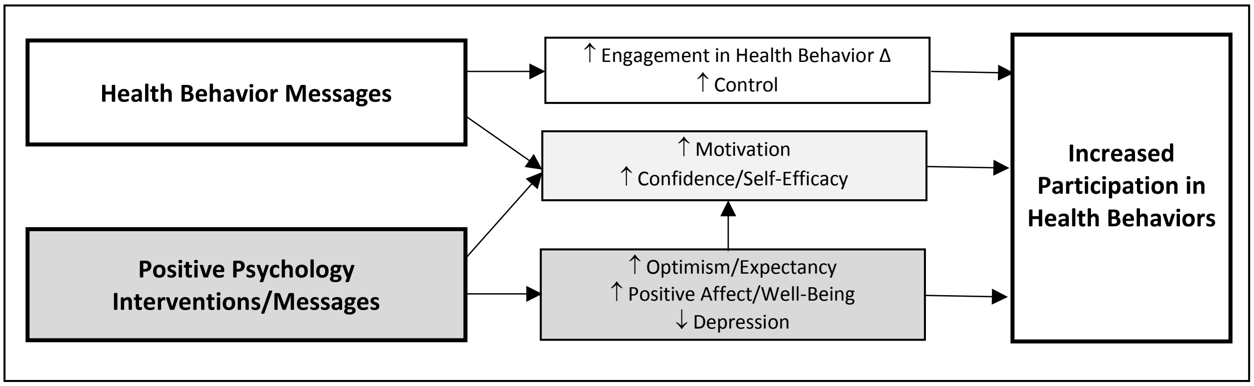
Supplementary Figure 1. Conceptual Model Outlining Potential Mechanisms by Which the Combined TMI May Promote Health Behaviors[32-45]



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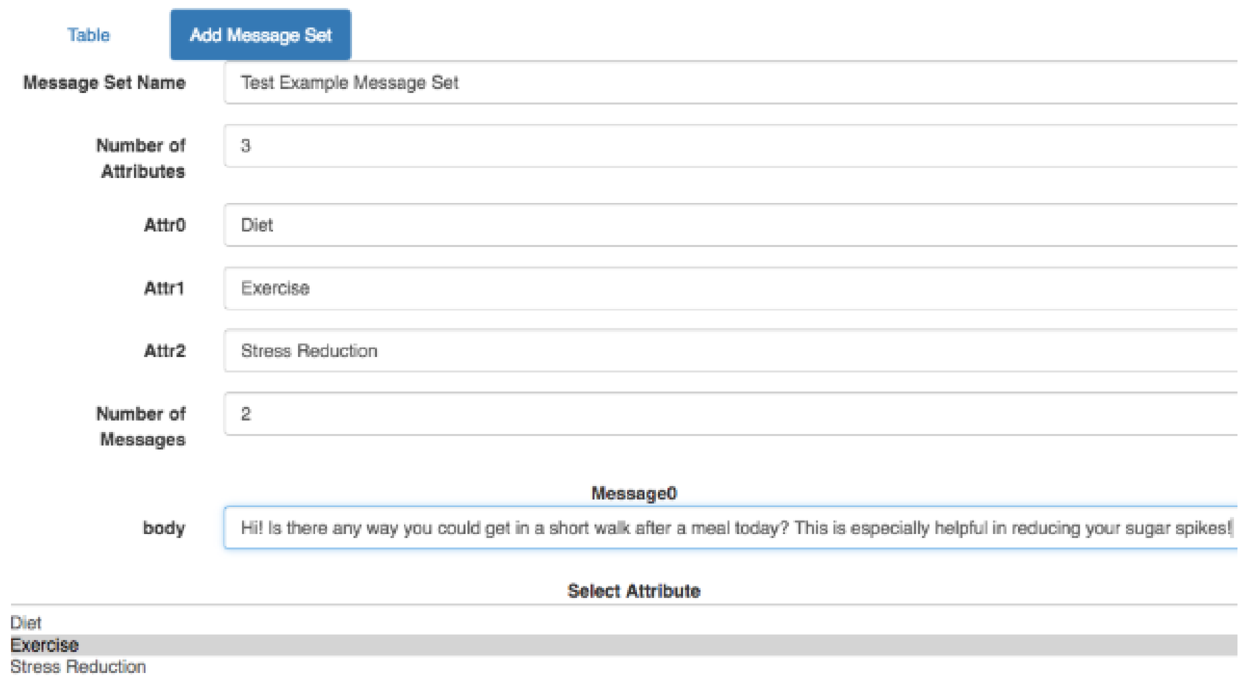
Supplementary Figure 2. A Screenshot Showing How the Internal Program Is Designed to Set Up an Algorithmic Messaging System



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