

RESEARCH REVIEW

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

Harry Mumford-Turner

School of Engineering  
University of Bristol  
APRIL 2017

Supervision from  
Dr. Oussama Metatla &  
Dr. Katarzyna Stawarz.



## 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. Such as automatically washing your hands, after using the toilet. Forming new positive habits gives us lots of benefits, in health and other areas. Forming a new habit requires 3 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, by reminding use to repeat the habit, giving us contextual cues and rewarding us to form positive reinforcement. But, most existing systems are not grounded in theory and build repetitive actions rather than habit automaticity. People then become dependent on the technology, rather than the habit. This is bad because when we remove the system, the habit stops. Therefore, successful habit forming systems need to build habit automaticity.

The current state of habit-forming mobile systems use apps for interaction, encouraging the user to repeat tasks using the app. This creates a dependency between the app and the user. Where the users are dependant on the app to continue to repeat the habit. When the app is removed, the user stops repeating the habit. This has been shown to decrease habit automaticity.

This project aims to explore a different method of forming habits, 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. Combining this 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 reminders and rewards across multiple modalities.

This project aims to build a chatbot that supports habit formation, by building habit automaticity with multi-modal interaction over 66 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 66 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, design recommendations 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

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Habit Formation</b>	<b>4</b>
2.1	What are Habits . . . . .	4
2.2	Forming Habits . . . . .	4
2.3	Three Elements of Habit Formation . . . . .	4
2.4	Technology . . . . .	5
2.5	Requirements . . . . .	5
2.6	Requirements Detailed Overview . . . . .	7
<b>3</b>	<b>Multi-Modal</b>	<b>9</b>
3.1	Methods of Interaction . . . . .	9
3.2	Delivering Rewards . . . . .	9
<b>4</b>	<b>Chatbot Design</b>	<b>10</b>
4.1	Design Considerations . . . . .	10
4.2	User Flow . . . . .	10
<b>5</b>	<b>Evaluating the System</b>	<b>12</b>
5.1	User studies . . . . .	12
5.2	Testing automaticity . . . . .	12
<b>6</b>	<b>Conclusion</b>	<b>13</b>
<b>7</b>	<b>Work Plan</b>	<b>14</b>
7.1	Risk Analysis . . . . .	16
<b>8</b>	<b>References</b>	<b>17</b>

# 1 Introduction

## Background

There are many goals people want to achieve, such as losing weight, that require repetitive tasks, such as regular exercise. 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 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 contextually 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. Although, 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 a audio clip and the tactile reward will integrate with a wearable to provide tactile feedback.

## **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 multi-modal rewards and habit formation, 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 a persons behaviour an action needs to be repeated performed to turn into a habit and ensure that the behaviour persists in the future.

### 2.1 What are Habits

Within Psychology, Habits are 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 repeating an action is not enough to form 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

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], [10]. 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 [10] 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

- What is a Modality - Research into how multiple modalities improve retention - Different types, most common and @TODO research says these are most effective

### 3.1 Methods of Interaction

#### Audio

- What is it - Why are we choosing it - Examples

#### - Why is it good?

- What does it give to us - @TODO research

#### - Reward

- Cross check with my requirements

#### Visual

- What is it - Why are we choosing it - Examples

#### - Why is it good?

- @TODO research

#### - Reward

- Cross check with my requirements

#### Tactile

- What is it - Why are we choosing it - Examples - Wearables, Fitbit

#### Why is it good?

- @TODO research

#### Reward

- Cross check with requirements

### 3.2 Delivering Rewards

- Table of multimodal reward implementation strategies - Table of requirements matched with modalities - If you could implement this, you could increase users automaticity for habits

## 4 Chatbot Design

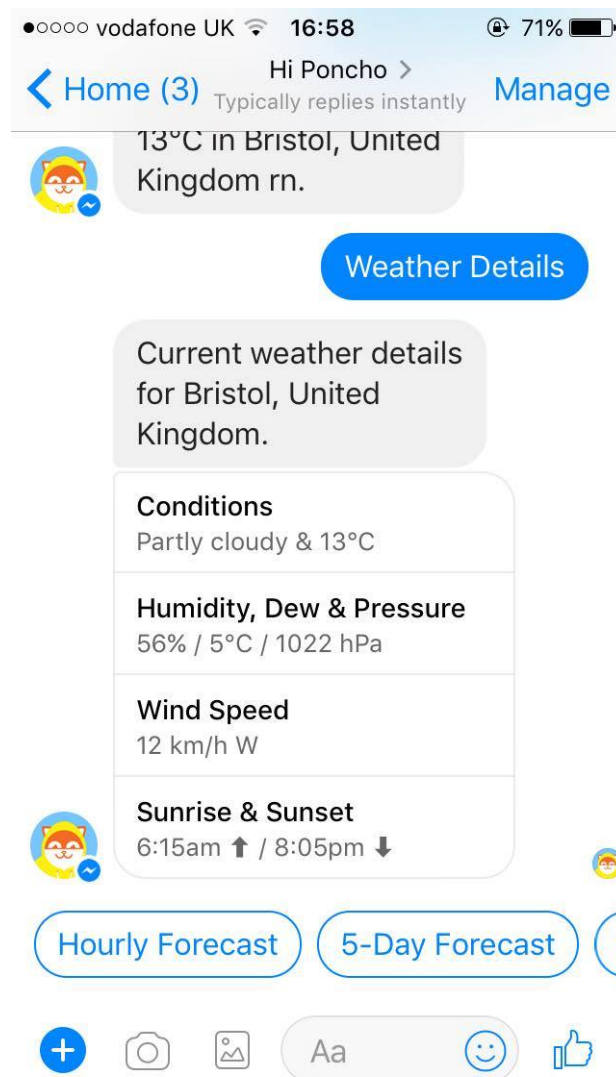


Figure 1: Poncho: A Facebook Messenger Weather Chatbot

### 4.1 Design Considerations

- 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 modality selected - Vision - Through message, of an image or gif - Could be: App, or message, gif - Auditory - Through phone via bot, link to mp3/spotify/apple music - Could be: App - Tactic - Through wearable - Could be: App, bot triggers wearbale alarm

### 4.2 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



## 5 Evaluating the System

Literature shows us the importance of designing for health and presents us with three questions for evaluating these technologies for behaviour change [11].

1. Is it usable?
2. Does it meet their 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 be the chatbot evaluation basis.

### 5.1 User studies

The above three questions will be used as the starting point for surveys to ask users for feedback on the implementation.

### 5.2 Testing automaticity

To measure if the chatbot completed the hypothesis, users habit automaticity will be tested after the study and during the 1 week follow up study.

## 6 Conclusion

### **Will this be a successful project?**

The design of the chatbot is heavily influenced by requirements grounded on habit-formation theory. This gives us a strong standing on the success of the implementation, as long as it adheres to those requirements.

### **Can we obtain the value that this project adds?**

If users do not increase habit-automaticity, the project still presents a novel method of interacting with users to track habits. Evaluation of this system still provides value on how to build chatbots to support habit formation.

## 7 Work Plan

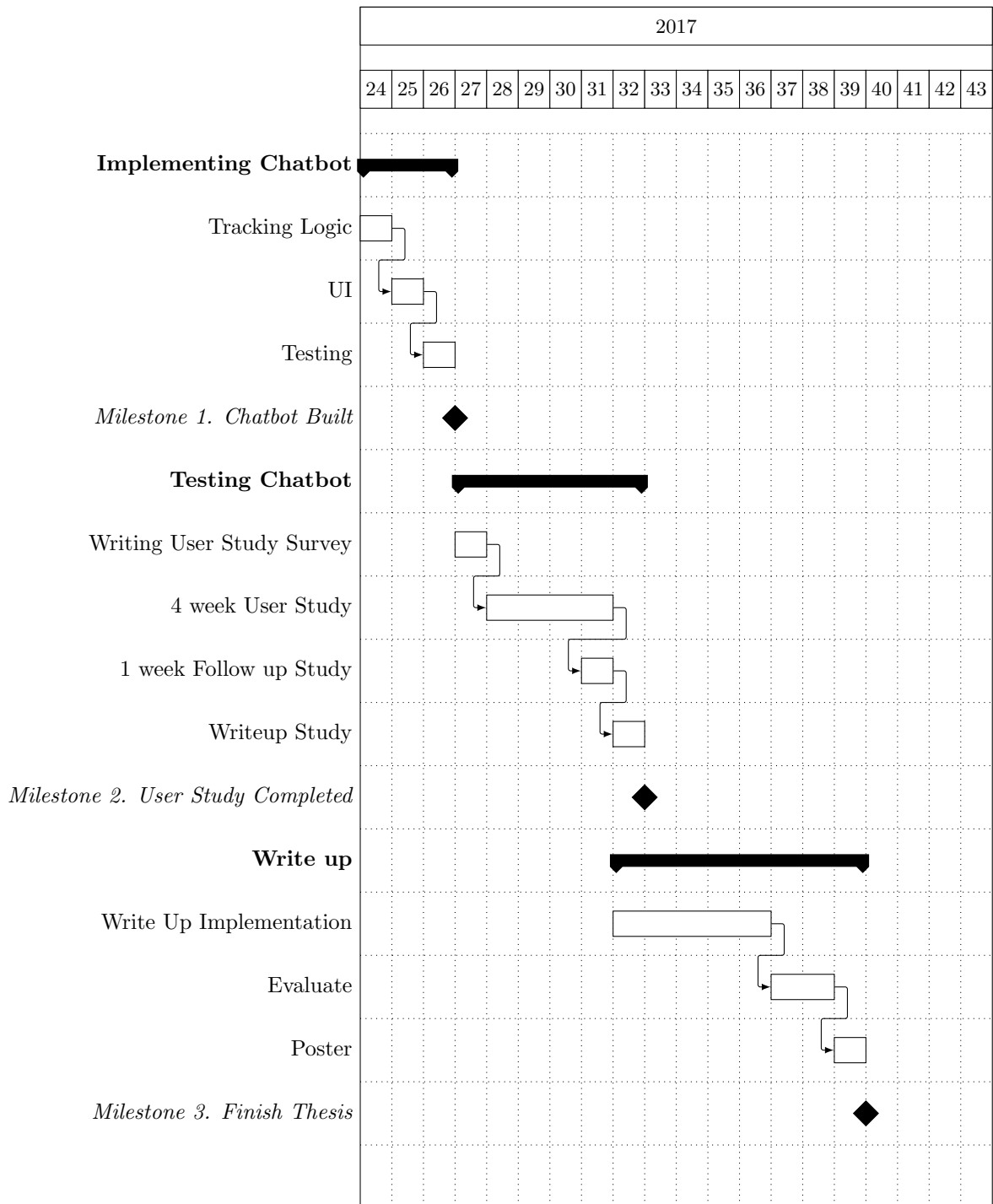
For this project there are X number of milestones to achieve.

### Scope

### Expected Timeline

The app is to be built, then two 30 day user studies will test the effectiveness of the app techniques.

@TODO find a way to add a title, and 'week' label @TODO only have 1 user study, but have 1 added week as a follow up study with no system interaction @TODO Say only 18/30 day user study as task is easy! Because [4]. See Beyond self tracking page 2, bottom left.



## **Deliverables**

### **7.1 Risk Analysis**

Table of risks and mitigation techniques.

## 8 References

- [1] Phillippa Lally and Benjamin Gardner. Promoting habit formation. *Health Psychology Review*, 7(sup1):S137–S158, 2013.
- [2] Katarzyna Stawarz, Anna L. Cox, and Ann Blandford. Beyond self-tracking and reminders: Designing smartphone apps that support habit formation. pages 2653–2662, 2015.
- [3] Phillippa Lally, Jane Wardle, and Benjamin Gardner. Experiences of habit formation: A qualitative study. *Psychology, Health & Medicine*, 16(4):484–489, 2011. PMID: 21749245.
- [4] Phillippa Lally, Cornelia H. M. van Jaarsveld, Henry W. W. Potts, and Jane Wardle. How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology*, 40(6):998–1009, 2010.
- [5] Katarzyna Stawarz, Anna L. Cox, and Ann Blandford. Don’t forget your pill!: Designing effective medication reminder apps that support users’ daily routines. pages 2269–2278, 2014.
- [6] Leena Ventä, Minna Isomursu, Aino Ahtinen, and Shruti Ramiah. ”my phone is a part of my soul&#148; - how people bond with their mobile phones. pages 311–317, 2008.
- [7] Julie R. Williamson, Marilyn McGee-Lennon, and Stephen Brewster. Designing multimodal reminders for the home: Pairing content with presentation. pages 445–448, 2012.
- [8] Wendy Wood and David T. Neal. The habitual consumer. *Journal of Consumer Psychology*, 19(4):579 – 592, 2009.
- [9] Katarzyna Stawarz, Marcela D Rodriguez, Anna L Cox, and Ann Blandford. Understanding the use of contextual cues: design implications for medication adherence technologies that support remembering. *DIGITAL HEALTH*, 2:2055207616678707, 2016.
- [10] Paul Weiser, Dominik Bucher, Francesca Cellina, and Vanessa De Luca. A Taxonomy of Motivational Affordances for Meaningful Gamified and Persuasive Technologies. 22:271–280, 2015.
- [11] Cox A. L. Stawarz, K. Designing for health behavior change: Hci research alone is not enough. *Crossing HCI and Health: Advancing Health and Wellness Technology Research in Home and Community Settings, CHI 2015 Workshop*, 2015.