BITxBIT: Encouraging Behavior Change with N=2 Experiments

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Abstract
In this work we introduce an experimental methodology and open-sourced web application designed to promote behavior change and wellbeing within a workplace environment. Colleagues are paired together and asked to design a Behavioral Intervention Technology (BIT) uniquely customized to suit their partner's behavior change goal. We present the results of a preliminary evaluation of the experiment, and suggest ways to further improve and expand our experiment design.

Author Keywords
Behavior change; wellbeing; N=2

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H.5.m [Information interfaces and presentation (e.g., HCI)]: User Interfaces.; J.4 [Computer Applications]: Social and Behavioral Sciences

Introduction
Although many of us aspire to improve our behavior – eat healthier food, exercise more, sleep better, etc. — behavior change is often a struggle. Interventions designed to improve behavior often fail, even when participants are highly motivated to change [8]. For example, despite overwhelming evidence that physical activity is important in decreasing the risk of a large array of health problems

[15][3], including premature death [1], adherence to exercise programs is typically very low. A comprehensive review of studies on exercise adherence showed that participant dropout rates typically reach 50% after 6 months [7]. Only 20% of people who have the goal to lose weight are able to maintain long-term weight loss [16].

Several reasons for the lack of success in behavior change interventions have been proposed. For example, generic interventions that ignore the needs of the individual may lack the power to drive behavior change. Material that is tailored to the individual tends to be more effective [4]; a meta-analysis of 57 studies found that tailoring health behavior messages improved behavior more than generic interventions [12]. Similarly, many studies have found that social support is extremely important for fostering behavior change (e.g. [6] [2] [5]). In addition to social support, social obligation and peer pressure can be powerful influences in changing behavior [10].

This work presents a system called BITxBIT, designed to leverage social pressure and build behavior change interventions specifically tailored to one person's needs. The name BITxBIT (pronounced *bit by bit*) comes from the term Behavioral Intervention Technology (BIT) [11], which refers to any technology developed to aid personal behavior change in daily life. The idea behind BITxBIT is to pair members of a workplace together, and task each person with designing a BIT to achieve their partner's behavior change goal. Essentially, BITxBIT represents a large scale behavior change study in which each participant acts as both a researcher and a subject in an N=2 experiment. Each person receives a custom solution to their behavior change problem designed tailored to their individual goals and situational circumstances. Collectively, a diverse set of solutions and approaches to behavior change is created.

Social obligation is created between each person and their partner, as the partner invests effort in getting to know the person and designing a BIT for them. For the same reason, social connections within the workplace are strengthened, which in itself promotes wellbeing [14].

This paper will describe the overall design of the BITxBIT experiment, introduce open-sourced code for a web application to support it, and present the results of a preliminary user evaluation. By providing these materials, we hope to allow other labs and workplaces to implement BITxBIT in their own environment. We believe this approach will not only make use of the diverse set of talents, skills, and ideas of the people within a given workplace, but build community and encourage a culture that recognizes and emphasizes the importance of personal wellbeing.

Related work

Other researchers have investigated the effects of peer pressure and customization on behavior change. In a study of the effects of peer pressure on physical activity, researchers gave a monetary reward based on participants' physical activity levels, either to the participant themselves, or to the participant's peers [10]. Not only was rewarding participants' peers a far more cost-effective strategy, but the participants in the peer-reward group showed much higher evidence of long-lasting behavior change. While behavior change studies have begun to explore the usefulness of tailored interventions (e.g. [4] [12]), scientists in the medical domain are actively promoting a movement towards N=1 experiments, where each subject is her or his own treatment and control, and treatments are specifically optimized to suit one patient's needs [9]. The central idea behind N=1 experimentation is deep investigation of every subject, with emphasis on treatments or interventions that elicit 'demonstrable changes in observed behaviors' [13].

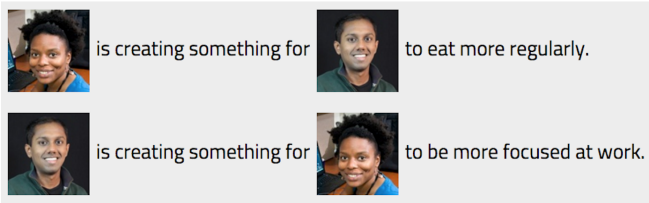

Figure 1: Example goals provided to participants, demonstrating how two participants are paired together.

Study design

BITxBIT is designed to be carried out within a period of approximately four months in a workplace environment or university lab. As presented above, the concept behind BITxBIT is to randomly pair any two members of the lab together and task them with designing personalized, unique solutions to each other's behavior change goals. Participants are asked to choose a goal related to general wellness. Example goals include "be more diligent in physical therapy", "drink more water", or "make time to meditate" (see Figure 1). After participants get to know their partners and design solutions to solve their behavior change problems, an anonymized version of the solutions can be collected into a shared repository. Thus, while each solution is created to solve a single person's behavior goal, the whole study produces a large-scale collection of solutions that can be used by anyone with share similar goals.

Preliminary evaluation and design modification

Before beginning the study, informal focus group interviews were conducted with potential participants within the MIT Media Lab to obtain feedback. While the responses received in these interviews were generally positive, major concerns were raised in relation to two general themes. The first concern related to the random matching process. Some students did not like the idea of being paired with a faculty member, and other participants were concerned simply about being paired with someone that they might not like. The second theme was that behavior change goals might be too intimate to share with a coworker or colleague. Participants felt that they might not feel comfortable sharing their goals, and members of the lab administration voiced concerns that students would have to shoulder too much responsibility if a partner chose a goal related to mental health, for example.

In order to account for these concerns, the initial study design was modified. First, provisions were made to allow the study researchers to vet each person's goal to ensure it was appropriate and related to wellness. If a goal required a greater degree of help than a fellow student could provide (e.g. a mental health issue), the participant could be referred to an appropriate service on campus. Because the study researchers would be reading each participant's goal, and because of the privacy concerns voiced in the interviews, participants were instructed to choose a goal that they would be "comfortable talking about at a dinner party with strangers present". To alleviate concerns over the random pairing aspect, participants were given the option to be paired within their own demographic (e.g. student-student, rather than student-faculty).

Final design and timeline

After revising the initial design, a final procedure and timeline for the study was determined and approved by the MIT Committee on the Use of Humans as Experimental Subjects (COUHES). In addition, a website (described below) was constructed to support `BITxBIT` by hosting participants' goals and design solutions, and providing instructions for the program. The study timeline was as follows. First, an initial meeting was conducted to inform

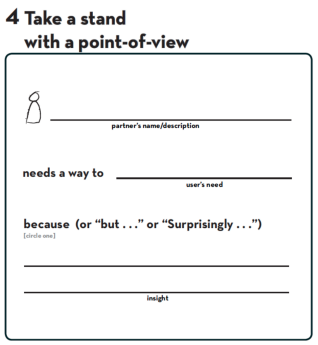

Figure 2: An example of the materials provided in the workshop on user-centric design.

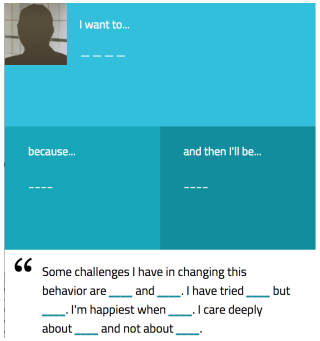

Figure 3: The problem description participants fill out about their own goal on their home page.

participants of the purpose of the study and obtain informed consent. Participants were instructed to choose a behavior change goal using the guidelines described above, and enter those goals using the BITxBIT website. After initial goal setting, participants were randomly paired with another member of the lab outside of their immediate research group, according to the pairing preferences they provided.

To guide participants in designing a BIT for their partner, they were provided with the opportunity to attend a workshop on user-centric design conducted by IDEO, a design consulting firm. At the workshop, participants were introduced to their partner and guided through designing an imaginary product for them[1]. In order to effectively design for their partner, participants were told to empathize with them, discover insights, and design for the context of the behavior, not just the person (see Figure 2 for an example of workshop material). Participants left the workshop with instructions to meet with their partner several times over the next two weeks in order to interview them in detail about their behavior change goal and begin designing their BIT.

One month into the study, another meeting was held with all participants in order to check in on their progress, receive feedback, and provide further instructions. By this meeting participants were expected to have met with their partners, conducted interviews, and begun designing a BIT. After the meeting, participants were given the rest of the semester to complete the design of the BIT and begin using it in order to change behavior. At the end of the semester, participants were interviewed to assess their behavior change progress and collect feedback about their experiences.

[1]The workshop materials were created by Stanford's d.school, and are available here: https://dschool.stanford.edu/sandbox/groups/dresources/wiki/welcome/attachments/f8e24/d.school's%20Facilitator's%20Guide%20to%20Leading%20Re.d%20the%20G.G.%20Exp.pdf

System design

To support BITxBIT, we have implemented a web application (bitxbit.media.mit.edu) that serves as a repository for participants' behavior change goals and solutions, and provides instructions and materials to guide participants through the BITxBIT protocol. The site allows participants to see both their own behavior change goal and their partner's. Figure 3 shows the first half of this page, in which participants fill out information about their own goal. The site scaffolds interviewing the partner and creating a design, by providing examples, incorporating the IDEO workshop materials, and allowing participants to take notes about the interviews and the resulting design ideas (see Figure 4). As participants are filling out this information about their partner, they can simultaneously view the partner's updates and design ideas for them in real time. The site also provides administrator tools for pairing participants, messaging them, and reviewing their anonymized behavior change goals.

BITxBIT is designed so that the program could be implemented in any workplace or lab, in order to promote a culture of wellbeing in that environment. With this goal in mind, we have open-sourced the code for the BITxBIT web application, and hope that other researchers will make use of it in conducting similar experiments: https://github.com/Viral-MediaLab/BitByBit. The design uses AngularJS, Flask API and Mongo. All frontend code compiles to files that can be statically hosted (e.g. using Amazon S3), reducing costs significantly. User authentication uses an internal Media Lab authentication system, but any alternative authentication can be integrated.

User evaluation

A trial run of BITxBIT was conducted at the MIT Media Lab over a period of approximately four months. Students were

Figure 4: The site provides instructions about conducting interviews and allows participants to take notes; the figure shows a small section of the interview portion.

enrolled in the study by default, but were allowed to opt out, while staff and faculty were invited to participate. A total of 79 lab members created accounts on the website; of those, N=65 agreed to participate in the study and provided informed consent. The sample comprised 48 students, 7 research scientists, 7 staff members, and 3 professors, 40% of whom were female; the demographics are similar to those of the lab itself.

Participants had a wide variety of behavior change goals, ranging from being more focused at work, to eating healthier or exercising more, to maintaining mindfulness. As described above, the study researchers reviewed participants' initial goals to ensure they were appropriate for colleagues and students to discuss and solve. Only one problem was flagged as inappropriate. Because this was a preliminary study, qualitative interviews conducted on a subset of participants (N=6) were used to obtain feedback about the program and assess behavior change. We have not yet devised a quantitative measure of behavior change that accounts for so many disparate behavior goals.

Interview feedback from participants was generally positive; participants said that `BITxBIT` "was beneficial" (P32), that their partner "was able to give helpful suggestions" (P54), and even stated, "I think this is a valuable experience for everyone" (P2). They found the IDEO workshops to be a "fun exercise" (P32), "interesting" (P51), and "very informative" (P2). Most participants highly valued the social aspect of the program. P36 stated that it was "really useful to meet with another person to discuss behavior change", while P54 felt that their partner "had very interesting insights". As P2 explained, "[the] reflection of a partner always helps with new insights that the individual cannot imagine. The individual cannot tell how it sounds to other people and what other people might spot". Another participant pointed out that the symmetric relationship of the two partners was important. "Having both people wanting to change something was helpful, [because] both people were vulnerable. It led to a more balanced relationship" (P36).

Despite initial concerns over sharing behavior problems with a colleague, most participants reported feeling comfortable talking to their partner; e.g. "It took a little bit at first to get to know each other, but I definitely wasn't uncomfortable" (P51) and "[we] had a comfortable conversation and were able to learn intimate details about each other" (P54). However, one faculty-student pair was less successful. The student reported that the faculty member was "unresponsive", and said, "[I] would not call [my partner] an equal co-participant" (P32). Interestingly, one participant asserted that "the pairs that were more successful already knew each other a bit" (P51). In support of this claim, a participant from a pair which applied for and received additional funding to develop their BIT stated, "it helped that we were friends before" (P32). This evidence may suggest that randomly pairing participants may not be the most effective strategy, although it is the most egalitarian.

Levels of participation in the program varied. While some participants were diligent (e.g. P51: "I think we met every week and a half", or P36: "[We] checked in with each other regularly to discuss their actions and brainstorm solutions"), there was also a somewhat high rate of attrition. Several participants spoke about the fact that their workload interfered with following through on implementing their BIT design, for example saying that they became "too busy" (P54), or that "all the other priorities took over" (P2). P32 provided a helpful summary of this problem: "It's kind of like an extracurricular activity, you don't get a grade for it, it's not part of your research. On the scale of things it's a long term reward, and it's harder to prioritize that when [my

supervisor] is like ‘I need research’". Some participants felt that they could have prioritized BITxBIT better if it was condensed over a smaller time period. P54 complained that the "framing of it was daunting, too opened ended", while several other suggested a hackathon-style format would have suited them better.

In spite of some problems with attrition, overall the program was encouraging in its effectiveness at promoting behavior change. Even in cases where participants did not manage to construct the BIT they designed, they still reported some benefit. For example, P2 stated, "The ideas were great. They helped. Even without making a specific tool behind the idea, the idea itself explained to me how I could deal with my concern or my vision. To move ahead and work with it". In other cases not only was a BIT successfully designed, but it was implemented and led to behavior change success. For one participant who wanted to improve his eating habits and bring healthy lunches more regularly, he and his partner jointly developed a 3-prong plan: "one was preparation, one was transportation, last one was storage. It was about how to optimize the process" (P32). To aid the plan his partner helped him purchase an oven-proof glass lunchbox and a toaster oven. "It made food a lot more tasty" (P32). Another participant’s BIT was a "personal research wiki, to keep notes on papers, concepts" (P8), designed to help him meet a goal of reading and summarizing one paper every day. He explained that BITxBIT helped him progress towards his goal. "I definitely improved it. I definitely did it more than before" (P8).

Conclusions and Future Work

Given the difficulty of changing behavior, even a few success stories show the promise of the BITxBIT program. Our preliminary results show that BITxBIT can encourage participants to improve their behavior, and produced a variety of unique solutions to behavior change problems. By challenging participants to design for each other, BITxBIT spurs each person to think carefully about their own behavior change goal as well as their partner’s. Through designing BITs for each other, participants receive a customized solution to their behavior change problem, and are compelled to work towards their goal through both social support and social obligation. The social connectedness of the lab is also strengthened through BITxBIT, further promoting wellbeing. We believe that BITxBIT could be a useful program to implement in any workplace or lab in order to promote a culture of wellbeing; for this reason, we have open sourced the code for the BITxBIT web application.

Based on the feedback received in response to the first trial run, there are several improvements we can make to BITxBIT. Firstly, incorporating a hackathon-style event to allow participants to build their BIT might prove useful, especially if this was followed up by asking participants to meet regularly with their partner to ensure they are making good use of the BIT. Revising the random-pairing structure of the study might also improve its effectiveness. Finally, the next step in this research is to compile a large-scale encyclopedia of the behavior change strategies and solutions the participants devised, organized by clustering types of behavior change issues. We believe such a repository could be a valuable resource to anyone wishing to achieve their personal wellbeing goals and help in positive behavior nudges at the organizational scale.

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