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Persuasive Technology: Designing Mobile Health Triggers to Impact Health Behavior

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Completed Research

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Abstract

Persuasive technology is an interactive computer technology designed to alter people's attitudes or behaviors. Behavior change in mHealth solutions is often promoted through the use of specific messages called triggers. Fogg, in his work, identified three types of triggers: sparks, facilitators and signals. Each trigger is believed to have a different intent. Sparks provide motivation, facilitators support achievement of a goal, and signals provide simple reminders. While these triggers are theoretically distinct, specifications of the message development are absent in the literature. Here, we describe the challenges in implementing the different types of triggers into comparable but distinct messages. We describe the iterative development used to operationalize trigger messages into reliably distinct categories.

Keywords

persuasive technology, mHealth triggers, behavior change, health information technology.

Introduction

Utilization of cell phones and in particular smartphones continues to rise as the latest Pew Research Center data shows 95% of American adults own a cell phone and 81% own a smartphone ("Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally | Pew Research Center," 2019). The volume of smartphone ownership creates an opportunity to transform healthcare through the development and utilization of mobile health (mHealth) technology (Fogg, 2003; Marcolino et al., 2018; McCarroll, Eyles, & Ni Mhurchu, 2017). MHealth applications can lead to appreciable health outcomes when integrated with behavior change theories and persuasive technology (Goyal et al., 2016; Lentferink et al., 2017). A characteristic of persuasive technology (PT) is delivering the right information at the right time through triggers such as messages and notifications (Fogg, 2009). While PT suggests the means of shaping behavior change, this framework does not provide a prescriptive methodology on how to implement content that is useful and usable (Mohr, Schueller, Montague, Burns, & Rashidi, 2014). The challenge is in crafting triggers to achieve a particular goal. This delivery of content to promote a particular behavior is a process and not as a single act or instance (Matthews, Win, Oinas-Kukkonen, & Freeman, 2016; Orji, Nacke, & Di Marco, 2017). Appropriately designed triggers facilitate the development of important behavioral characteristics such as achieving self-efficacy through accomplishing small tasks which leads to support in accomplishing larger tasks needed in chronic disease management (Chiang, Guo, Amico, & Lester, 2018; Mohr et al., 2014).

Creating behavioral change techniques through persuasive design and trigger delivery can take on many forms. Some of the most effective techniques include the utilization of self-monitoring components, tailoring, gamification, and utilization of push messaging for engaging patients in the management of their healthcare (Goyal et al., 2016; Mayberry, Mulvaney, Johnson, & Osborn, 2017). Selecting behavior change models and persuasive technologies that align with mHealth principles is vital to creating sustained behavior change. One proposed model of behavior change in mHealth solutions is the Fogg Behavior Model (FBM). The FBM states that if a person is to perform a target behavior he or she must: 1) be sufficiently motivated, 2) have the ability to perform the behavior, and 3) be reminded to perform the behavior (Fogg, 2009). Fogg proposes that triggers for each of these stages can support change. While the FBM model

specifies the need for these triggers (sparks, facilitators and signals), little is known about the variability and interaction across trigger types. Studies exploring different triggers often consider the implementation of the trigger message (text, video, etc), but little has been studied beyond the use of signals (reminders) and to a degree sparks (mainly just simple motivation statements) for their effectiveness (Muench & Baumel, 2017).

Another model is the persuasive system design (PSD) by Oinas-Kukkonen and Harjumaa which groups persuasive features into four categories: primary task support, dialogue support, credibility support and social support (H. Oinas-Kukkonen & Harjumaa, 2008; Win, Mullan, Howard, & Oinas-Kukkonen, 2017). These four categories are then delineated into 28 principles representing mechanisms such as: personalization, praise, reminders, suggestion and recognition (Geuens et al., 2016; Harri Oinas-Kukkonen & Harjumaa, 2009). Implementing these types of persuasive design features is important as individuals often know that a particular behavior is beneficial for them to adhere to but actually sustaining the behavior is difficult. Many individuals face similar roadblocks in their attempt to sustain a health behavior such as: lack of motivation, lack of ability to perform a specific behavior (Fogg, 2009; Halttu & Oinas-Kukkonen, 2017). This is where appropriately designed trigger messages can help individuals accomplish behavioral tasks such as increasing motivation, improving ability to perform a specific behavior/act. The existing literature has focused mainly on tailoring messages to match an individual's motivation or ability level or utilizing simple reminder messages to prompt an immediate action (Brar Prayaga et al., 2018; Burner, Menchine, Kubicek, Robles, & Arora, 2014; McGlone, Stephens, Rodriguez, & Fernandez, 2017). As these studies have focused on targeting interventions toward individuals, little has been done to evaluate messages aimed at a population (ex. individuals with type II diabetes) level rather than personal level (Weymann, Härter, Petrak, & Dirmaier, 2013). Creating persuasive message constructs that influence behavior change by population type could increase the permeation of these types of behavior change deliveries through mHealth technology. In our study, we describe the development of distinct messages that reliably convey spark and facilitator messages at a group level.

The objectives of our study are to develop spark and facilitator triggers that are reliably interpreted for their intended function (i.e. to motivate and support achievement of a goal.) We describe here the iterative process of (re)defining and evaluating these messages first in a cohort of experts and then within a more representative group of potential users. We chose to utilize spark and facilitator triggers from the Fogg Behavior Model to frame our trigger messages due to their potential impact on behavior change, specifically improving self-efficacy. These two triggers provide constructs for motivation and simplifying behavior which are key to producing a targeted behavior (Fogg, 2009).

Fogg Behavior Model

In Fogg's Behavior Model he identifies three prerequisites as well as three specific types of triggers called: sparks, facilitators and signals (Fogg, 2009). While the FBM model specifies the need for these triggers, little is known about the variability and interaction across trigger types. A spark trigger is designed for individuals who lack motivation, a facilitator trigger is designed for individuals who lack ability and a signal is simply a reminder message to perform a specific behavior (Fogg, 2009). Research has shown that individuals usually identify with behavioral trigger messages such as motivational cues when they are delivered (Burner et al., 2014). In many cases, reminder messages have been added to existing or developed behavior change interventions to serve as cues but don't necessarily have behavioral constructs embedded in them (Brar Prayaga et al., 2018; Lee et al., 2014). Many individuals want to make a distinct lifestyle change (i.e. individuals with chronic disease) however they may lack the motivation to consistently stick with the new behavior (Dennison, Morrison, Conway, & Yardley, 2013). Developing triggers through a framework like the FBM can help individuals achieve the type of motivation or increase in ability that they need to accomplish and sustain specific behaviors (Sittig et al., 2020).

Designing the Triggers

Sparks

According to Fogg, sparks are elements of motivation. These sparks can encompass 1) pleasure or pain, 2) hope or fear, and 3) social acceptance or rejection (Fogg, 2009). Although each of these motivators includes the potential of motivation of behavior through the avoidance of a negative consequence, we utilized only positive spark triggers in our designs (i.e. forms of pleasure, sense of hope and social acceptance). For instance, to foster feelings of social acceptance, we direct individuals to view materials including "people

like yourself are able to accomplish similar goals" instead of providing language such as "people like yourself accomplish goals that are more complex than yours". This type of spark is intended to motivate the participant to engage in positively modelled behavior motivated by feelings of similarity to their peers and by extension potential similarity to their success.

Patient motivation support has been linked to improvements in self-management and continued performance of a desired behavior (Fu, McMahon, Gross, Adam, & Wyman, 2017; Partridge et al., 2017). Designing distinct messages that incorporate the different segments of a spark trigger content is difficult. A recent study focused on the end-user designing the type of motivational message but did not quantify what key elements of the message a user identifies with as a motivational cue (Schindler-Ruwisch, Leavitt, Macherelli, Turner, & Abroms, 2018). Deciphering which words, contextual layout and form of motivational cue that elicits an interpretation of a spark trigger is critical to the sustainable design of these trigger messages. Figure 1 delineates a tree diagram annotating the constructs we utilized to motivate (spark) and increase ability (facilitator).
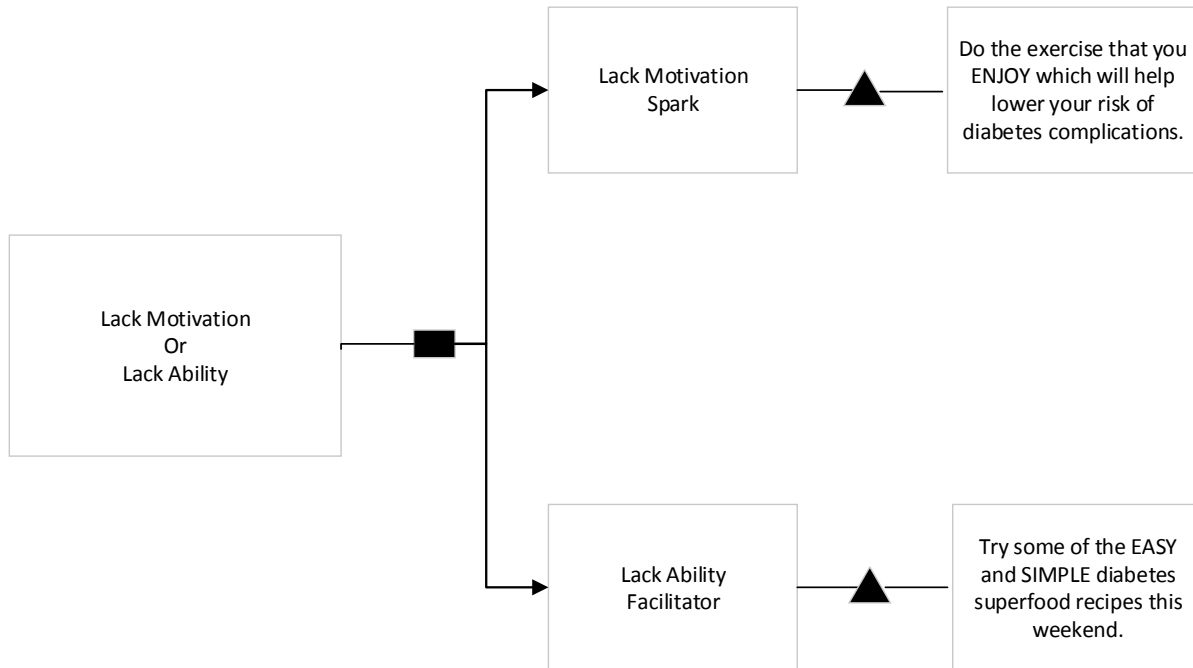

Figure 1. Spark and Facilitator Tree Diagram

Facilitators

Like sparks, facilitators are intended to support behaviors that are currently challenging to an individual. Facilitators promote change by helping individuals understand they already possess the needed means to achieve success. Fogg's notion is that people who lack ability can be persuaded to try through messages that show tasks are accomplishable and that the participants have everything they need at hand to complete a task or behavior (Fogg, 2009). For example, one means of facilitating adherence to diet and nutrition behaviors may be to help participants recognize they can prepare appropriate meals with readily available items (e.g. "make a delicious dessert with items you have on hand.").

Methods

Trigger messages were created as part of the development of an mHealth application called capABILITY to support behavior management of type II diabetes (Sittig et al., 2020). The content of capABILITY includes education modules on diet, exercise, medication adherence, preventative measures, glucose monitoring, stress and environmental factors. Spark and facilitator triggers were developed to help individuals with type II diabetes accomplish smaller behavioral tasks and engage with capABILITY more frequently in an effort to improve self-efficacy and self-care management. Given the limited published research studies involving spark and trigger messages, we wanted to determine which type of behavioral trigger message would cue

individuals to engage with capABILITY quicker post message delivery and stay engaged (duration of time in the app) in the utilization of capABILITY. In order to accomplish this, we incorporated educational type II diabetes content from the American Diabetes Association, American Association of Diabetes Educators and the Summary of Diabetes Self-Care Activities Measure along with the core concepts of FBM to design the spark and facilitator triggers.

For the spark messages we focused on elements of motivation. The FBM provides three core motivators and each one has two components. For example, motivator 1 focuses on providing an immediate motivation using either pleasure or pain. Essentially, each motivator has a positive and negative connotation. We created our spark messages around the positive constructs of motivation in an attempt to elicit positive and sustainable motivation. For example, we designed the following spark message related to exercise: Do the exercise that YOU ENJOY which will help lower your risk of diabetes complications! This message would be delivered during the exercise module as we would also provide a list of exercises that can be done at home, outside or at a gym. Each spark trigger was designed with a focus on pleasure, hope or social acceptance. We designed the social acceptance spark triggers with an emphasis on showcasing language that the reader can interpret as: others like me are able to accomplish these tasks.

The triggers were evaluated for interpretation reliability through three distinct iterations of testing. In the first iteration, subject matter experts evaluated three spark and facilitator triggers. In the second iteration of testing, the subject matter experts evaluated five redesigned spark and facilitator messages. In the last round of testing, we utilized participants who were unfamiliar with persuasive technology to evaluate five newly designed spark and facilitator triggers. All participants were provided with operational definitions of spark and facilitator triggers along with examples (see Figure 2). Each participant was asked to individually classify each message as a spark or facilitator based on their interpretation of the message content and operational definitions.

Trigger Definitions

Sparks - Motivate behavior so that users feel ready to take action. This is accomplished by increasing motivation utilizing one of the following three motivation elements via text, video, graphics etc: 1.) pleasure or pain, 2.) hope or fear and 3.) social acceptance or rejection.

Pleasure or Pain = Motivation to something that is happening in the moment and the result of the motivation statement is immediate.

Hope or Fear = Hope is the anticipation of something good happening. Fear is the anticipation of something bad happening or the anticipation of some type of loss.

Social acceptance or rejection = Social acceptance is motivation through social acceptance. Social rejection is the motivation to avoid being socially rejected.

Example: Other individuals like yourself have managed to control their diabetes while adding healthy snacks/desserts to their diet. Eating these can still be fun and pleasurable. Click the following link to view yummy but healthy snack ideas!

Facilitators - Trigger the behavior by making the behavior easier to do/accomplish while not requiring resources that the user does not have at the moment. This is accomplished by increasing the simplicity of accomplishing a specific task through text, video, graphics, etc.

Example: Make a low-carbohydrate dessert with items you have on hand. Click the plate to review the peach crisp recipe (uses canned peaches and other items that you probably already have). No peaches – No problem! Use what you have!

Figure 2. Trigger definitions with example messages

For the facilitator messages we focused on simplifying tasks to inform the messages we developed. The FBM provides a construct of six simplicity factors which focus on making behavior simpler (time, money, physical effort, brain cycles, social deviance and non-routine). We concentrated our message constructs around the following simplicity factors: time, money and physical effort. These three simplicity factors interconnected well with the challenges that individuals with type II diabetes have. For example, we designed the following facilitator message related to diet: Try some of the EASY and SIMPLE diabetes superfood recipes this

weekend! This message would be delivered while a participant is using the diet module of capABILITY and in particular the week that focuses on diabetes superfoods. A list of diabetes superfood recipes from the American Diabetes Association are provided in the diet module of capABILITY, saving the participant time and physical energy in an effort to reduce the barriers for performing a specific behavioral task. The trigger messages were designed to coincide with the content the user would be accessing that week in capABILITY. We felt this would help to promote behavior change and cue the user to accomplish a task easier if the trigger messages were related to the educational content they were receiving via capABILITY. For the first iteration of testing we developed three facilitator messages that would be reviewed by subject matter experts.

Evaluating the Triggers

Subject Matter Expert and End User Review

The triggers were evaluated in two consecutive rounds of expert feedback and iterative redesign. Eight subject matter experts (SME) were drawn from the faculty members at the School of Biomedical Informatics (University of Texas Health Science Center at Houston) and College of Nursing and Allied Health Professions at the University of Louisiana at Lafayette. The participants were recruited based on their familiarity with usage of persuasive technology and mHealth applications. Using a survey tool, (Survey Monkey) each expert independently reviewed trigger messages and provided their interpretation of the message as either a spark or facilitator. Following this independent classification, each participant provided feedback to the author regarding their categorization choices through semi-structured interviews. Participants were not provided feedback as to the 'correctness' or adherence of their response to the authors' expected classification system. This was completed in two rounds of participations.

10 participants unfamiliar with persuasive technology theory were recruited to complete a similar evaluation of trigger messages. The participants evaluated 10 new triggers (5 sparks and 5 facilitators) and The procedure followed the survey and interview processes described above. However, as these participants were unfamiliar with these terms, formal definitions of sparks and facilitators were provided (See Fig. 2).

Results

SME Review of Triggers

Consensus for the meaning of the triggers was not unanimous. Although two of the messages were agreed on by 6 of the eight SMEs, other messages had little agreement. Interviews with SMEs revealed struggles with ambiguity in our proposed language. As participants reported viewing each message as potentially motivating as well as containing kernels of support for facilitating a sense of ability. For example, the message "thinking about your meals ahead of time allows for snack substitutes" lead to conflict in our participants. Reviewers did not feel confident in interpreting this trigger as a spark (the intended meaning.) Some individuals felt that it was focused on ability (here to think and plan). As we did not provide feedback to the participants, respondents were unaware that their interview responses in some instances contradicted their classification of items on the survey. We believe this lack of consistency/confidence reflects their noted ambiguity in interpretation of the correct trigger message.

Redesigning the Triggers

Using the feedback from the first evaluation, we attempted to simplify the trigger statements to highlight the intent of the message. A common comment in the feedback was confusion on the diabetes management content from the trigger itself. Essentially, the diabetes education content and merging of the spark/facilitator content was leaving the message recipients unclear as to what the intent of the message was. The new message constructs focused more on the delineation of the type of trigger and less on the educational content. We felt this would improve message interpretation and allow the message to focus on the behavioral characteristics of the specific type of trigger. Table 1 shows some of the changes to the messages including reduction in overall message length, conciseness of educational content from the message itself, and a focus on the behavioral construct of the trigger. For the spark triggers we focused the behavioral construct around positive motivation (hope, pleasure and social acceptance) and for the facilitator trigger we focused the behavioral construct around simplifying the task. We then set a limit of 40 words per message based on SME feedback.

Iteration 1 - Spark Trigger	Iteration 2 - Spark Trigger
Thinking about your meals ahead of time allows for snack substitutes. Swap the regular bread on your sandwich for low-calorie bread and add a couple small cookies (your total carb count remains the same for the meal). Incorporation of snacks can be fun and rewarding!	You can still have snacks while managing your diabetic diet. Snacks can help curb hunger while adding a nutritious energy boost to your day!
Iteration 1 - Facilitator Trigger	**Iteration 2 - Facilitator Trigger**
A properly stacked pantry makes creating healthy snacks easy! Stock your pantry with the following to create great snacks that are 5 grams of carbohydrates or less: 15 almonds, 3 celery sticks + 1 tablespoon of peanut butter, 1 hard-boiled egg, 1 cup sliced cucumbers + 1 tablespoon ranch dressing or 10 goldfish crackers.	In order to cook quick diabetic friendly meals at home your pantry must be stocked appropriately. Click the menu icon to review an article on how to stock your pantry/kitchen! A quick easy solution!

Table 1. Spark and Facilitator Triggers showing simplification process.

Second SME Review

Following the redesign of triggers to include less educational content and a focus on positive motivation (sparks) and simplifying behaviors (facilitator) the reviewers evaluated 10 new trigger messages (5 spark and 5 facilitator). Greater consistency and consensus in categorizing of these messages was noted. Average agreement for spark triggers is now 80% versus 54% from iteration 1, and the average agreement for facilitator triggers is now 90% versus 67% from iteration 1 (see figure 3). Interviews with SME reviewers revealed easier identification of facilitator triggers due to consistent content about "making a task easier to accomplish" and "having all resources on hand to accomplish that task". The reviewers also mentioned that spark triggers lacked cueing key words and sentence structures like the facilitator messages. The spark messages that focused on social acceptance did have cueing words that the SMEs picked up on like "Yourself". Other spark messages that focused on hope and pleasure were less transparent to the reviewers.
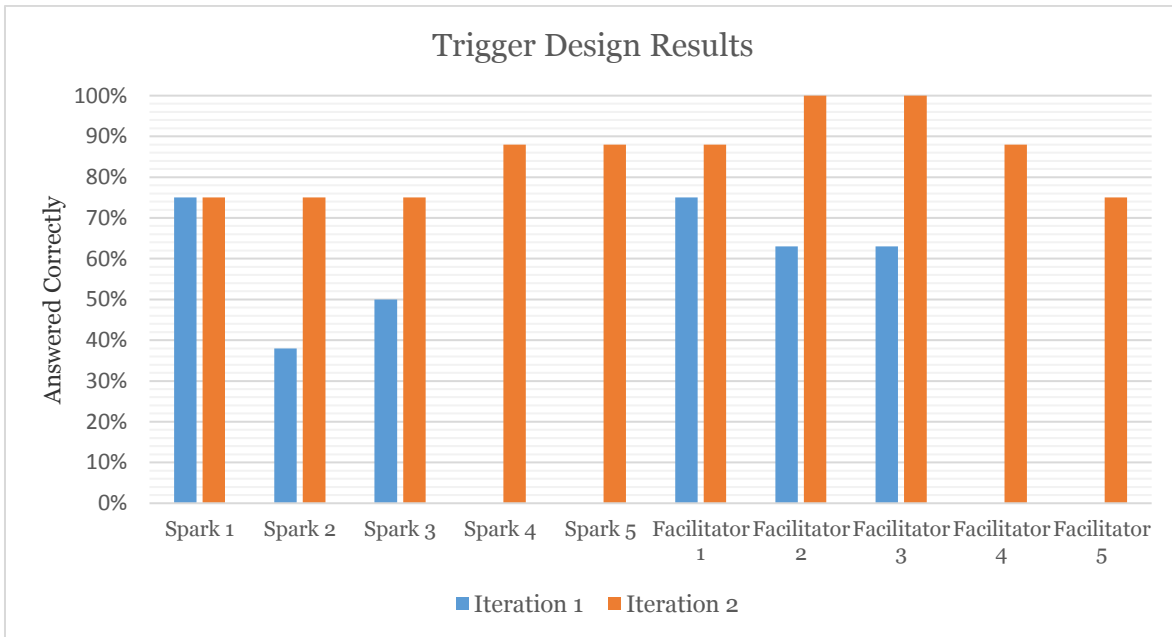

Figure 3. Trigger Design Results: Iteration 1 compared to Iteration 2

Iterative Modifications

Using the interview feedback from the second evaluation, we redesigned all the facilitator triggers to include terminology indicative of: "making a task easier to accomplish" and/or "having all resources on hand to accomplish that task". This included using cueing terms that the SME reviewers identified with such as simple and easy. For spark triggers we attempted to capitalize key motivational words in the messages in an effort to prominently indicate its intent and to focus on hope and pleasure. This new design feature was intended to cue the reviewers in the final iteration to recognize hope and pleasure in the same way they identified with social acceptance in terms of a spark trigger.

Final Evaluation

The final iteration of triggers was evaluated by 10 participants naïve to the study and unfamiliar with persuasive technology. We felt that the SMEs had reached message interpretation saturation and that it was critical to have the new messages constructs evaluated by individuals that were unfamiliar with persuasive technology. The procedure followed the survey process as described for iterations one and two. The participants evaluated 10 newly designed trigger messages (5 spark and 5 facilitator). Classification of trigger messages into distinct and separate categories was achieved in the third round of evaluations. Average agreement between participant classification and intended categorization (sparks and facilitators) was 94% compared to just 73% for iteration 1. In all the previous iterations, the spark messages were significantly less identifiable than the facilitator triggers. In the final iteration the participants were in 93% agreement for spark triggers and 95% agreement for facilitator triggers (see figure 4). In the interviews post evaluation, the participants expressed their confidence in selecting the triggers as either a spark or facilitator. Comments from the participants included: "the capitalization of motivational words led me to select spark" and "using words such as easy let me know it was a facilitator".
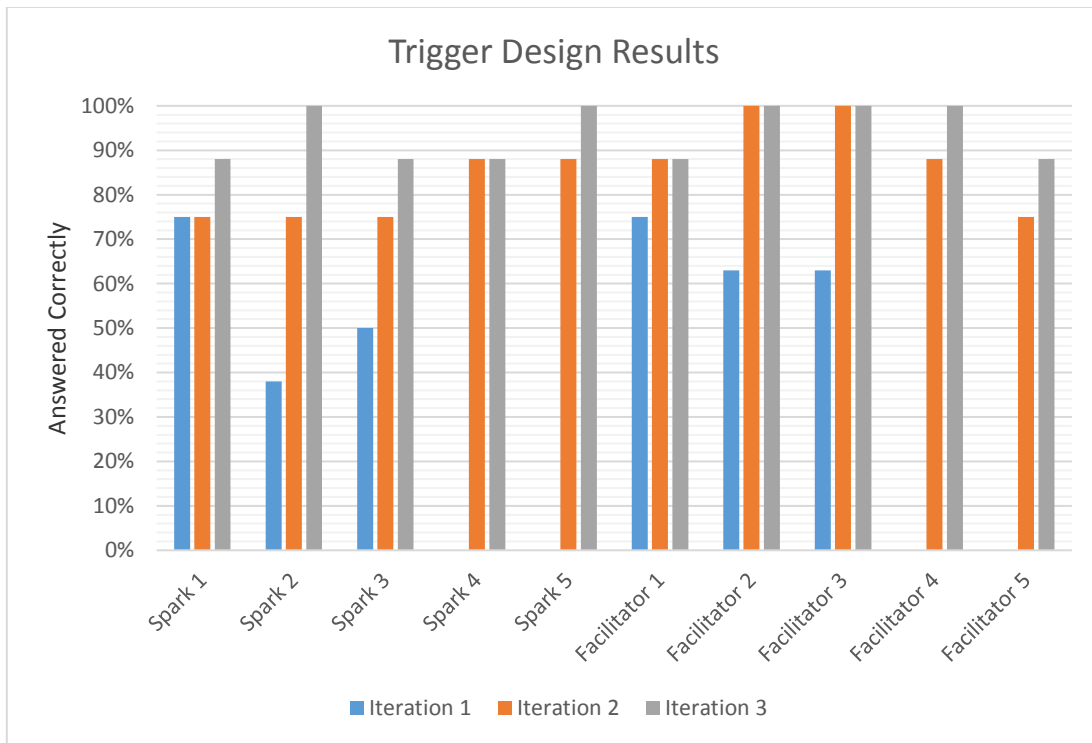

Figure 4. Trigger Design Results: Iteration 3 compared to Iteration 1 and 2

Discussion

The Fogg Behavior Model states that in order for a person to accomplish a specific behavioral task the following must occur: be motivated, have the ability/capacity to perform the behavior and be triggered to perform the behavior (Fogg, 2009). Appropriately designed spark and facilitator triggers could be the missing link in an attempt to cue individuals to perform specific behavior within mHealth applications.

Our evaluation process indicates that although it is possible to achieve a high degree of consensus regarding the intent of a trigger (i.e. to motivate or to support recognition of ability), careful crafting of the message is required. The reflections from our participants highlighted their dependence on cueing terms 'ease', 'accomplishment', and 'simple steps' to indicate facilitators. Language around positive motivational constructs such as 'enjoyment' supported the recognition of sparks within our study population. Following the positive motivational constructs from the FBM can assist in designing spark messages that resonate with the reader. The reviewers more easily identified social acceptance as a spark trigger throughout all iterations and in the first two iterations struggled with aligning messages that contained hope and/or pleasure as a spark trigger. To improve hope and pleasure identification we capitalized key motivational words such as REWARDING, ENJOYABLE and YOURSELF which enhanced the interpretation and recognition of the trigger message being a spark. Capitalizing these cueing words appeared to bridge the gap between the educational content and the behavioral wording constructs of the spark triggers. In addition, reducing the message content to 40 words or less allowed us to create concise messages that improved correct interpretation. This was a key finding after the first iteration as reviewers were losing the behavioral meaning of the trigger message due to the length of the educational components within the message. In addition, when we redesigned the trigger messages with a clearer delineation of the trigger type and a more concise educational content, we improved the message interpretation.

Iterative development and user-testing of trigger messages is essential to designing trigger messages that produce a desired outcome such as increasing motivation or improving the ability to perform an action. Designing trigger messages around a concise centralized educational theme while combining constructs of the Fogg Behavior Model allows you develop population-based messages (i.e. Type II Diabetes). This would give tools such as mHealth applications, patient portals and wearables the ability to deliver trigger messages by a chronic disease population without the need for tailoring detailed messages. Tailoring could then focus on mHealth system use criteria (i.e. personalization, timing of message delivery) which would hopefully improve consumer interaction throughout the mHealth lifecycle.

Limitations and Future Work

The study described in the paper has limitations. A convenience sample of participants was utilized with a small number of messages evaluated. Further research needs to be conducted to fully understand how larger and more varied groups decipher trigger messages. Additional research needs to be conducted to determine if the type of educational content influences the deciphering of trigger type (spark vs. facilitator). The next step in this research program is to experimentally compare the relative effectiveness of different trigger types on behavior.

Conclusion

MHealth applications are increasingly incorporating trigger messages or cues along with behavioral constructs (i.e. Social Cognitive Theory) to enhance behavior change (Muench & Baumel, 2017). Our findings suggest that trigger messages require evaluation of their reliable interpretation prior to deployment in mHealth design. Simply developing and deploying motivational messages (sparks) without validating their interpretation can lead to unintended deciphering outcomes. The challenge is ultimately understanding how your intended audience will interpret these messages, operationalizing the common definition and following the structured methodology when generating instances. Our results indicate this might include, breaking triggers into two parts: 1) behavior change/perform action now and 2) the prompting with terms specific to each trigger type to ensure proper interpretation).

This study has demonstrated that user-testing of persuasive triggers messages is needed to ensure reliable participant interpretation of the message intent. Appropriately designed and evaluated triggers can help transform low-cost scalable mHealth interventions into functional applications that support patients with

chronic diseases (Burner et al., 2014). In addition, a formal user-testing process helps to eliminate common pitfalls with health communication such as: cultural interpretation, cognitive beliefs, perceptions and behavioral ideology (Muench & Baumel, 2017).

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