RESEARCH REVIEW

Investigating the Impact of Rewards from Different Modalities on Habit Formation

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APRIL 2017

Acknowledgements

Thank you to my supervisors Dr. Oussama Metatla and Dr. Katarzyna Stawarz, for their patience and guidance through this project.

Executive Summary

Habits are automatic actions that require little effort. The action of washing your hands automatically after using the toilet is an example of a positive habit. Positive habits grant many health benefits. To form a new positive habit, three elements are required: Repetition, contextual cues and positive reinforcement. The contextual cue acts as a trigger to push that person into performing the action and the positive reinforcement rewards the person encouraging them to perform the action again when triggered by the cue. After using these three elements the strength of a habit can be measured using a validated 12-question habit strength questionnaire that specifically looks at how automatic the action is after the trigger occurs. Literature uses this habit strength to show that using these three elements repetitively, on average, takes 66 days to form a new habit. However, studies show people still fail at forming new positive habits and many give up because people don't stick to a routine, straying away from the three elements.

Mobile technology can help people stick to a routine for forming a habit that focuses on the three elements, by using reminders as the trigger, reminding us to repeat an action, helping us associate contextual information around the action and rewarding us with positive reinforcement. However most existing mobile apps are not grounded in theory and build repetitive actions rather than habit automaticity. Therefore, people become dependent on technology rather than the habit and when the system is eventually removed their habit performance decreases.

Building habit automaticity is the key to removing this dependency and studies show motivation to complete the action increases habit automaticity and removes this dependency between the mobile technology and the user. We can encourage motivation with positive reinforcement by granting users satisfaction after completing the action. However what the reward is and how it is delivered is very important. Rewarding people with monetary gains (extrinsic rewards) hinders motivation, so rewards that benefit the person with satisfaction (intrinsic rewards) should be preferred. In addition, the type of reward should be delivered to suit each individual users needs, therefore a system should have a choice of reward delivery. Different research shows how interaction with users should span different modalities to suits the needs to users. This project will combine this knowledge from these two domains to focus on how intrinsic rewards from different modalities affects peoples habit strength.

This project will use the three elements to build a mobile technology tool to deliver rewards from different modalities. These rewards will be delivered using a chatbot instead of a mobile app to present a novel method of interacting with users. Chatbots are a method of communicating with a computer system using natural language. They provide deeper integration into users mobile phone and can hook into messaging services users are familiar with, such as Facebook Messenger. The chatbot will be built using the three elements of habit formation, providing a vehicle for repetition, contextual cues and positive reinforcement.

The chatbot design will be based on a combined set of theory-based design requirements. One for building habit formation apps that aim to increase habit automaticity and one for increasing motivation by delivering intrinsic rewards.

A user study will evaluate the tool during a 30-day controlled test to measure users habit strength. Participants will engage daily with the bot for 30 days, then for a further 7 days all interaction with the bot will be stopped to test if users continue to perform their chosen habit after the bot is removed. The chatbot will provide habit tracking using reminders as triggers, and rewards from three modalities, visual, auditory and tactile vibration. Participants shall split into four groups, a control group will not receive rewards and the remaining three groups will each receive rewards from a single different modality. The user study will test the success of the chatbot by measuring users habit strength after the study, comparing the results with the control group.

The project will deliver insight into how rewards from different modalities effect habit strength and opens up new research avenues for the investigating the use of chatbots as vehicles for promoting behaviour change.

Definitions

Human-Computer Interaction (HCI) - Field of computer science that studies how people interact with computers.

Modality - In the context of HCI, a modality or mode is the classification of a single independent channel of sensory input or output between a computer and a human.

Multi-Modal Interaction - Provides the user with multiple modalities or modes for interacting with a system.

Chatbot - A method of communicating with a computer system via a conversation using natural language.

Contents

1 Introduction

Background

People have goals they want to achieve that require repetitive actions, such as regular exercise or losing weight. Habits can be used to perform these actions with almost no conscious thought in a automatic-like way. Forming a positive habit can increase the chance people achieve these type of goals by changing their behaviour [1]. There are three elements of habit formation, repetition, contextual cues and positive reinforcement [2]. Associating the cue with performance and grounding the process with a reward encourages regular repetition, leading to automatic behaviour [3]. Building a new habit requires a contextual cue, to trigger the start of the habit (action), and a reward for positive reinforcement [2, 4]. For example, a reminder on your phone (trigger) reminds you to stretch (action), relaxing you and removing back pain (reward). Studies have shown that the process of creating a new habit takes on average up to 66 days of repetitive use [4]. However, anyone who has ever made a new years resolution knows the difficulties in changing our behaviour. Too many people try to create new positive habits only to drop them a few days into their new routine.

Motivation

Habit Formation

Technology can solve this problem, by coaching us through a new routine action until it becomes a habit. Mobile technology can issue reminders and build motivation for repetitive tasks. They provide us with an interactive platform that can help support habit formation. Plenty of existing habit formation systems use apps that guide users through a series of experiences to form a new habit. However, literature shows these apps are unsuccessful at forming habits because they are not grounded in habit formation theory [2, 5]. The apps create a dependence on the technology and do not build the automatic reaction to a trigger (habit automaticity) [6] e.g. when people stop using habit forming mobile apps, they also stop performing the habit.

Studies have shown that routine-based remembering strategies are good for building habit automaticity. Stawarz et al. [7] has produced a set of design requirements for building mobile apps grounded in habit formation theory. These requirements aim to facilitate the formation of reliable routine-based remembering strategies.

Chatbots

Interaction with current habit formation systems is often via a mobile app. This creates a notable difference in the person when the system is removed, as people personalise their phone and it becomes a part of them [8]. This is also the case with many mobile feedback systems that aid with behaviour change, when the system is removed any improved performance does not persist [9, 6].

Chatbots are a method of communicating with a computer system via a conversation using natural language. They provide a better mobile phone integration for users, as they hook into messaging services users are familiar with. When removing the system, instead of removing an app, users stop messaging a person (the chatbot). This project will build a chatbot to deliver reminders and rewards to users, to test if users sustain habit automaticity.

Multi-Modal

@TODO cite oussamas work here

Studies have shown that good reminder systems should be multi-modal [10], providing alternative ways to interact with the user, either visual, auditory or tactile. This increases the likelihood that the delivery method will be pleasant and satisfactory to the user. Incorporating this technique into the chatbot by delivering rewards to users across multiple modalities ensures rewards are intrinsic. But, reminders will be issued on a single mode to limit the scope of this project to test how rewards are effected.

Aims

This project aims to support habit formation by building a chatbot that delivers reminders and rewards to users. The reminders will be on a single mode and the rewards will be multi-modal.

Objectives

The chatbot will provide habit tracking with reminder messages as triggers, and rewards as positive reinforcement in three modalities, visual, auditory and tactile.

The rewards will provide the user with the satisfaction of completing the habit action and encourage them to build user habit automaticity. The visual reward will be a photo, the auditory reward will be an audio clip and the tactile reward will integrate with a wearable to provide tactile feedback from vibrations.

Methodology

To net the largest amount of users to test, the chatbot will be built using a popular messaging platform, Facebook Messenger.

A 30-day user study, and a 1-week follow up study, will test the success of the chatbot by evaluating the impact of each modality on facilitating the development of habit automaticity. Chatbot interaction will be removed during the follow up study to test if users continue with the habit. Participants will split into four groups, all groups will receive reminders, three groups will receive rewards each from a different modality, and one group (control group) will not recieve any rewards.

The user study will gather the following:

- quantitative analysis of chatbot interaction
- qualitative survey of habit interaction at the end of the study, and end of follow up study @TODO state you are gonna test w survey, rather than 'habit interaction'
- automaticity test at beginning and end of study

Deliverables

- A chatbot that supports habits formation, using notification reminders as triggers and for rewards uses a combination of these 3 rewards
  - visual rewards as photos
  - auditory rewards as audio clips
  - tactile rewards as vibrations integrated with a wearable
- Analysis of the effectiveness of different modalities on [habit automaticity] @TODO better state this / what

- Design recommendations for building a habit formation chatbot

Added value

The design recommendations will aid further research into building habit formation systems. The user study will show how effective chatbots are for delivering reminders and rewards and show how different types of reward deliveries through different modalities effect user habit automaticity.

This research review looks at the literature around habit formation and multi-modal rewards, summarising with design guidelines and a project plan, to test if multi-modal rewards provided by a chatbot support habit formation.

2 Habit Formation

To change the behaviour of a person an action needs to performed repetitively to turn the action into a habit and ensure that the behaviour persists in the future.
To understand how to build a system that supports habit formation, we must discuss how people fundamentally form habits.

2.1 What are Habits

Psychology defines habits as learned automatic cue-response actions, such actions that will perform automatically in response to another action or trigger that has been actioned repeatedly in the past [11].

2.2 Forming Habits

Studies have shown people must keep to strict strategies and perform an action repeatedly before it turns into a action that occurs with little concious thought [1].

2.3 Three Elements of Habit Formation

Forming a habit occurs similarly to how a person changes their behaviour. A study [3] into how habits are formed shows that using the following three elements ensures an action becomes permanent.

1. Repetition
2. Contextual Cues
3. Positive Reinforcement

Repetition

Lally et al. [4] conducted a test on how long it takes for an action to become automatic. They found that the process of creating a new habit takes on average up to 66 days of repetitive use. The easier the action, the shorter time before the action turns into a habit, from drinking water (18 days), to going to the gym (254 days) [4]. However applying the other two elements is a must, before the action develops into a habit.

Contextual Cues

Context from information around the action, serves as a cue to trigger events to push the person onto performing the action. For example, if you wanted to adopt a stretching habit, you could attach it onto an existing context like brushing your teeth. The contextual cue of brushing your teeth will trigger you to stretch. Literature @TODO cite primary source from this paper [2] shows that attaching habits onto existing event-based cues are easier to remember, when compared with time-based habits, e.g. stretch every 4 hours. These help connect the contextual information with the action and builds habit automaticity [12]. Further research into the design implications of contextual cues shows how multi-cue routines are more effective that a single cue [13].

Positive Reinforcement

Self-efficacy, the belief in ones ability to succeed, plays a large part in forming habits and is a main part of behaviour change [14]. Increasing this and increasing motivation is to experience successes after performing an action. Rewards give people this experience by feeding back their success of their action.

Rewarding a person with positive reinforcement after the action, strengthens the habit by giving the feeling of satisfaction [1]. Rewards that benefit the person with satisfaction (intrinsic rewards) should be used over monetary gains (extrinsic rewards), due to issues with extrinsic rewards hindering motivation [15].

2.4 Technology

There has been little research into how systems can support habit formation and behaviour change. A large number of habit-forming systems are mobile apps. Studies into the effectiveness of these apps has been recently conducted [6, 2] revealing that although most of these apps are rated highly, they do not ground themselves in behaviour change theory, with research into some of these apps showing that habits are not sustained when the app is removed, due to the lack of habit automaticity built.

However there is hope. Two piece of literature both discuss different concrete strategies for building habit-forming mobile apps that do ground themselves in theory [16, 17]. Stawarz [16] present formal requirements for building habit-forming apps, based on the above three elements of habit formation with the aim to build habit automaticity. Weiser et al. [17] shows that 'motivation is a key requirement for behaviour change' presenting 5 design principle requirements and 6 requirements about the implementation mechanics of habit-forming systems that focus on rewards and motivational needs. This project will build upon this set of requirements, combing them into a new set of design requirements for a system that supports habit formation focuses on rewards.

2.5 Combined Requirements

Combining information from the above two sources [16, 17], produces the following list of methods to build a habit forming app.

The system must:

1. Help users define a good remembering strategy
2. Give users little difficult tasks (challenges)
3. Give them Competition & Comparison & Cooperation
4. Give insights for strategy improvements and support changes
5. Remind them about cues and remembering strategies
6. Reward Users
7. Disable cue reminders when behaviour is routine
8. Check if action has already happened

The following table shows how the two sources [16, 17] were combined.

REQ	Stawarz. [16]	Weiser et al. [17]	Combined Requirement
1.	REQ 1. Help users define a good remembering strategy. REQ 2. Provide examples of good remembering strategies	Design REQ 2. Support User Choice. Design REQ 4. Provide personalized experience.	Help users define a good remembering strategy
1a.	NA	Mechanic REQ 3. Offer challenges	Give users little difficult tasks (challenges)
1b.	NA	Mechanic REQ 5. Competition & Comparison. Mechanic REQ 6. Cooperation	Give them Competition & Comparison & Cooperation
2.	REQ 3. Provide suggestions for strategy improvements and support changes.	Design REQ 1. Offer meaningful suggestions. Mechanic REQ 2. User Education.	Give insights for strategy improvements and support changes
3.	REQ 4. Remind about cues and remembering strategies.	Design REQ 3. Provide User Guidance. Mechanic REQ 2. User Education.	Remind them about cues and remembering strategies
4.	NA	Mechanic REQ 4. Rewards.	Reward users.
5.	REQ 5. Disable cue reminders when the behaviour becomes a part of a routine.	Design REQ 5. Design for every stage of behaviour change.	Disable cue reminders when behaviour is routine.
6.	REQ 6. Help users check whether the habit has already happened.	Mechanic REQ 1. Feedback.	Check if action has already happened.

Figure 1: The combined table of requirements for designing mobile systems focused on rewards.

2.6 Requirements Overview

The combined requirements based on methods from [16, 17] create a list grounded in habit formation theory and focused on rewards. Each requirement provides detailed breakdown about why it's used and what mechanics it relates to from theory.

1. Help users define a good remembering strategy

- Make personalized, well defined, structured multi-cue routines & also support users choice of not setting remembering strategies
- Provide examples of some

1a. Give users little difficult tasks (challenges)

- Assignments: Turn the bigger habit into smaller assignments to make it more joyful. Careful to not make them forced.

- Quests: Same as assignments, but optional
- Goals: User specified to support user autonomy. Should be specific and challenging to get better results

1b. Give them Competition & Comparison & Cooperation

- Friends, teams & groups
- Leader-boards and collections

2. Give insights for strategy improvements and support changes.

- Make them meaningful instant feedback & accumulated feedback

3. Remind them about cues and remembering strategies.

- Reminders can effectively support prospective memory in the short term.
- Educate them about what they should perform

4. Rewards

- A good form of external motivation because they don't change the ability to perform a behaviour, unless the reward itself is a tool that increases ability
- Provide strong motivational source, but like all extrinsic motivators, these are less effective for changing behaviour in the long run, because externally motivated behaviour lasts as long as the external motivator exists.
- Identifying methods that enable internalization of externally motivated behaviour is TBC.
- Achievements and badges

5. Disable cue reminders when behaviour is routine.

- Relying on reminders in the long term can hinder habit development.
- Ease off from reminders later

6. Check if habit has already happened

- Easy to forget whether a task done automatically, completed.

Summary

@TODO Summarise the requirements table and states so what and leads to next section.

3 Multi-Modal

Research shows multiple contextual cues better support behaviour change, compared with a single mode [13]. If we combine this with crossmodal interaction - The process of signals we receive through a single sense affecting how we process information perceived through a different sense [18], we can interact with users on different modalities. This can be used by testing rewards delivered from different modalities, to see if the crossmodal interaction differs when the modality changes.

Interacting with a user with a different modality might affect their behaviour in a different way. Therefore, each type of modality will be experimented with to test if the users behaviour is affected. The next section discusses methods of interaction in practice.

3.1 Why Multi-Modal Interaction

@TODO add references!

Research [19] into unimodal reminders (triggers) systems compared with multi-modal, suggests a need for highly flexible and contextualised multi-modal and multi-device reminder systems. Although this study focused on the elderly, and the need to multiple modalities was important because some peoples sensory modalities decline with age, this principle still holds true for general case reminder systems. The study presents design guidelines for reminder systems. These are mainly focused on users needing a choice of modalities for interacting with users, as users want a highly configurable system. These aspects will be implemented into our project and adapted for delivering rewards.

3.2 Modality Types

Research into designing multi-modal reminders for the home, states that 'good reminder systems should be multi-modal, because they provide alternative ways to interact with a user. Using multi-modal interaction could increase both accessibility of information being presented and the likelihood that the delivery method will be pleasant or acceptable to the user without becoming disruptive or annoying' [10]. @TODO add so what???

Visual

One study looked at improving habit consistency for how often patients took medication, by using a visual display device that gave constant feedback [9]. They found that this feedback improved consistency of the habit and increasing rating of self-efficacy. But when the device was removed, their performance dropped (2 months follow up study), because users integrated the feedback display with their routines. This habit-forming system used visual feedback to encourage consistency, however, this system shouldn't integrate visual cues into the system, otherwise users will become dependent on the technology. Users should instead build these cues outside of the system to build performance longevity after removing the system.

Auditory

Another key paper, discussed their need for multimodal applications when designing for the elderly [20], combing different sounds with high visual contrast to suit their needs, given deteriorating senses due to age. The study showed that multimodal interaction gives a means of communication to people with varying levels of sense ability. But studies have also shown people need a choice of mode when designing for multimodal interaction [19], and thus the design requirements produced from this study can be applied to general multimodal applications, such

as this project. The design guidelines discuss the need for interaction consistency, such as using similar audio interaction. @TODO therefore the mapping between the visual, auditory and tactile will be mapped to a similar pattern.

Tactile Vibration

The majority of electronic activity monitors have behaviour change techniques and these monitors present a medium which behaviour change interventions could occur [21]. This provides us with a final modality to explore reward delivery techniques - implemented with a wearable device using vibration. One of the activity monitors researched, the Fibit, will be the primary platform for integrating a Tactile mode for rewards, due to @TODO better phrase this: researcher availability.

3.3   Reward Types

Rewards will be delivered from each modality, with the content based on the habit-forming requirements listed above. Visual rewards will present the user with a photo that gives users satisfaction of completing the habit, auditory rewards will provide a similar result but via the auditory mode, finally the vibration patterns shall cater towards the tactile mode. The next section discusses design recommendations for delivery methods for these rewards.

4 Design

'Mobile phone adoption presents us with highly available, contextually aware and interactive platforms' [22]. Research into designing systems for mobile behaviour change technology, presents us with some implementation design requirements. Implementing a chatbot using these design considerations produces a solid ground for building this system.

Design Process

Current mobile systems use apps to interact with users, but a recent study showed apps fall into a low behavioural theory adherence scale [22]. Research into how to build systems that are theory-based, suggest four main stages for designing mobile health solutions. Conceptualisation, Formative Research and Pretesting, Pilot trails and Evaluation trials [22]. The first two stages use the Behaviour Change Wheel [23] (a framework for planning health behaviour interventions), to understand the behaviour, better define the characteristics and form the mobile concept into a prototype. The pilot trials tests the prototype before it moves to a finalised app with the commitment of a full trail. The final stage tests the finalised app with a wider range of participants. This project will use these four stages as design steps to build the prototype.

Gamification Elements

- Gamification elements [24] - Designing outstanding feedback loops [25]

4.1 Implementing Rewards

- Vision - Send notification - Show nice visuals

- Audio - Send notification - Play uplifting music

- Tactile Vibration - A.P.I. sets wearable alarm - Wearable (fitbit) issues and tracks alarm times

Methods of implementation

'There are two main reasons why anyone would use a chatbot: Conversational: When an App cant do it because multiple variable inputs are needed to solve the problem. Simplicity: When a bot offers the most immediate and direct solution to a persons problem.' We are going to use the bot because what a bot offers directly solves our problems above.

- 3 Types: 1. specific apps - Bad cuz takes a long time 2. Web Apps - Still another app 3. Chatbot - Good useful - Android/iOS/chatbot specific notifications from web app - Save to home screen

Technology

Talk about different chatbot tech available, e.g. amazon lex, and why im choosing fb messenger `https://aws.amazon.com/lex/`

Web app could be chosen because its easiest and achievable, however the ease of use with a chatbot, integrated into fb messenger means everyone can use it on multiple devices. The addition, means that people get used to the UI.

4.2 Components

Flow diagram style
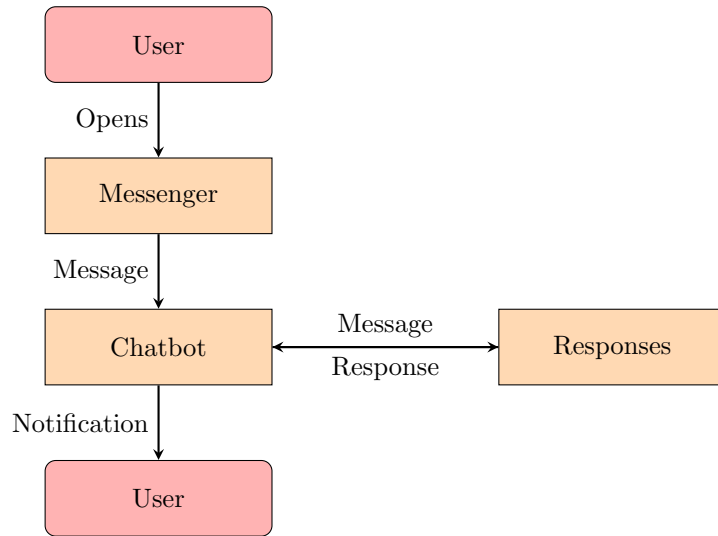
4.3 Chatbots

How 2 build and deliver these rewards to users

Current Chatbots

- Setup: - Setup the bot via a messaging platform, such as fb messenger - Trigger: - Either A, certain configured time of the day - B: No trigger - C: Around a specific time - Action: - Choose habit from list of habits - Perform - Use app to track the action - Reward: - You get one of these rewards, based on modalitiy selected - Vision - Through message, of an image or gif - Could be: App, or message, gif - Audatory - Through phone via bot, link to mp3/spotify/apple music - Could be: App - Tactic - Through wearable - Could be: App, bot triggers wearbale alarm

FB messenger

4.4 User Flow

- Pre-Start - Choose daily habit type from list of X, e.g. 1 press up before breakfast - Enable notifications or fitbit if chosen - Time action / reward, variable rewards, e.g. then work out average time to send, or none - Start: - New day - @ trigger time, send reminder, if set, notification - Open notification, do habit, press tracked - Get reward type
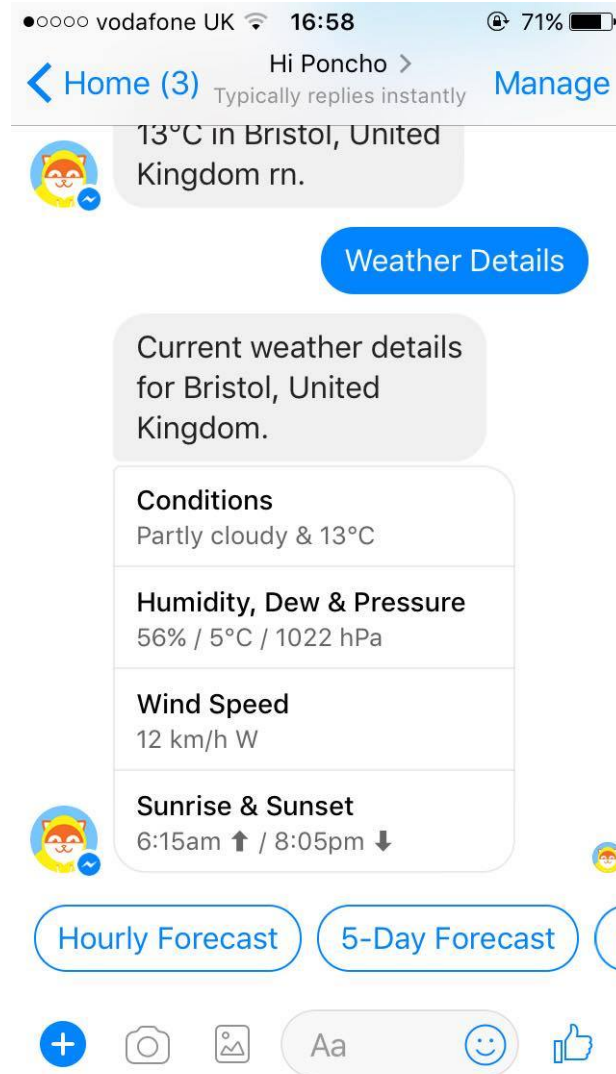
Figure 2: Poncho: A Facebook Messenger Weather Chatbot

5 Evaluation

Literature demonstrates the importance of designing for health and behaviour change [26, 22], but each have varying opinions about how to evaluate these systems. Klasnja et al. [27] focuses on the usability of the system and if it meets users needs. However, Stawarz and Cox argue that when designing for health behaviour change, we must look into evaluating the system from other fields to properly consider the effectiveness of a system [28]. The validated Behaviour Change Wheel Framework [23] does just this, evaluating the system using validated behaviour change techniques from multiple domains. This project will use this framework to evaluate the system with evaluation trails testing the long-term effects and efficiency drawn from two fields of study, HCI research and health psychology.

5.1 Evaluation Trails

The final part of the Behaviour Change Wheel Framework highlights and HCI research that focuses on health interventions [22] demonstrates the importance of evaluation trails for evaluating mobile health systems. These trails have three goals to test: objective-quantitative efficacy,

subjective-qualitative feedback measures and real-world feedback about how the system is utilised [27].

The length of the trail will be based on the action and a previous habit formation trail [2]. The number of repetitive days required for an action to be considered a habit varies based on the complexity of the action [4]. Simple actions, such as drinking 2 glasses of water a day, can take a minimum of 18 days to form. The suggested actions used for this project will be considered as simple, e.g. stretching for 30 seconds. A previous evaluation trail on habit-formation systems [4] showed an increase in habit automaticity after 4 weeks. This project will mirror this timeframe.

A 4-week study will test the success of the chatbot by evaluating the tool and the effectiveness of each modality on users habit strength. Chatbot interaction will be removed during the follow up study to test if users continue with the habit. Three groups, and a control group, will each receive reminders and rewards from a different modality. The above three questions will be used as the starting point for surveys that ask for feedback about the implementation.

5.2 Testing Habit Strength

Habit strength will be measured using a validated 12-question habit strength questionnaire that specifically looks at automaticity [29]. Automaticity will also be measured using a validated subset of the questionnaire from [29] to test users habit behavioural automaticity index [30]. This will show the impact each modality has on habit automaticity and test the hypothesis. These questionnaires [29, 30] will occur half-way through the study (at 2-weeks), after the study has finished and after the follow up study.

6   Conclusion

The survey on the relevant literature demonstrates two sets of design requirements for building systems that support habit formation. In particular; Building habit automaticity is key to building lasting behaviour change; Multi-Cue routines better support behaviour change than single cues; How rewards are key to building habit automaticity; Finally how multi-modal interaction increases user interaction. These combine to form new requirements that focus on delivering multi-modal rewards.

This will be a successful project because the requirements are based on theory. This gives us a strong standing for the success of the implementation, as long as the construction adheres to those requirements.

A chatbot designed from these requirements delivers rewards to users. A 30-day user study tests the effectiveness of the chatbot implementation and the design requirements. Finally a 7-day follow up study tests users habit automaticity.

Evaluation from real users testing the implementation reveals important positive and negatives aspects of the requirements. Following up after the study plays an important part in determining if the requirements were effective for building habit automaticity and testing our hypothesis. accepted. If users habit automaticity does not increase, the project still presents a novel method of interacting with users to track habits and a system evaluation provides value on how to build a chatbot to deliver rewards from different modalities to support habit formation. Finally, the project opens uo new research aveues for investigating the use of chatbots as vechicles for promoting behaviour change.

7 Work Plan

For this project there are four milestones that split into two parts, Building and Testing.

7.1 Milestones

1. Building
   - 1.1 Build the Chatbot.
   - 1.2 Build delivery of rewards from 3 modalities, Visual, Auditory and Tactile.
2. Testing
   - 2.1 Conduct 30 User Study.
   - 2.2 Conduct 7 day Follow up study.

7.2 Tasks

1. Building

Tasks for building the chatbot are to implement:

1. Interaction between a user and our system via the Facebook Messenger platform.
2. Question-response statements for the chatbot.
3. Training the chatbot on these responses.
4. Reminder component for habit triggers.
5. Visual rewards.
6. Auditory rewards.
7. Tactile virbation rewards by integrating with FitBit.
8. On-boarding for new users to get started with the chatbot.

2. Testing

1. Test the chatbot using a unit-test harness, to increase the quality of the chatbot.
2. Write 30 day user study.
3. Write 7 day follow up study.
4. Conduct 30 day user study, users will use the chatbot daily to track a habit and perform a habit automaticity test before the study starts and after it has finished.
5. Conduct 7 day follow up study, users will stop using the chatbot, after 7 days will be contacted to perform a habit automaticity test and present how often they performed their habit in the 7 days.
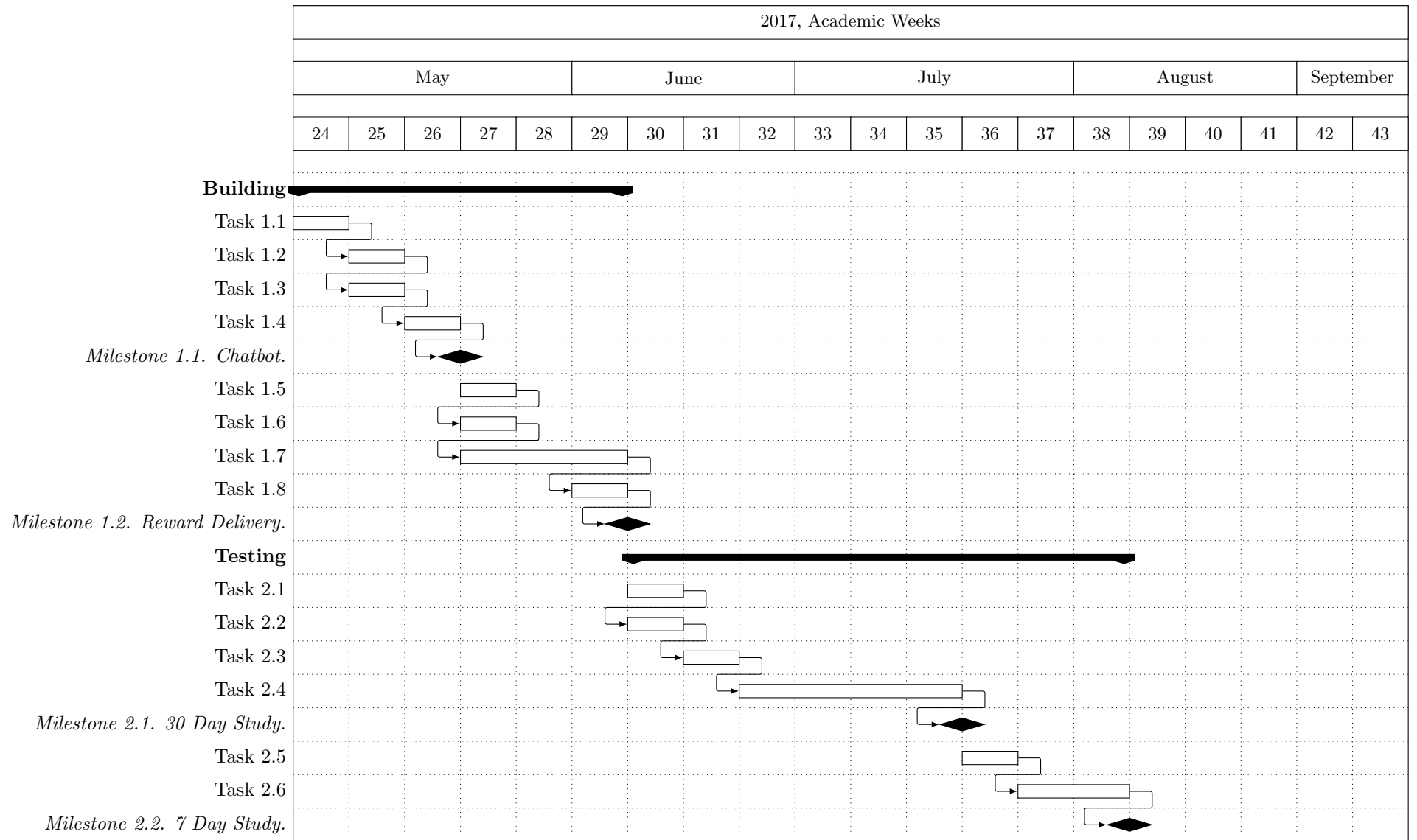6. Analyse study results.

2017, Academic Weeks																			
May					June				July					August				September	
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43

Building
Task 1.1
Task 1.2
Task 1.3
Task 1.4
Milestone 1.1. Chatbot.
Task 1.5
Task 1.6
Task 1.7
Task 1.8
Milestone 1.2. Reward Delivery.
Testing
Task 2.1
Task 2.2
Task 2.3
Task 2.4
Milestone 2.1. 30 Day Study.
Task 2.5
Task 2.6
Milestone 2.2. 7 Day Study.

Figure 3: Gantt Chart of estimated project timeline. Starts 01/05/17, ends 21/08/17

7.3 Risk Analysis

Problems that might occur in the project are summarised below with contingency plans and risk mitigation techniques.

Main Project Risks				
Severity	**Likelihood**	**Risk**	**Prevention**	**Contingency**
5	1	Chatbot could break during user study.	A unit-test harness will be constructed to increase the quality of the prototype before the user study.	Design recommendations can still be used from chatbot construction and if the chatbot doesn't completely break, the modalities that work can be tested against users.
4	4	Low sample size of users with wearable devices.	A popular wearable device has been chosen for integration to increase the number of users.	Additional wearable device integrations will be added, such as Jawbone, to increase pool of users.
4	2	Low sample size for user study.	Participants will be recruited ahead of time and University resources will be utilised.	Qualitative feedback will be gathered and focused upon, rather than quantitative to gleam a better understanding of design recommendations.
3	2	Under-estimate task length.	Overestimation of project tasks allows for task slippage.	Modification of project objectives allows for a focus on HCI design recommendations for building chatbots that support habit formation.

7.4 Deliverables

To summarise, these are the following key project deliverables.

- Chatbot that supports habit formation.
- Analysis about how rewards from different modalities affect habit automaticity.
- Design recommendations for building a habit formation chatbot.

8 References

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