RESEARCH REVIEW

Building a Chatbot to Support Habit Formation with Multi-Modal Rewards

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Executive Summary

Habits are automatic actions that require little effort. For example automatically washing your hand after using the toilet is a habit. Forming new positive habits has many benefits, in health and other areas. Forming a new habit requires three elements. Repetition, contextual cues and positive reinforcement. On average, habits take 66 days of repetitive use to become automatic.

Mobile technology can help form habits using these three elements, by reminding use to repeat the habit, giving us contextual cues and rewarding us to form positive reinforcement. However most existing systems are not grounded in theory and build repetitive actions rather than habit automaticity. People become dependent on the technology rather than the habit. This is bad because when we remove the system, the habit performance decreases. Therefore, successful habit forming systems should build habit automaticity.

The current state of habit-forming mobile systems use apps for interaction, encouraging the user to repeat actions using the app. This creates a dependency between the app and the user. Users are dependant on the app to repeat the habit. When the app is removed, the user stops repeating the habit. This dependancy decreases habit automaticity.

This project aims to explore a different implementation that supports habit-formation, by using a chatbot. Chatbots are a method of communicating with a computer system using natural language. They provide deeper integration into users mobile phone, as they hook into messaging services users are familiar with. When users stop using chatbots the impact is less than removing an app, as the user simply stops having a conversation with the chatbot.

The literature presents us with a set of design requirements for habit forming apps that build habit automaticity, focused on routine-based remembering strategies. Combined with another study, showing that good reminder and remembering systems should also interact with the user across different modalities, to allow delivery of triggers and rewards across a modality to suit different types of users. This project will base the design of the chatbot on these requirements and principles to deliver habit rewards across multiple modalities.

This project aims to build a chatbot that supports habit formation, by building habit automaticity with multi-modal interaction over 30 days. After removing the chatbot, users should continue to perform the habit. The chatbot will provide habit tracking by means of reminders as a trigger, and rewards in three modalities, visual, auditory and tactile. A 30 day user study, and a 1 week follow up study will test the success of the chatbot by evaluating effectiveness of each modality on habit automaticity. 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 project will deliver a chatbot that supports habit formation, design recommendations for building chatbots that support habit formation and analysis of the effectiveness of different modalities on habit automaticity.

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]. For example, when you eat breakfast (trigger), you might write in a journal (action), and then reflect on last week (reward). Studies have shown that the process of creating a new habit takes on average up to 66 days of repetitive use [4]. This is a long time for people to remember, perform and sustain a new habit without any help, if only the majority of people carried around a contexually aware device that could aid us...

Motivation

Habit Formation

Technology can solve this problem, by reminding and building motivation for repetitive tasks. Mobile phones provide us with an interactive platform that can help with 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]. The apps create a dependence on the technology and do not build the automatic reaction to a trigger (habit automaticity) 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. [5] 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 [6]. Removing the habit formation app, has shown to stop people performing the habit.

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

Studies have shown that good reminder systems should be multi-modal [7], 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 effectiveness of each modality on habit automaticity. 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 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
- 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
- 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 understand how to build a system that supports habit formation, we must discuss how people fundamentally form habits.

To change the behaviour of a person an action needs to be performed repeatedly to turn the action into a habit and ensure that the behaviour persists in the future.

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 [8].

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. Research [2] shows that using these 3 elements ensures an action becomes permanent.

1. Repetition
2. Contextual Cues
3. Positive Reinforcement

Repetition

Lally et al. (2010) states 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]. Although applying the other two elements is a must, before the action develops into a habit.

Contextual Cues

Contextual Cues are actions attached to a context. These act as 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 [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 cue with the habit and builds habit automaticity (CITE: In Beyond self tracking, ref 12.). Further research into the design implications of contextual cues shows how multi-cue routines are more effective that a single cue [9].

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 [10]. 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, builds the habit by giving the feeling of satisfaction. 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 [2].

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 [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 [2], [11]. Katarzyna et al. (2015) presents formal requirements for building habit-forming apps, based on the above three elements of habit-formation, that aim to build habit automaticity. Paul et al. (2015) states that 'motivation is a key requirement for behaviour change' presenting habit-forming requirements focusing on rewards, motivational needs and implementation about the mechanics of habit-formation apps. This project will build upon both of these requirements, combing them into a new set of design requirements for a system that supports habit-formation focuses on rewards.

2.5 Requirements

Combining information from these following 2 sources, produces the following list of methods to build a habit forming app.

The system must have:

1. A structured, personalised strategy.
2. Improvement insights.
3. Reminders about strategy changes.
4. Rewards.
5. Disable reminders when behaviour is routine.
6. Checks if habit has already happened.

Katarzyna et al. (2015)

Presents us with 6 requirements for habit-formation apps.

1. Help users define a good remembering strategy
    - Clearly defined multi-cue routines are the most effective.

2. Provide examples of good remembering strategies
    - People do not always know what constitutes a good strategy.
3. Provide suggestions for strategy improvements and support changes
    - Finding the right cues takes time and is a result of trial and error.
4. Remind about cues and remembering strategies
    - Reminders can effectively support prospective memory in the short term.
5. Disable cue reminders when the behaviour becomes a part of a routine
    - Relying on reminders in the long term can hinder habit development.
6. Help users check whether the habit has already happened
    - It is easy to forget whether a task done automatically has been completed.

A Taxonomy of Motivational Affordances for Meaningful Gamified and Persuasive Technology

Presents us with 5 design principles and 6 Mechanics or Interaction requirements between user and the system. The paper also discusses reward mechanics, such as quests, goals and virtual points. However, these are extrinsic rewards and shouldn't be used as they hinder motivation [2].

5 Design Principles

1. Offer meaningful suggestions
    - Make users aware of behaviour that is harmful to achieving their goal
    - Offer meaningful alternatives to their current behaviour that doesn't align with their goal
2. Support User Choice
    - Give users chance to set their own goals (or not even set a single goal)
    - Be careful about users feeling patronized if 1 form of behaviour is available.
3. Provide User Guidance
    - Give users clear, structured information to help identify the desired outcome and supporting users by suggesting how they can achieve it.
4. Provide personalized experience
    - Let users express their identity.
5. Design for every stage of behaviour change
    - System should provide ways to collect, integrate and reflect on behaviour-related data, such that the user is aware of problematic behaviour.

6 Mechanic Requirements

1. Feedback
    - Tactile, Visual or auditory information about the users current state.
    - Hard to determine when to give users feedback.

- Instant feedback creates a stronger link between behaviour and its consequences.
- Accumulated feedback with historical comparison, helps with self-monitoring and aids with making users aware of their behaviour.

2. User Education
   - Provides advice on what tasks users should perform.
   - Best in early stages of behaviour change.
   - 'You must do x' will have little impact on behaviour change, because it lacks contextual information.
3. Challenges
   - Give users little difficult tasks
   - Users with no goals, will find these effective
   - Gives user ability to split up task into smaller chunks
   - Provide reasonable default challenges, as little people deviate from defaults
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.
5. Competition & Comparison
   - Increase motivation in people who are naturally competitive
   - Although be careful as when different skill levels compete, it can have a negative affect!
6. Cooperation
   - Appeals to relatedness
   - Effective in settings where users are naturally social and have diverse levels of knowledge
   - Anonymous team cooperation is less effective

2.6 Requirements Detailed Overview

The combined requirements based on methods from [2] and [11] 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.

3 Multi-Modal

Research shows multiple contextual cues better support behaviour change, compared with a single mode [9]. 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 [12], 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

Research [13] 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' [7].

Visual

One study looked at improving habit consistency for how often patients took medication, by using a visual display device that gave constant feedback [14]. 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 [15], 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 modalitiy choice when designing for multimodal interaction [13], 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, cheating prevention, such as barriers to stop users from 'gaming' the system. Finally proper onboarding for users with walk-through and think aloud techniques, enabling users to better understand the interface.

Tactile

The majority of electronic activity monitors have behaviour change techniques and these monitors present a medium which behaviour change interventions could occur [16]. 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 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' [17]. 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 (2013) showed apps fall into a low behavioural theory adherence scale [17]. 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 [17]. The first two stages use the Behaviour Change Wheel [18] (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 [19] - Designing outstanding feedback loops [20]

4.1 Implementing Rewards

- Vision - Send notification - Show nice visuals

- Audio - Send notification - Play uplifting music

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

Methods of implementation

- 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

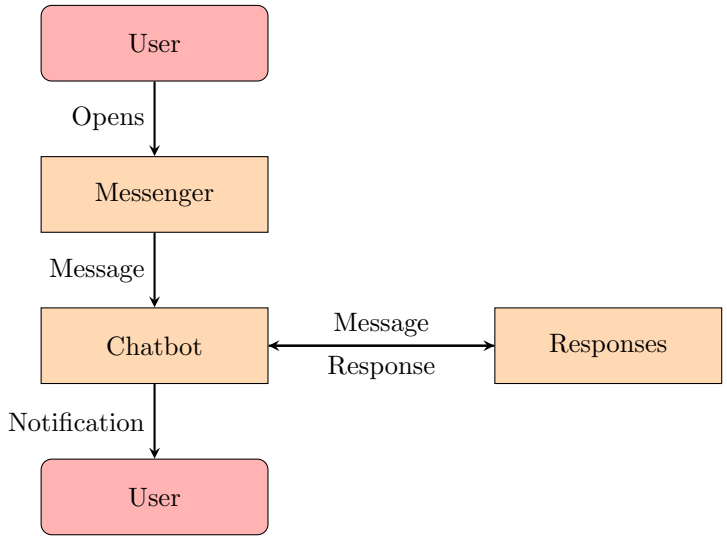
Talk about different chatbot tech available, e.g. amazon lex, and why im choosing fb messenger `https://aws.amazon.com/lex/`

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

[app] ——-¿ (Database) ——¿ at certain time —¿ Send notification to trigger type of reward [big button that says track] taskname textbox

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

Training a chatbot

4.4 Design Requirements

4.5 Scope

@TODO Scope and is the relevance of the reviewed work to the project is always made clear?

4.6 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

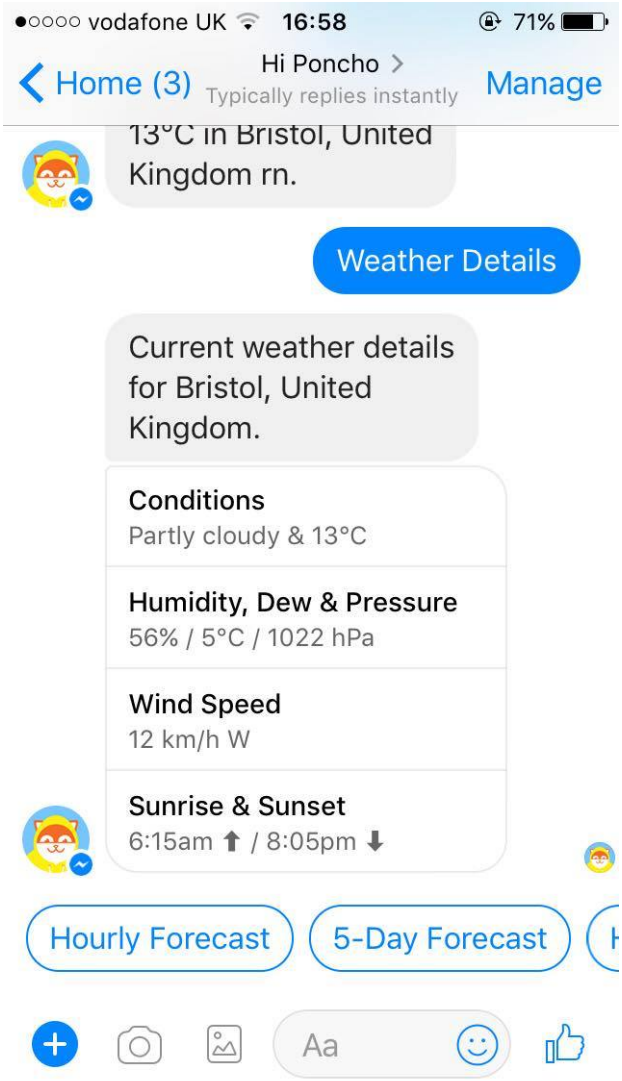


Figure 1: Poncho: A Facebook Messenger Weather Chatbot

5 Evaluation

Literature demonstrates the importance of designing for health. Stawarz, K. et al. presents three questions for evaluating technologies for behaviour change [21].

1. Is it usable?
2. Does it meet users needs?
3. Is it effective?

These questions are drawn from several fields of study, not just HCI research, considering long-term effects and efficiency. These will serve as the basis for evaluating this project.

5.1 User studies

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 a minimum of 18 days to form. The actions used for this project shall be consider as simple,

e.g. stretching for 30 seconds. Therefore, a user study above 18 days will be enough time for a simple action to form into a habit.

A 30 day study will test the success of the chatbot by evaluating effectiveness of each modality on habit automaticity. 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. Habit strength will be measured using a 12 question questionnaire by Verplanken et al. 2003 [22]. This test will occur before the study, after the study and after the follow up study.

5.2 Testing automaticity

Finally, users habit behavioural automaticity index will be measured, by Lally et al. 2012. [23] to test the impact each modality has on habit automaticity. This will test the hypothesis. Users habit automaticity will be tested before the study, after the study and after the 1 week 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 do not increasing habit-automaticity, 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 multi-modal rewards to support habit formation.

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 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.

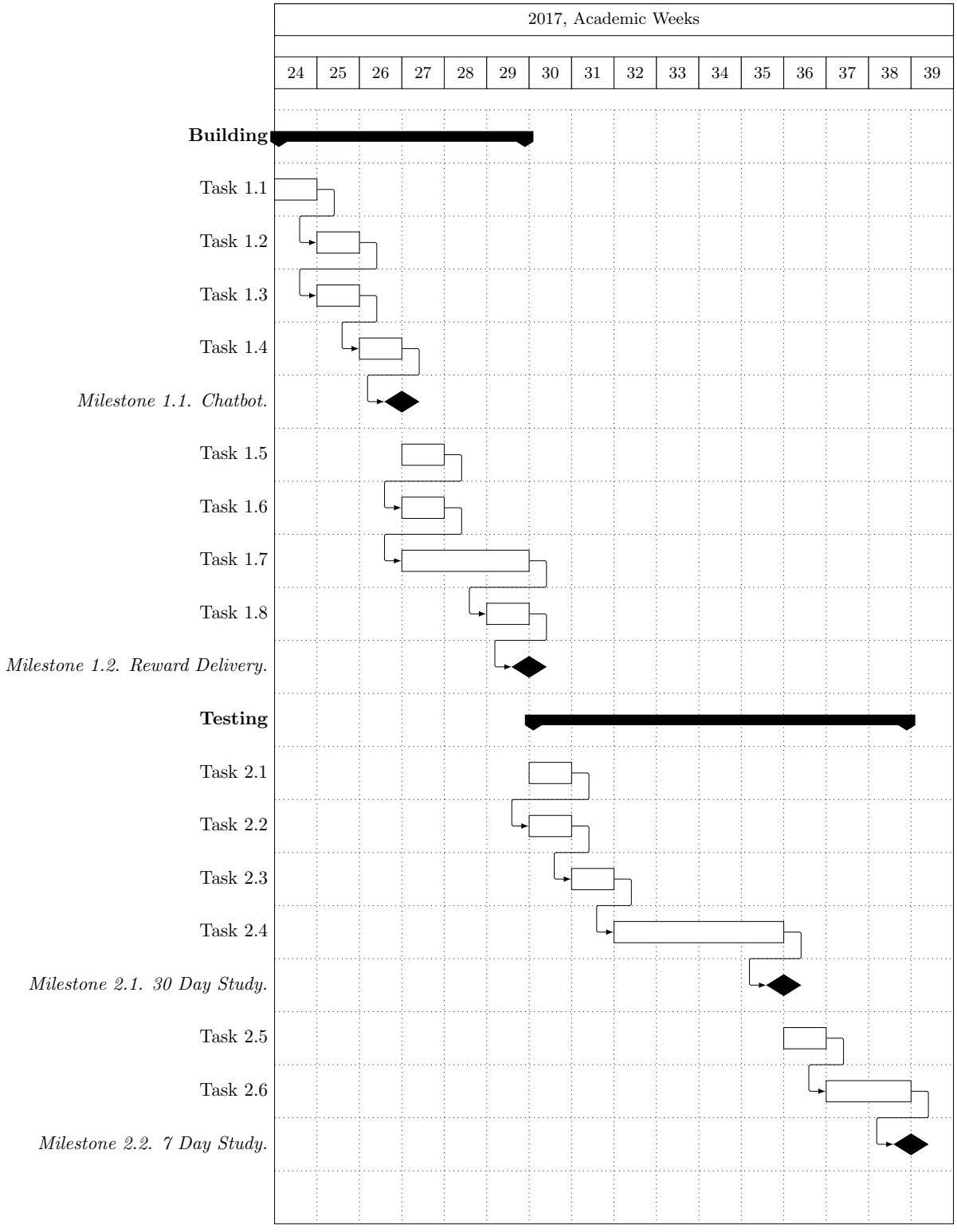


Figure 2: Gantt Chart of estimated project timeline. Starts 02/05/17, ends 21/08/17

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	Underestimate 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 key deliverables the project will deliver.

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

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