

MOTIVATING SMOKERS TO QUIT THROUGH A COMPUTER-BASED
CONVERSATIONAL SYSTEM

by

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Abstract

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Cigarette smoking contributes to one in every five deaths annually in the United States according to the Centre for Disease Control and Prevention (CDC). The majority of cigarette smokers are unmotivated to quit, meaning that they don't plan to attempt to quit or seek help in quitting within the next six months. Motivational Interviewing (MI) is an effective counselling style for eliciting behaviour change. This thesis presents an Artificial Intelligent (AI) conversational system that uses MI to engage smokers in a conversation about smoking, with the goal of moving them towards a decision to quit. A total of 221 subjects were recruited online to participate in two studies. The first study engages 121 subjects in a conversation to improve the system's Natural Language Understanding (NLU) abilities. The second study engages 100 subjects in a conversation and measures the effectiveness of the system in increasing their motivation to quit. The result of the two studies shows potential for the conversational system to help an unmotivated smoker to move towards the decision to quit.

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Contents

1	Introduction	1
1.1	Goals	3
1.2	Overview	3
2	Background	4
2.1	Smoking Cessation	4
2.2	Motivational Interviewing	4
2.2.1	Evoking Change Talk	5
2.2.2	Readiness Ruler	6
2.3	Natural Language Processing	7
2.3.1	Rule-based and Corpus-based NLP	7
2.3.2	Conversational Systems	8
2.4	Related Work	9
2.5	Summary	11
3	Conversation Design	12
3.1	Eliciting Reflection	12
3.1.1	Expressing Pros and Cons of Smoking	13
3.1.2	Running Head Start	14
3.1.3	Exception Case Questions	17
3.2	Improving the Conversation	18
4	Chatbot Design	22

4.1	Conversation Rules	22
4.1.1	Conversation as FSM	23
4.1.2	Response Generation	24
4.2	NLU Models	24
4.2.1	Keyword Models	25
4.2.2	Classification Models	27
5	Results	34
5.1	Methods	34
5.1.1	Study Design	35
5.1.2	Participants	36
5.2	Results and Discussion	36
5.2.1	Free-form Feedback from Subjects	37
5.2.2	Reflection	40
5.2.3	Readiness Ruler	42
5.2.4	One-Week Actions	44
5.3	Limitations	45
5.4	Summary	46
6	Conclusion	48
6.1	Future Work	49
	Bibliography	50
A	Three Example Conversations	54
A.1	Conversation 1	54
A.2	Conversation 2	62
A.3	Conversation 3	67
B	Subjects' Feedback	80
B.1	Training Study Feedback	80
B.2	Intervention Study Feedback	89

List of Tables

1.1	Stages of behavioural change [34]	2
2.1	MI core skills examples	5
2.2	The three questions of the readiness ruler	7
2.3	Famous ELIZA conversation [17]	10
3.1	Conversation introduction and ending	13
3.2	A list of all the smoking reason categories used in the conversation	15
3.3	Reflection and summarization in the conversation	17
3.4	An example of the three exception case questions	18
3.5	Conversations fillers for the exception case questions	19
3.6	An example of handling confusion by politely asking again	20
3.7	Example of carrying new reasons forward in the conversation	21
4.1	Response generation given an FSM state and NLU model results	24
4.2	NLU models used in the chatbot	25
4.3	WordNet synonym set for word ‘stress’	27
4.4	Correcting the chatbot in the training mode	29
4.5	Classes for the <code>SmokingReason</code> and <code>SmokingReason2</code> classification models	30
4.6	Precision, Recall, and F1 Score for the <code>SmokingReason</code> and <code>SmokingReason2</code> NLU models	32
4.7	Examples of acceptable and unacceptable FPs from the <code>SmokingReason2</code> NLU model	33
5.1	Demographics of the 121 subjects in the Training study	37

5.2	Demographics of the 97 subjects who completed the Intervention study	38
5.3	Descriptions of feedback categories	39
5.4	Feedback samples from subjects in Training study	40
5.5	Feedback samples from subjects in the Intervention study	40
5.6	Paired t-test values for readiness ruler measurements	43
5.7	Action taken by subjects in the Intervention study to reduce smoking	46
A.1	Conversation 1 from the Intervention study	62
A.2	Conversation 2 from the Intervention study	67
A.3	Conversation 3 from the Training study	79
B.1	Training study feedback	89
B.2	Intervention study feedback	99

List of Figures

4.1	A subset of the FSM used to encode the conversation rules	23
4.2	TN, FP, and FN rates for the <code>SmokingReason</code> and <code>SmokingReason2</code> NLU models	31
5.1	Histogram of word count for the Training study	41
5.2	Histogram of word count for the Intervention study	42
5.3	Net increase in the readiness ruler scores for immediately after and one week after the conversation	44

Chapter 1

Introduction

Cigarette smoking is a health issue that has contributed to more than 20 million premature deaths since 1964 in the United States [26]. Canadians are facing the same threat as 5.3 million Canadians smoked cigarettes in 2015 [4]. Some of the conventional smoking cessation methods to help smokers in quitting include education, counselling, and support groups. These methods are generally only available to smokers who are currently seeking help, however, the majority of smokers are ambivalent about their behaviour and are not actively seeking help [12]. To decrease the number of cigarette smokers, it is important to motivate people to seek help. In this thesis, we explore helping smokers increase their motivation to quit using an artificially intelligent conversational system (also known as a *chatbot*).

The transtheoretical model (TTM) of health behaviour change suggests that change happens in five stages: pre-contemplation, contemplation, preparation, action, and maintenance [34]. Table 1.1 defines each of these stages in the context of smoking cessation. Generally, people who are in the pre-contemplation stage are ambivalent about their smoking behaviour. They do not plan to change in the foreseeable future. As they become aware of the pros and cons of their behaviour they may move to the contemplation stage, where they start thinking about changing. At the contemplation stage, people are often not ready to take an action yet. This ambivalence and lack of readiness to take an action make it hard to reach smokers and offer them help.

Cigarette smokers in the first two stages of pre-contemplation and contemplation con-

Stage	Description
Pre-contemplation	No intention of quitting in the next 6 months
Contemplation	Intention to quit in the next 6 months
Preparation	Thinking of taking action in the next 30 days
Action	Behaviour change occurred within the past 6 months
Maintenance	Behaviour change occurred more than 6 months ago

Table 1.1: Stages of behavioural change [34]

stitute a significant number of people that need help. A potential way to reach those smokers is by using Artificial Intelligent (AI) systems that can interact with smokers on their personal devices. Using this kind of approach, which connects to smokers directly, where they live and work, lowers the economic cost of smoking cessation programs and enables them to reach more people than ever before. This is especially true since intelligent personal assistance systems are ubiquitous and people are becoming accustomed to them. Moreover, recent advancements in the Natural Language Processing (NLP) field make it feasible to build AI systems capable of engaging people in meaningful conversations [8]. However, these advancements are not enough alone to help smokers; there needs to be a psychological framework that an AI system can apply.

One common psychological framework that smoking cessation professionals use known as *Motivational Interviewing* (MI) [25]. MI is a client-centric counselling style that helps clients resolve their ambivalence. A systematic review of multiple studies that used MI in smoking cessation shows that MI is effective for both adolescents and adults [13]. In an MI counselling session, health professionals explore the reasoning of the client without authoritatively offering advice. The focus is to resolve ambivalence and elicit change within the client. Furthermore, MI counselling extends beyond the first two stages of the change. However, the focus of this thesis is motivating smokers who are the in the first two stage of contemplation and pre-contemplation.

1.1 Goals

The goal of this research is to design and deploy a computer-based conversational system that engages cigarette smokers in a text-based MI conversation and observe the conversation's effect on their motivation to quit. We intend to achieve this goal by:

1. Designing an MI-based conversation structure for counselling cigarette smokers and choose a valid method for measuring the anticipated effect.
2. Create and train a chatbot capable of delivering the designed MI-based conversation.
3. Recruit smokers to converse with the chatbot and observe the effect of the chat on their motivation to quit.

1.2 Overview

The thesis begins by providing background in Chapter 2 on smoking cessation, MI, and conversational systems. In Chapter 3 we present the design of the chatbot and how we arrived at it. Chapter 4 explains the chatbot training process and the chatbot's capabilities. Chapter 5 presents the results of training the chatbot on 121 smokers, and then deploying it on 100 more, and Chapter 6 concludes.

Chapter 2

Background

This chapter provides the necessary knowledge to understand the discussion in the following chapters. We discuss smoking cessation, Motivational Interviewing (MI), Natural Language Processing (NLP), and related work in using chatbots in the mental health space.

2.1 Smoking Cessation

The general field of Smoking Cessation is concerned with helping people who smoke cigarettes to stop, so as to avoid many negative health effects [7]. Traditional approaches to get help in quitting includes doctors' visits for personal counselling, support groups, smoking hotlines, or self-help books. Unfortunately, not all smokers are eager to quit. Less than 10% of smokers want to quit in the immediate future [6]. A common approach to help those smokers is Motivational Interviewing (MI) [25], a counselling style used to increase smokers' motivation to reduce or quit smoking [13].

2.2 Motivational Interviewing

MI is a direct client-centric counselling style for increasing clients' motivation to change their behaviour [25]. MI is not about specific techniques, rather it has a spirit that providers of MI follow. The spirit of MI revolves around four elements: partnership,

acceptance, compassion, and evocation. MI is an active collaboration with clients; It is done with and not on them, and it is about evoking what is in them and not forcing what is missing [25]. To practise MI, providers use the following core skills: *open-ended questions*, *affirmations*, *reflections*, and *summaries*. MI providers ask open-ended question to leave room for the client to elaborate. Affirmations are provided to encourage and acknowledge the client. Reflective listening, where what is heard is played back, and Summarization (and the end of a section of conversation) allow the client to strengthen any concepts that they themselves have produced. Table 2.1 gives an example conversation where those core skills are at play.

MI Provider	What is bad about smoking? -- <i>Open-ended question</i>
Client	When I am out of cigarettes, it is torture until I can get more
MI Provider	I understand, you crave smoking and find it addictive -- <i>Reflective listening</i>
MI Provider	I appreciate you talking about your cigarettes cravings, it takes courage to admit that -- <i>Affirmation</i>
MI Provider	Let me summarize: You told me ‘When I am out of cigarettes, it is torture until I can get more’ which I believe is related to addiction -- <i>Summarization</i>

Table 2.1: MI core skills examples

When engaging clients, MI providers look for *sustain* and *change* talk. Sustain talk occurs when clients are not expressing a desire or intention to change. A client expressing sustain talk might express something similar to the following: “*I like smoking, it is my medicine*”. On the other hand, change talk happens when clients show a desire to change like in the following example: “*I want to change, but I feel addicted*”. Furthermore, clients, a priori, show commitment to change and MI would still be helpful then. It is important to note that MI is used to evoke change within clients as well as guide them through the steps of change once they are ready [25].

2.2.1 Evoking Change Talk

The direct nature of MI comes from providers specifying goals with clients. It is important to distinguish between authoritatively setting goals and picking goals by listening to clients. MI seeks to do the latter, where goals are discussed to achieve *focus* but not

results. In addition, MI has multiple strategies to deal with neutral clients who don't express goals. One of these strategies is the *running head start* [25]. The running head start strategy asks questions to evoke the pros and cons of behaviour change. It questions the client's status quo in an attempt to produce change talk. The running head start strategy is the main strategy used to evoke change in the chatbot presented in this work.

Recall in Chapter 1 the transtheoretical model (TTM) of health behaviour change suggested that change happens in five stages: pre-contemplation, contemplation, preparation, action, and maintenance [34]. TTM and MI complement each other and do not conflict [25]. Moving forward in the five stages is associated with increased motivation toward behaviour change, and the practise of both TTM and MI anticipate that clients move back and forth in the five stages and between change and sustain talk.

Furthermore, there is a relationship between the running head start strategy and the TTM stages. In a study observing change in 12 different behaviours such as cigarette smoking and drinking, the "pro" change reasons increased twice as much as the "con" change reasons decreased from the pre-contemplation to the action stage [28]. This finding was verified in a later study on 48 different behaviours [11]. Both studies include smoking as one of the covered behaviours.

2.2.2 Readiness Ruler

The readiness ruler is a commonly used tool for measuring the impact of MI on clients' motivation toward behaviour change [9]. Specifically, it measures the client's perception of the importance of doing the behaviour change, their confidence that they would succeed at changing, and their readiness to embark on the process of making the change. Each of the three measurements is scored on a 10 point scale. Table 2.2 shows the three questions in the readiness ruler. In this work we will use the readiness ruler as one measure of the effectiveness of the proposed chatbot intervention.

Measurement	Question
Importance	On a scale from 1 to 10, how important is it for you right now to reduce or stop smoking?
Confidence	On a scale from 1 to 10, how confident are you that you would succeed at reducing/stopping smoking if you start right now?
Readiness	On a scale from 1 to 10, how ready are you to start making a change at reducing/stopping smoking right now?

Table 2.2: The three questions of the readiness ruler

2.3 Natural Language Processing

Natural Language Processing (NLP) is the study of extraction and processing of specified or implied information in linguistic expressions. In this section, we discuss the main two approaches for performing NLP tasks and how they are realized in the context of conversational systems.

2.3.1 Rule-based and Corpus-based NLP

NLP tasks generally follow two different approaches to obtain information from linguistic expressions: a rule-based approach and a corpus-based approach [20]. In a rule-based approach, the processing is based on rules defined by expert knowledge in a specific domain. For example, the Porter stemming NLP algorithm uses rules based on linguistic features present in English words to remove inflectional ending from them [27]. On the other hand, corpus-based NLP tasks employ rules generated from the observation of patterns in the corpus (i.e body of text) without expert assistance. A common example of an NLP task is the word prediction functionality commonly found in today's personal computers (i.e. to predict the next word that you are typing). Word prediction requires large corpora of text for counting the number of times a pair of words appeared together. This counting is done to calculate the probabilities of pair occurrences in the corpora. The probabilities are then used to fetch the next word that has the highest probability given the previous word. This specific statistical approach is known as N-gram language modeling [17].

Stemming and N-gram modeling illustrate how specific NLP tasks follow the two

approaches of rule-based and corpus-based. However, these two approaches can extend beyond narrow NLP tasks and into larger NLP systems such as conversational systems.

2.3.2 Conversational Systems

Conversational systems receive text or speech utterances as input and generate one or more responses as output. These systems can be task-oriented or can carry extended conversations with subjects [17]. Some examples of task oriented conversational systems are Amazon Alexa, Apple Siri, or the Google Assistant [14][15][16]. These systems don't usually carry on an extended conversation; they have a low number of turns where turn is the count of how many interactions can be taken before the system starts over. Conversational systems that have many turns are usually not considered task-oriented. For the purposes of this work, we'll refer to conversational systems that carry on extended conversations as *chatbots*. An example of such chatbot is Microsoft's social chatbot Xiaolce [17], a chatbot which converses with more than 200 millions users on chat platforms in the Chinese language [23][22]. Building chatbots require three strategies: extracting meaning out of utterances, keeping the conversation context, and response generation [21]. In the context of this thesis, the first step of extracting meaning out of utterances is referred to as Natural Language Understanding (NLU).

Corpus-based Chatbots

A corpus-based approach to building chatbots requires all three strategies to be learned from some corpus. This corpus should contain bodies of text relating to the domain of which the chatbot is conversing in. Furthermore, there are multiple techniques that can be used in a corpus-based chatbot. One common technique is Information Retrieval (IR) [17], where the chatbot responds to utterances by picking a response that was used to respond to an utterance similar to the current one. The definition of similar varies depending on the techniques and corpus used in the chatbot. Furthermore, the context of the conversation can also be kept in various ways. One possible way is to use all previous utterances from the subject and use it as input to whatever statistical model

the chatbot is using. The decision space of corpus-base approaches is very large and usually an ensemble of multiple different learned models is used for some or all of the three strategies [33].

Rule-based Chatbots

Generally, rule-based chatbots use expert hand-crafted rules to implement the three strategies of NLU, conversation context, and response generation [21]. An example of such chatbot created in the 1960s is the ELIZA chatbot [35]. The NLU strategy in ELIZA was looking for specific keywords in utterances and each keyword was associated with decomposition rules that extracted the keyword found and other ones in the utterance. In addition, ELIZA had response generation rules that generated pre-determined responses with slots for the keywords found in the decomposition step. It also used another set of rules to keep a basic conversation context. ELIZA is a pure rule-based chatbot but modern rule-based chatbot are not the same. They use a combination of rule-based and corpus-based approaches in the NLU step. The NLU models used inform the other rules of the conversation context and response generation.

2.4 Related Work

In general, using MI in smoking cessation has proven to be effective in helping smokers toward making the decision to quit [13]. There have been previous technology-assisted smoking cessation systems that make use of MI and text messaging (SMS) [10] [30]. Our work in this thesis is inspired by a previous student's work on the feasibility of using chatbots as a way to deliver MI interventions in smoking cessation [18]. This work stemmed from the same research group and we are not aware of any attempt to use chatbots and MI in smoking cessation. However, there are other examples of using chatbots in the mental health space.

ELIZA, the chatbot mentioned in previous sections, was the first example of using chatbots in general and in the mental health space [36]. It used Rogerian psychology where it reflected everything the subjects said [17]. Some of the people who used ELIZA

at the time connected with it. Weizenbaum, the creator of ELIZA, wrote that his secretary used to ask him to leave the room so she can be alone conversing with ELIZA [36]. An example conversation with ELIZA is shown in Table 2.3.

Subject	Men are all alike.
ELIZA	IN WHAT WAY
Subject	They're always bugging us about something or other.
ELIZA	CAN YOU THINK OF A SPECIFIC EXAMPLE
Subject	Well my boyfriend made me come here.
ELIZA	YOUR BOYFRIEND MADE YOU COME HERE
Subject	He says I'm depressed much of the time.
ELIZA	I AM SORRY TO HEAR YOU ARE DEPRESSED
	...
ELIZA	WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU?
Subject	My father
ELIZA	YOUR FATHER
Subject	You are like my father in some ways.
ELIZA	WHAT RESEMBLANCE DO YOU SEE
Subject	You are not very aggressive but I think you don't want me to notice that.
ELIZA	WHAT MAKES YOU THINK I AM NOT AGGRESSIVE
Subject	You don't argue with me.
ELIZA	WHY DO YOU THINK I DON'T ARGUE WITH YOU
Subject	You are afraid of me.
ELIZA	DOES IT PLEASE YOU TO BELIEVE I'M AFRAID OF YOU
Subject	My father is afraid of everybody.
ELIZA	WHAT ELSE COMES TO MIND WHEN YOU THINK OF YOUR FATHER
Subject	Bullies.

Table 2.3: Famous ELIZA conversation [17]

Modern chatbots in the mental health space are becoming popular in the research and commercial worlds. One example is Woebot, a chatbot that helps individual with anxiety and depression using CBT (Cognitive-Behavioural Therapy) [8] [3]. Woebot was tested in a randomized control trial where the control group received an information-only intervention. The research found that after subjects interacted with Woebot for two weeks, the intervention group experienced a significant reduction in the level of depression compared to the information only group. It is worth noting that Woebot is also a commercial product that has been on the market since 2016. It is reported to be conversing with subjects at a rate of two millions messages per week [19]. There are other notable attempts such as ElizzBot for consulting family caregivers [5].

2.5 Summary

In this Chapter we have discussed the key techniques planned to be used in our chatbot as a way to help smokers make the decision to quit. We have also given a summary of the techniques used in computer-based conversational systems. In the following chapter we provide the design of the conversation that we plan to automate.

Chapter 3

Conversation Design

Recall that the overall goal of this research is to create and test a chatbot that will help a smoker move towards the decision to quit. In this chapter we discuss the design of the conversation itself, as distinct from how it is implemented, which is discussed in the next chapter. To achieve this goal, the conversation must cause self-reflection using a Motivational Interviewing (MI) counselling style and reduce smokers' ambivalence toward smoking [25]. We also believe that it will be important for the conversation to be personable or pleasant, to help motivate the subject to continue the conversation. The conversation has an introduction, reflection, ending, and several stages in-between. It begins with a brief introduction to obtain consent and it ends by saying goodbye as shown in Table 3.1. The important part of the conversation is the reflection that happens in between these two parts. In the next two sections, we explain how the conversation elicits reflection and how we made conversing with the chatbot a pleasant experience.

3.1 Eliciting Reflection

In the context of the transtheoretical model (TTM), there are strong correlations between individuals' discovery and reflection of the pros and cons of their behaviour and moving from the pre-contemplation to the action stage [34]. Subjects move into the direction of the action stage as the pros of their behaviour increase and the cons decrease [28]. We make use of this correlation and base the conversation around discussing the pros and

Bot	Hey! I am a computer chatbot created in a research project by the University of Toronto and CAMH. Our goal is to help smokers understand and reflect on their cigarette smoking, with the ultimate goal of helping them make the decision to quit
Bot	In our conversation, I will ask you questions to try to understand what you like and don't like about cigarette smoking
Bot	In this project we will record what you say, but only for the purposes of learning how to engage in better conversations
Bot	Would you like to chat?
Subject	Sure
Bot	Wonderful, thank you very much
Bot	Before we begin, I just want to let you know that currently my knowledge is limited, so I might ask you to clear things up for me
Bot	Don't worry though, I'll get better at understanding with your help
Bot	Okay. Let's begin
Bot	Are you a smoker?
Subject	Yes
	...
Bot	Thanks, we covered all the good and bad reasons you have for smoking
Bot	Talk to you later
Subject	Thank you :)
Bot	I have nothing more to say
Subject	Ha! Friendly finish ;-D
Bot	I left my AI somewhere else. Can't talk right now

Table 3.1: Conversation introduction and ending

cons of smoking. Our conversation reveals to subjects their pros and cons of smoking and encourages them to reflect on these pros and cons. To establish this self-reflection, the chatbot engages subjects in two exercises; first, it uses the MI running head start technique [25] mentioned in Section 2.2.1 to explore the pros and cons of smoking [25]. Second, it follows up with each pro and con provided by the subject using a specific set of questions adapted to the current pro or con being discussed. But before we explain how the chatbot engages subjects in these two exercises, we need to understand how subjects express the pros and cons of smoking.

3.1.1 Expressing Pros and Cons of Smoking

Subjects generally cannot articulate the exact pros or cons of smoking. They explain feelings associated with a given pro or con. For example, a subject might say *"I smoke*

when I feel stressed” to communicate *stress* relief as a pro reason for smoking. Health professional use tests such as the “Why do I Smoke” test to help subjects categorize their pros or cons into reason categories [31]. This test is a questionnaire that presents subjects with 18 statements of why one person might smoke and asks them if they relate to each statement. The test determines if subjects smoke because they experience some or all of the following reasons: Pleasure, stimulation, stress, routine, craving, or having something in their hand. This list does not cover all possible reason categories, however, we have used it as the basis to categorize the subjects’ expressed pros and cons in the conversation.

We later improve on this list by conversing with many subjects and reviewing their conversations with the chatbot. We have extracted an additional 16 reason categories from the conversations to add to our basis of six. The end result is the list of categories shown in Table 3.2. In addition, the categories in Table 3.2 can be pros, cons, or both depending on the context in the conversation. For example, a subject might think of the smell of cigarettes as a pro reason for smoking and another might think of it is a con. We discuss how we expanded this list of categories from 6 to 22 in greater detail in Chapter 4.

In the context of the conversation, the chatbot uses a different language for discussing the pros and cons of smoking. It substitutes pros and cons with good and bad reasons for smoking. From this point forward, we will refer to the pros and cons as the good and bad reasons. Now that we understand how subjects express their reasons for smoking, we can move on to how the chatbot engages them in the two exercises mentioned in the beginning of this section.

3.1.2 Running Head Start

After the conversation introduction, the chatbot begins the first exercise by discussing the good and bad reasons for smoking using the running head start technique described in Section 2.2.1 [25]. This exercise asks subjects three main questions; Do you enjoy smoking? What is good about it? And what is bad about it? The answer to the first question determines subjects’ sentiment toward smoking, and consequently the order of

Reason	Good/bad	Possible example of the reason
Addiction	Bad	The first thing I think of when I wake up is my first cigarette
Boredom	Good	I smoke out of boredom
Cool	Good	Makes me look cool
Cost	Bad	Cost so much for such little joy
Dirty	Bad	The cigarette ash drops about
Distraction	Good	It gives me time to myself and time to think
	Bad	how it interrupts your work
Feel good	Good	I enjoy the feeling that it gives me
Fire hazard	Bad	It burns my home and furniture
Flavour	Good	I like the way the smoke tastes
	Bad	The taste smoking leaves in your mouth
Focus	Good	Helps me concentrate doing computer work
	Bad	Can't concentrate if I need a cigarette
Health	Good	Cigarettes help with bowel movements
	Bad	All the health problems smoking is linked to causing
In my hand	Good	Gives me something to occupy my hands with
Physical appearance	Bad	Aging or appearance change is always a fear
Poor role model	Bad	I feel guilty because my son doesn't like me smoking and nags
Routine	Bad	It is a habit and routine for me, its just part of my life
Smell	Good	The smell of cigarette smoke is nice
	Bad	Leave you smelling on fingers breath and clothes
Smoking restriction	Bad	You can't smoke in a lot of places
Social	Good	I like to socialise with other people who smoke
	Bad	people around me do not smoke, only I do
Stigma	Bad	Being made to feel unwelcome by non smokers
Stimulation	Good	The sensation of the tobacco as it catches my throat
Stress	Good	Helps me relax and decrease stress
	Bad	Feeling anxious when I've run out

Table 3.2: A list of all the smoking reason categories used in the conversation

the remaining two main questions. If the subject's sentiment is positive, then the subject is asked about what is good first. Similarly, if the sentiment is negative, then the subject is asked about what is bad first. The matching of conveyed sentiment around smoking to which goes first was done to follow the principles of MI and keep the conversation

client-centric. In addition, the purpose of the second and third questions is to accumulate subjects' good or bad reasons for reflection and summarization. Reflection and summarization come at different points in the conversation as the result of the good and bad questions. Reflection occurs after each reason is expressed by the subject, whereas summarization occurs after the subject expressed all good or bad reasons.

In the running head start exercise, the conversation reflects to subjects the exact reasons for their smoking behaviour, similar to what the "Why do I Smoke?" test does [31]. For example, when a subject says "*Smoking gives me a pleasurable and happy feeling*", the chatbot replies with "*I understand, you get pleasure and satisfaction from smoking*". This confirmation reply reflects that the reason being communicated is in the category of pleasure or satisfaction. Reflection is most useful when subjects write long utterances that can be distilled into smaller reasons, or when subjects express multiple reasons that fall under the same category [25].

After all the reflections are done for each inferred reason, the chatbot summarizes by repeating everything the subject has said verbatim with its category. For example, the chatbot might write "*You said 'the way it makes me feel', which I believe is essentially feeling good or satisfaction*". In addition, the chatbot responds correctly if subjects write multiple reasons that have the same category. It does that by summarizing each category in one utterance. For example, the chatbot summarizes two reasons as stress reasons by saying "*You said 'calms nerves', and 'relieves stress', which I think are related to stress*". A conversation example of reflection and summarization is shown in Table 3.3.

The above-mentioned conversation exercises follow MI principles. The chatbot understands subjects' sentiment toward smoking to determine whether good or bad reasons should be discussed first. This decision is aligned with MI because it keeps the conversation client-centric. In addition, the chatbot explores the good and bad reasons and reflects on each one. Finally, the chatbot brings all the reasons together to summarize at an appropriate point in the conversation.

Bot	Do you like to smoke?
Subject	I do
Bot	What do you enjoy about smoking?
Subject	It is a great way to kill some time between tasks
Bot	I get it, smoking is helpful because it provides a useful distraction for you
Bot	What else do you enjoy about smoking?
Subject	it is relaxing when doing something stressful
Bot	Let me see if I understand: smoking relieves you of stress
	...
Bot	You said ‘‘It is a great way to kill some time between tasks’’, which I think is related to distraction
Bot	You also said ‘‘it is relaxing when doing something stressful’’, which I believe can be classified as stress
Bot	Did I summarize everything back correctly?
	...
Bot	Okay. Let’s now chat about the bad things about smoking

Table 3.3: Reflection and summarization in the conversation

3.1.3 Exception Case Questions

The next step in the general MI process is to stimulate the subjects by asking them to reflect around their reasons for and against smoking. In this step, the conversation aims to achieve two desired outcomes in the subjects. The first desired outcome is to make subjects understand how a specific reason leads them to smoke or don’t smoke. The second desired outcome is to possibly uncover situations where subjects were able to prevent themselves from smoking and understand why they did. To give a concrete example, imagine a subject that expressed stress release as something good about smoking. This subject smokes before entering an exam, but not after a stressful argument with a partner. We want this subject to realize that he/she has successfully relieved their stress without smoking in some occasions. These occasions happen at different times and bringing them to light in one setting helps subjects reflect on their behaviour.

To seek the two mentioned outcomes, we designed the exception case questions exercise. This exercise aims to find the exception cases by doing the following: for each reason, the chatbot asks subjects three questions. The first question asks subjects to remember a situation where they experienced the reason and it lead them to smoke. On the other hand, the second question ask them to remember a situation where they

experienced the reason and it did not lead them to smoke. The first question is referred to as the positive case, while the second as the negative case. Then the third question asks subjects to identify the difference between the positive (i.e smoked) and negative (i.e did not smoke) case. These questions are designed to make subjects contemplate what triggers them to smoke and possibly reveal times when they successfully avoided it. In addition, all three questions follow the spirit of MI since they are designed to gently reveal exception cases without authoritatively telling subjects to try stopping after they have avoided smoking in some situation. An example showing the three questions is shown in Table 3.4.

Bot	Please describe a time when you experienced stress and ended up smoking
Subject	Smoking is associated with ‘‘de-stressing’’ for me. If I feel anxious smoking takes the edge off.
Bot	Please describe a time when you experienced stress and didn’t end up smoking
Subject	Before I got divorced my ex-husband used to really stress me out but he also made me feel bad about smoking. Many times he would be stressing me out and I would not choose to smoke around him.
Bot	Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?
Subject	The emotional baggage involved with having that cigarette far out weighed any pleasure I would gain from smoking it, so I didn’t do it.

Table 3.4: An example of the three exception case questions

3.2 Improving the Conversation

We have explored and employed a number of different strategies to make conversing with the chatbot a pleasant experience. The simplest one is using different responses that communicate the same ideas, to avoid repetition that could lead to boredom or frustration of the subject. The chatbot chooses randomly from a set of prepared responses after it determines what it should say next. For example, to ask if a subject enjoys smoking, the bot might say ‘‘Do you like to smoke?’’, ‘‘Do you like smoking?’’, or ‘‘Do you enjoy smoking?’’. There are at least two responses for almost all the chatbot statements that

are likely to be used multiple times in the conversation. In addition, we have written specific responses for each of the categories of reasons being discussed, rather than less-information or responsive generic responses. This strategy is expected for the reflection exercise, but it is also used in the exception case questions as shown in Table 3.4.

Another strategy to improve the conversation is adding conversation “fillers”, which are pleasant connecting language between stages of the conversation. This strategy makes the conversation feel less like a survey, which is a potential problem because the conversation is mostly questions. One opportunity to add fillers is at points of transitions. For examples, saying “*Ok. Let’s begin!*” after obtaining subjects’ consent, or saying “*Okay. Let’s now chat about the bad things about smoking*” after discussing the good reasons about smoking. In addition, the chatbot uses conversation fillers to explain what it’s going to say next and ease subjects into answering questions. One example is used before the exception case questions: “*For the next part of our conversation, I want to discuss every bad and good thing you mentioned about smoking*”. Furthermore, conversation fillers make the conversation less abrupt and convey the chatbot’s expectations clearly to the subject as shown in Table 3.5.

Bot	Before we begin with your first reason, I want to explain what I’m going to ask you next
Bot	My next set of questions will require you to remember some of your experiences in dealing with the reasons we’re going to discuss
Bot	Don’t worry, it will become clear momentarily. Okay?
Subject	ok

Table 3.5: Conversations fillers for the exception case questions

Another class of strategies concern situations where it was not possible to determine the meaning based on a subject’s utterance. The chatbot should communicate this inability to characterize the subject’s words gracefully. For example, the chatbot offers choices for the subject to choose from when the chatbot does not succeed in characterizing what the subject said. However, this can lead to undesirable situations where subjects rely on the chatbot’s options to carry the conversation forward. To avoid this problem, the chatbot, when it receives an utterance it is unable to characterize, will first ask the subject to rephrase what is being said to enable a second attempt at characterization

as shown in Table 3.6. This behaviour does not always happen in the conversation, but only at points where the subject’s reflection is beneficial.

Bot	What is it about smoking that makes it good?
Subject	It is a peaceful thing I do just for myself.
Bot	I apologize, I don’t get what ‘It is a peaceful thing I do just for myself.’ means. Can you give more details
Bot	I’m trying to learn what you say, I’ll give you options if I can’t figure it out
Subject	It is ME time. A little break from my work.
Bot	I get it, smoking is helpful because it provides a useful distraction for you
Bot	What else do you find positive about smoking?
Subject	Gives my hands something to do.
Bot	I’m sorry, I don’t get what ‘Gives my hands something to do.’ means. Can you give more details
Bot	Don’t worry, I’ll give you options to choose from if I can’t understand you
Subject	Gives my hands something to do.
Bot	My bad, I still don’t get what you’re saying
Bot	Is it on of the following options? <i>Having something in my Hand ...</i>
Subject	<i>Having something in my Hand</i>

Table 3.6: An example of handling confusion by politely asking again

The above strategies for dealing with an incident of missed characterization assumes that the subject is trying to communicate something the chatbot will succeed in characterizing but it fails to do so from the specific utterance. However, this is not always the case. Subjects may communicate new reasons that do not fit within the scope of reasons that have been determined during the research project to-date. When that situation is detected, the subject is asked to provide a name for a new smoking reason. This new reason is still carried forward into the summarization, reflection, and the exception case questions. In the case of reflection and summarization, the chatbot replies with the new smoking reason (as give) verbatim. However, for the exception case questions, the chatbot uses generic questions with slots to fill in the new reason. This strategy is illustrated in Table 3.7 for a subject who came up with the new reason “marital problem” when the chatbot couldn’t characterize the following: “*i resent my wife for being more addicted to smoking than i am and i am convinced that if i were not married to her - i would have quit long ago.*”.

Another strategy the chatbot uses is communicating to subjects the possibility that it might not be able to understand them. It does that in the introduction and at different points in the conversation. This strategy aims to lower the annoyance of conversing with the chatbot. It vital for the chatbot to avoid frustrating subjects since that might cause the opposite of the intended effect.

Bot	Let me see if I recall correctly, so you think of marital problem as something bad about smoking
Bot	I want you to describe a time or situation where you experienced the reason 'marital problem' and it led you to smoke
Subject	it's kind of the other way around. my wife's smoking is what causes the marital problem
Bot	I want you to describe a time or situation where you experienced the reason 'marital problem' and it did not lead you to smoke
Subject	in the car the other day when i wouldnt stop
Bot	Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?
Subject	i felt like: this could be the decisive moment when we make it happen

Table 3.7: Example of carrying new reasons forward in the conversation

To summarize, we have designed a basic pleasant conversation that aims to elicit reflection in subjects. It is centred around discussing the good and bad things about smoking, and it uses MI principles to carry this discussion forward. The discussion happens in two exercises. The first exercise reveals to smokers their reasons for and against smoking, while the second exercise help them reflect on each reason. Examples of some full conversations are available in Appendix A.

Chapter 4

Chatbot Design

Generally building a chatbot requires three tasks: designing a conversation, creating a set of rules to navigate the designed conversation, and adding Natural Language Understanding (NLU) capabilities to inform the rules of the conversation. Chapter 3 presented the conversation design; This chapters describes the technical infrastructure that contains the rules and NLU system. First, it describes how the chatbot encodes the rules of the conversation into a computer program. Next, it describes the NLU models used to inform the rules of the conversation.

4.1 Conversation Rules

Recall that a chatbot is a system that receives utterances as input and generates one or multiple responses as output. Depending on the complexity of the chatbot, many steps can happen in between receiving an utterance and generating a response. These steps mostly deal with strategies for tracking the context of the conversation to generate responses. In Section 2.3.2 we mentioned two types chatbot systems; A rule-based chatbot and a corpus-based chatbot. A rule-based chatbot generates responses using hand crafted-rules while a corpus-based chatbot uses statistical approaches to generate responses. As also mentioned in Section 2.3.2, rule-based chatbots can use statistical approaches to inform its rules without entirely abandoning them. In the case of our chatbot, it uses hand-crafted rules informed by NLU models and it encodes the rules of

the conversation as a finite-state machine (FSM). The following two sections describe the details of encoding the conversation rules as an FSM as well as how the chatbot generates responses.

4.1.1 Conversation as FSM

A conversation encoded as an FSM is separated into states. Each state represents a point in the conversation where the chatbot is communicating something to the subject and expecting some or no information in return. The context of the conversation depends on which state the chatbot is in and its previous state transitions. Therefore, the conversation is carried forward as the chatbot moves across states in the FSM and it ends when the chatbot reaches the final state. Figure 4.1 shows a part of the FSM used to encode the conversation described in Chapter 3.

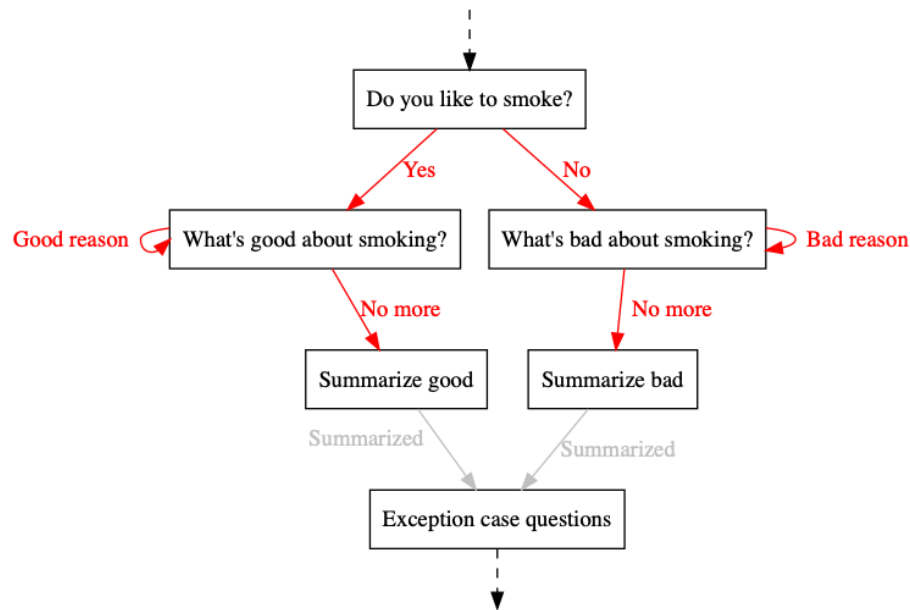


Figure 4.1: A subset of the FSM used to encode the conversation rules

In the conversation FSM, there are two types of events that cause state transitions. The first event happens as a result of the chatbot receiving information from a subject by processing their utterance through an NLU model. For example, the chatbot understands

the utterance *“I love smoking”* as an agreement answer in the state where it is expecting the subject’s reply to the question *“Do you like to smoke?”*. Events of this type are depicted as a red transition in Figure 4.1. The other type of event occurs in states that don’t expect information from the subject. In these states, the chatbot enters them to send a response to the subject and then automatically creates a self-generated event that will cause a state transition. These events are depicted as grey transitions in Figure 4.1.

4.1.2 Response Generation

The FSM described above is used to keep the conversation context and navigate it with the subject. It also generates the responses required. The chatbot uses a collection of hand-crafted responses that it can utter to the subjects. Some of these responses are specified verbatim and some are parameterized. The parameters for any given response are the current state of the conversation FSM and the results of the NLU models used in that state. For example, the chatbot will generate the response *“I understand, smoking is a social habit for you”* if the current state is *“What’s good about smoking?”* and the NLU model is signalling a **social** reason. More examples of how FSM states and NLU results generate responses are shown in Table 4.1.

Parameters	Response
State: Do you like smoking? NLU: Positive sentiment	I’ll take that as a yes
State: What’s good about smoking? NLU: Social smoking reason	Ok, so you smoke when people around you are smoking
State: What’s good about smoking? NLU: Stress smoking reason	I see, you may smoke because you feel stressed
State: What’s bad about smoking? NLU: No more smoking reasons	I understand, you have no more bad things to say about smoking

Table 4.1: Response generation given an FSM state and NLU model results

4.2 NLU Models

Now that it is clear how the chatbot uses an FSM to encode the conversation rules, let’s discuss the NLU models that inform those rules. In the context of the chatbot, there

are two types of NLU models: *keyword* NLU models that search for specific words in utterances and *classification* models that capture a specific meanings in utterances. The chatbot uses 6 classification NLU models and 3 keyword ones. Some of these models are used off-the-shelf from a third party service called Wit.ai (an online NLU service) [37] and some are custom-built. Table 4.2 show a summary of the 9 models discussed in this section.

Model	Type	Source	Description
SmokingReason	Classification	Wit	Detects categories of smoking reasons such as: health, social, stimulation and their absence
SmokingReason2	Classification	Custom	Detects categories of smoking reasons such as: health, social, stimulation and their absence
Sentiment	Classification	Wit	Categorizes utterances into positive, negative, or neutral
Greetings	Classification	Wit	Detects if utterance has a greeting
Thanks	Classification	Wit	Detects if utterance has thanks
Bye	Classification	Wit	Detects if utterance has goodbye expressions
SmokingReasonKeywords	Keyword	Custom	Scans utterances for synonyms of the 22 categories of smoking reasons
YesNo	Keyword	Custom	Scans utterances for yes and no keywords
Agreement	Keyword	Custom	Scans utterances for keywords such as: I do, I have

Table 4.2: NLU models used in the chatbot

4.2.1 Keyword Models

Keyword NLU models generally look for specific words in utterances using simple heuristics for pattern matching. The chatbot uses three different keyword models: `YesNo`, `Agreement`, and `SmokingReasonKeywords`.

YesNo and Agreement

There are many points in the conversation where the chatbot expects yes or no answers from subjects. For example, the chatbot asks subjects if they would like to continue after being presented with the consent information and for which the chatbot expects them to answer with a ‘yes’ or ‘no’. The answers don’t have to be exactly ‘yes’ or ‘no’, as there are many other words that convey the same meaning. To detect and understand these yes or no words, the chatbot uses the **YesNo** and **Agreement** models. The **YesNo** model detects synonyms of the words yes and no. For example, yes words such as ‘yeah’, ‘yup’, ‘sure’, ‘ofcourse’, or unusual ones such ‘yuppers’. The **Agreement** model searches for words such as ‘am’, ‘have’, ‘do’, ‘would’, and their negation.

Both models use the following heuristics: They remove articles and punctuation from the utterance before looking for the keywords. In addition, they only handle short utterances (four words or so). The **YesNo** and **Agreement** models assume that yes or no synonyms appearing in long utterance should be ignored, since most yes or no answers are short in nature.

SmokingReasonKeywords

Recall in Section 3.1.1 we used the “Why do I Smoke” test [31] and other methods to come up with 22 categories of all the good or bad reasons about smoking. The chatbot uses the **SmokingReasonKeyword** model to detect when subjects give one word answers such as ‘rush’, ‘cost’, or ‘socialize’ for what is good or bad about smoking. More specifically, the model looks for common synonyms for each of the 22 categories of the good and bad reasons for smoking.

The common synonyms used in the **SmokingReasonKeywords** model are generated using the WordNet database [24]. WordNet is a lexical database that contains useful information about the English language. One of its features is that it can group words in what is called a synonym set. A synonym set is a group of words that can be used interchangeably in some context. Each synonym set has a definition of the context that the words in it can be used in. Take the word ‘stress’ for example. It can mean different

things depending on the context and its part of speech as shown in Table 4.3. The `SmokingReasonKeywords` model uses the second and fourth ‘stress’ synonym sets from Table 4.3 and generates all the possible forms of the words in the set such as: stress, stressful, tenseness, tensenesses, and tension. The same process is used for the remaining 21 categories of good and bad smoking reasons. This approach of using WordNet’s synonym sets allows the model to discover new keywords for the 22 categories of what is good or bad about smoking.

	POS	Context definition	Synonym set
1	Noun	The relative prominence of a syllable or musical note (especially with regard to stress or pitch)	stress, emphasis, accent
2	Noun	(Psychology) a state of mental or emotional strain or suspense	tension, tenseness, stress
3	Noun	Special emphasis attached to something	stress, focus
4	Noun	Difficulty that causes worry or emotional tension	stress, strain
5	Noun	(Physics) force that produces strain on a physical body	stress
6	Verb	To stress, single out as important	stress, emphasize, emphasise, punctuate, accent, accentuate
7	Verb	Put stress on; utter with an accent	stress, accent, accentuate
8	Verb	Test the limits of	try, strain, stress

Table 4.3: WordNet synonym set for word ‘stress’

4.2.2 Classification Models

One key difference between the NLU keyword models and the classification models is the need for training for the latter. All the classification models shown in Table 4.2 require training. However, only the `SmokingReason` and `SmokingReason2` models are trained by us. The remaining models are provided by Wit trained and ready to use. Before we present the two smoking reason classification models and their differences, we first describe how we gathered the training data to build them.

Training Process

Subjects were recruited online to gather training data about their perceived good and bad reasons for smoking, *and the way that they express these reasons*. The subjects were asked to converse with a chatbot that delivers a slightly modified version of the conversation specified in Chapter 3. This modification is a configurable training mode in the chatbot that allows it to confirm its classification of what is good or bad about smoking with subjects. Here the chatbot asks the following question after it receives an utterance that is describing a good or bad reason for smoking: *“I understood ‘...’ as something related to ‘...’, did I get it right?”*.

After this confirmation question, a subject can either confirm, correct, or teach the chatbot something new. If the subject confirms, the chatbot continues with the conversation. If the subject does not confirm, the chatbot presents the subject with a list of the classes in the `SmokingReason` model. Then, the subject can choose a valid class from the list or provide the chatbot with a new class. In all three cases, the utterance and its original class, corrected class, or new class are saved to be reviewed and added (manually) to the training data set. An example illustrating how a subject might teach the chatbot something new or correct it is shown in Table 4.4.

The process of asking subjects to confirm or correct the chatbot about what is good or bad about smoking implies that it must be able to understand basic good or bad reasons to collect training data in the conversation. Recall that, in Section 3.1.1 the first six categories of what is good or bad was taken from the “Why I do Smoke” test [31]. We combined the basic six categories and their examples from the test to build the first version of the `SmokingReason` NLU model. Then, we iteratively asked subjects to converse with the chatbot and re-trained the `SmokingReason` model for the next group of subjects. A total of 121 subjects in 11 groups allowed us to gather a data set of a 1068 examples and 23 classes. This data set is used to build and evaluate the two `SmokingReason` and `SmokingReason2` NLU classification models described in the following sections. Table 4.5 shows all the 23 classes as well as a brief description of each.

Bot	What else do you find positive about smoking?
Subject	I like the way the smoke tastes
Bot	I understood ‘I like the way the smoke tastes’ as something related to ‘Feeling good’
Bot	Am I right?
Subject	Wrong
Bot	Is it on of the following options? <i>Addiction, Stimulation, ..., Other</i>
Subject	<i>Other</i>
Bot	Can you please tell me what it is in one or two words?
Subject	Flavor
Bot	Thank you for teaching me something new!
	...
Bot	What else do you dislike about smoking?
Subject	yellow fingers
Bot	I understood ‘yellow fingers’ as something related to ‘Health’
Bot	Am I right?
Subject	Wrong
Bot	Is it on of the following options? <i>Addiction, Stimulation, ... Physical Appearance, ..., Other</i>
Subject	<i>Physical Appearance</i>

Table 4.4: Correcting the chatbot in the training mode

SmokingReason and SmokingReason2 NLU Models

Similar to the `SmokingReasonKeywords` NLU model, the purpose of the `SmokingReason` and `SmokingReason2` models is to determine which of the 22 categories an utterance belongs to. The main difference is that these classification models generalize over long utterances instead of one word utterances. Another difference is that the classification models have an extra class (i.e `no_more`) indicating the absence of a smoking reason as shown in Table 4.5.

The `SmokingReason` NLU model was built and trained on the Wit.ai platform. Wit enables the construction of custom models on its platform when supplied with training data. To build a custom model on Wit, the process is as follows: First, create an empty NLU model on the Wit website and specify its type (i.e classification model). Next, upload the training data to the newly created model through Wit’s Application Programming Interface (API). Then, the Wit service will train the model and expose a classification API for the chatbot to interact with. The training data consists of utter-

Class	Good/Bad	Description
addiction	Bad	Relating to smoking addiction or craving
boredom	Good	Indicates smoking out boredom
cool	Good	Appearing cool or fashionable to other
cost	Bad	Hight monetary value of cigarettes
dirty	Bad	Relating to cigarette ashes or other unclean aspects of them
distraction	Both	Smoking a distraction from something else
feel_good	Good	General pleasure of satisfaction
fire_hazard	Bad	Hazards associated with burning
flavour	Both	Taste of smoking cigarettes
focus	Both	Ability to concentrator lose concentration
health	Both	Indicating health benefits (i.e weight control) or harm
in_my_hand	Good	Having a cigarette in your hand without realizing
no_more	NA	Nothing more to say
physical_appearance	Bad	Effects on the body such as discolouring
poor_role_model	Bad	Worry of being a poor role to model
routine	Both	Smoking cigarettes routinely in the day
smell	Both	Relating to good or bad oder or smoking
smoking_restriction	Bad	Relating to inability to smoke indoors or other restricted places
social	Both	Smoking in social settings
stigma	Bad	Negative view of smoking
stimulation	Good	Relating to rush or drive of smoking
stress	Both	An indication of stress relief or induction

Table 4.5: Classes for the `SmokingReason` and `SmokingReason2` classification models

ances labelled with the correct reason class collected as described above in the training process.

Building classification models and training them on the Wit.ai platform was initially very convenient. However, over time we encountered several problematic issues with Wit. One major issue is the lack of visibility on how models are trained. There is no information or documentation describing how the Wit.ai service is training its models or fine-tuning them. A particular frustration was the inability to set the threshold of success (i.e prediction probabilities) for a result, as well as the lack of a confidence that was given for an answer. This lack of visibility quickly became frustrating as the

performance of the `SmokingReason` model was not improving with more training data. In fact, the performance was becoming worse. Specifically, it was starting to become conservative and generate a lot of false negatives (FN), which we could identify by our own inspection of the results. This lead us to create our custom classification model, the `SmokingReason2` model.

The `SmokingReason2` classification model was build using the Natural Language Processing (NLP) framework `spaCy` [1]. `spaCy` is a framework that contains many useful NLP tools for processing text. One of these tools is the `TextCategorizer`, a Convolutional Neural Network (CNN) that can be trained for text classification. We used this CNN to train the `SmokingReason2` classification model using the recommended parameters for training a `TextCategorizer` in `spaCy` [2].

To evaluate the `SmokingReason2` and `SmokingReason` models quantitatively, the following steps were taken; First, the 1086 samples in the data set were randomly split into 75% training (868 samples) and 25% test (200 samples) sets. Second, the two models were trained using the training set. Third, measure the true positive (TP), false positive (FP), and false negative (FN) rates to calculate precision, recall, and F1 score on the test set. The results are shown in Table 4.6 and Figure 4.2 where the `SmokingReason` and `SmokingReason2` models are abbreviated as SR and SR2 respectively.

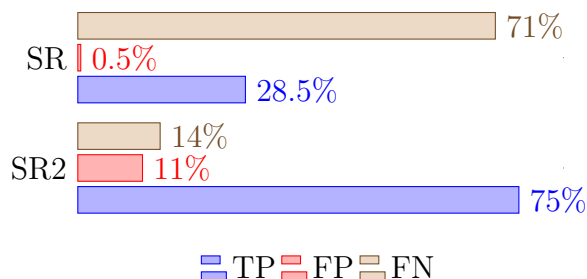


Figure 4.2: TN, FP, and FN rates for the `SmokingReason` and `SmokingReason2` NLU models

The results shown in Table 4.6 and Figure 4.2 indicate that the `SmokingReason2` models outperforms the `SmokingReason` model since it has a significantly higher F1 score. The higher F1 score can be easily predicted by looking at the distribution of the TP, FP, and FN rates depicted in Figure 4.2. The `SmokingReason` model is extremely

Measurement	SR	SR2
Precision	0.98	0.87
Recall	0.28	0.84
F1 Score	0.44	0.86

Table 4.6: Precision, Recall, and F1 Score for the `SmokingReason` and `SmokingReason2` NLU models

conservative (high FN, low FP). On the other hand, the `SmokingReason2` model is more balanced and has better TP, FP, and FN rates. The only issue in the `SmokingReason2` model is that it has a higher FP rate when compared with the `SmokingReason` model. However, an 11% FP rate is not that harmful in the context of the conversation delivered by the chatbot. This is because there is an overlap between the classes which means that some mis-classifications are not completely wrong, and may well be what the subject intended. Sometimes the chatbot will mis-classify something according to the test set but the subject would agree with the chatbot’s classification. To illustrate this point, Table 4.7 shows the 22 FPs that the `SmokingReason2` models wrongly classified and whether they are acceptable or not.

The predicted classes for the 9 *acceptable* utterances in Table 4.7 are actually sufficient in the context of the conversation. For example, if the `SmokingReason2` mis-classifies the utterance *“how it interrupts your work”* to `focus` instead of `distraction`, the chatbot will respond with *“I understand, smoking makes you lose focus”* instead of *“I get it, smoking can be a distraction for you”*. The generated response from the chatbot will most likely satisfy the subject. If we consider the *acceptable* 9 FPs as TPs, we get an increased 79.5% TP rate, decreased 6.5% FP rate, unchanged 14% FN rate, and an increased F1 score 0.89.

Acceptable	Utterance	Class	Prediction
Yes (9)	Feeling isolated around non-smokers.	stigma	social
	Having to leave social situations to smoke	stigma	social
	It helps me focus and concentrate	focus	distraction
	helps stimulate my senses	stimulation	feel_good
	how it interrupts your work	distraction	focus
	i like rolling tobacco into a cigarette	in_my_hand	stimulation
	i like that it gives me something to do	boredom	distraction
	it gives me something to do when i am out of the house and have some free time	boredom	distraction
the effects	stimulation	health	
No (13)	I don't like what it does to my body	health	stigma
	I'm a bad influence for my son	poor_role_model	health
	Identifies me as a person.	cool	health
	It help to relieve frustrating	stress	cost
	contains unknown additives	health	addiction
	i honestly have run out of things i hate about smoking	no_more	health
	my parents disapprove of it	stigma	focus
	polluting the air	dirty	in_my_hand
	releases stress after a hard/long day	stress	health
	routine cigarettes	routine	in_my_hand
	shorter life expactancy	health	feel_good
	there are more regulations	smoking_restriction	no_more
to keep myself from slowing down	stimulation	distraction	

Table 4.7: Examples of acceptable and unacceptable FPs from the SmokingReason2 NLU model

Chapter 5

Results

In the previous chapters, we presented the designed conversation in Chapter 3 and how we implemented it using a finite state machine (FSM) and NLU (Natural Language Understanding) models in Chapter 4. This chapter describes the studies completed to evaluate the effectiveness of the chatbot on subjects' motivation to quit. The following sections describe the studies' designs and subjects' demographics, the results of studies and their discussion, and finally the limitations of our approach.

5.1 Methods

Recall that the goal of the chatbot is to motivate subjects toward making an action to quit smoking. A total of 221 subjects were recruited online to train and test the effectiveness of the chatbot. These subjects were recruited from the Prolific platform [29], a website that allows researchers to recruit individuals to participate in human research experiments in exchange for financial compensation. Prolific allows researchers to select from a large demographic of more than 40,000 individuals. In addition, most of this demographic reside in the UK where the company is based. We designed and published two studies on the Prolific platform; The first study, referred to as the *Training study*, recruited subjects to train the chatbot as well as gather feedback on their experience with the chatbot. The second study, referred to as the *Intervention study*, recruited subjects to measure the effect of the chatbot on their motivation to quit. The following sections present the

studies' design and demographics.

5.1.1 Study Design

Both the Training and Intervention studies were conducted through the internet, by recruiting subjects through the Prolific platform and asking them to interact with the chatbot. The two studies asked for the following inclusion criteria:

1. English Speaker
2. Smokes cigarettes daily
3. Resides in UK, US, or Canada
4. Age between 16 and 60 inclusive

Furthermore, the Training and Intervention studies were reviewed and approved by the University of Toronto's Health Science Research Ethics Board (REB). The Training study's REB protocol number is 35962 and was approved on May 28, 2018, and the Intervention study's REB protocol number is 36639 and was approved on September 10, 2018.

On the prolific website, only subjects who meet these criteria are given the opportunity to participate in the studies. In the Training study, subjects were presented with a consent form on the Prolific website detailing the study's information and asking them to converse with the chatbot for the purpose of training it. More specifically, the training study asked subjects to visit our website and complete two tasks. The first task is conversing with the chatbot, and the second one is giving feedback on the overall experience of conversing with the chatbot and to make suggestions on how to improve it. The feedback task was not mandatory and not all subjects completed it. However, all subjects completed a conversation with the chatbot. In addition, the chatbot conversation in the Training study was different from the conversation presented in Chapter 3. It had additional questions for the purpose of training as was described in Section 4.2.2.

In the Intervention study, subjects were presented with a different consent form. The new consent form, which asked participants to perform seven tasks in two phases. In the

first phase, subjects were asked to fill out a survey about their smoking behaviour, answer the readiness ruler questions [29], converse with the chatbot, answer the readiness ruler questions again, and finally provide feedback on the overall experience of conversing with the chatbot. The Intervention study used the same conversation as the one described in Chapter (3). Furthermore, the second phase required subjects to report back in a week to fill out another survey. This one-week later survey asked participants the readiness ruler questions as well as asked them if they have taken any action toward quitting or reducing smoking.

5.1.2 Participants

A total of 221 subjects participated in both studies; 121 in the Training study and 100 in the Intervention study. Of the 100 that participated in phase one of the Intervention study, 97 reported a week later and completed the one-week reporting survey. The demographics of the 121 Training subjects and 97 who completed the Intervention study are shown in Tables 5.1 and 5.2 respectively. Both tables show subjects' self-reported information about their age, gender, smoking frequency, last quit attempt, employment status, and the country of residence. When a category value in Tables 5.1 and 5.2 has the value "NA", it indicates a missing value. The reason for these "NA" values is that the demographics data was collected from Prolific [29] and some fields are absent.

5.2 Results and Discussion

This section presents qualitative and quantitative results from the conversations that took place with chatbot in the Training and Intervention studies. To evaluate the chatbot's effectiveness in motivating smokers, we review their feedback, count the number of words they uttered in their conversation, the readiness ruler data, and reported smoking actions taken in the week following the intervention. The first two measurements results are available for both the Training study and the Intervention study. However, the readiness ruler and action taken results are only available in the Intervention. The Training study was intended to train the chatbot as the name implies. Nevertheless, there are some

Demographic	Category	Count
Age	16-19	0 (0.0%)
	20-29	40 (32.8%)
	30-39	42 (34.4%)
	40-49	23 (18.9%)
	50-59	13 (10.7%)
	60	1 (0.8%)
	NA	3 (2.5%)
Gender	Female	60 (49.2%)
	Male	59 (48.4%)
	NA	3 (2.5%)
Smoking Frequency	Once a day	5 (4.1%)
	2-5 times a day	20 (16.4%)
	6-10 times a day	29 (23.8%)
	11-19 times a day	48 (39.3%)
	20+ times a day	19 (15.6%)
	NA	1 (0.8%)
	Last Quit Attempt	Never
Year+		30 (24.6%)
7-12 months		10 (8.2%)
4-6 months		14 (11.5%)
1-3 months		15 (12.3%)
Currently trying		14 (11.5%)
NA		23 (18.8%)
Employment Status	Full-Time	61 (50.0%)
	Part-Time	21 (17.2%)
	Not in paid work	17 (13.9%)
	Unemployed (and job seeking)	15 (12.3%)
	Other	7 (5.7%)
	NA	1 (0.8%)
Country of Residence	United Kingdom	66 (54.1%)
	United States	50 (41.0%)
	Canada	6 (4.9%)

Table 5.1: Demographics of the 121 subjects in the Training study

interesting results from that exercise as well.

5.2.1 Free-form Feedback from Subjects

Subjects in both studies were asked the following question at the end of their engagement with the chatbot: *“Before you finish the study, please take some time to comment on*

Demographic	Category	Count
Age	16-19	1 (1.0%)
	20-29	25 (25.8%)
	30-39	46 (47.4%)
	40-49	10 (10.3%)
	50-59	14 (14.4%)
	60	1 (1.0%)
Gender	Female	52 (53.6%)
	Male	45 (46.4%)
Smoking Frequency	Once a day	5 (5.2%)
	2-5 times a day	12 (12.4%)
	6-10 times a day	33 (34.0%)
	11-19 times a day	24 (24.7%)
	20+ times a day	15 (15.5%)
	NA	7 (7.2%)
Last Quit Attempt	Never	15 (15.5%)
	Year+	33 (34.0%)
	7-12 months	8 (8.2%)
	4-6 months	10 (10.3%)
	1-3 months	14 (14.4%)
	Currently trying	7 (7.2%)
	NA	10 (10.3%)
	Employment Status	Full-Time
Part-Time		16 (16.5%)
Not in paid work		15 (15.4%)
Unemployed (and job seeking)		6 (6.2%)
Other		3 (3.1%)
NA		1 (1.0%)
Country of Residence	United Kingdom	50 (51.5%)
	United States	43 (44.3%)
	Canada	4 (4.1%)

Table 5.2: Demographics of the 97 subjects who completed the Intervention study

your experience chatting with the chatbot. Other than it's ability to understand more of your responses, what kind of advice can you give us to improve it?". The purpose of this question was to identify issues and potential improvement in the chatbot provided by the subjects. The majority of answers to this question suggested improvement to the chatbot. However, there were other signals in the feedback that emerged. Subjects expressed that they enjoyed conversing with the chatbot, found it beneficial, or were frustrated by it. To

measure this data quantitatively, we categorized subjects feedback into four categories: improvement suggestions, enjoyment, benefit, and frustration. Table 5.3 describes each one of the four categories.

Feedback category	Description
Improvement suggestions	Any feedback that suggested bug fixes, new capabilities, or comments relating to functionality
Enjoyment	Feedback that indicates a positive pleasant experience with the chatbot
Benefit	Feedback explicitly indicating that the subject found the conversation helpful in motivating them to quit
Frustration	Any feedback that indicates the subject had a negative experience or caused negative effect

Table 5.3: Descriptions of feedback categories

In the Training study, 72.72% (88) of the subjects answered the feedback questions. The following percentages of the four categories were observed in their feedback: 43.0% (52) improvement suggestions, 39.7% (48) enjoyment, 9.1% (11) benefit, and 2.5% (3) frustration. Table 5.4 shows some examples of the benefit and frustration feedback received from subjects in the Training study; one can observe that some of the frustrations expressed were addressed in the improvements made between the Training and Intervention studies. On the other hand, 90.7% (88) of the 97 subjects in the Intervention study provided feedback. The following percentages were observed: 73.2% (71) improvement suggestions, 34.0% (33) enjoyment, 7.2% (7) benefit, and 3.1% (3) frustration. Examples of feedback taken in the Intervention study are provided in Table 5.5. A full list of all the received feedback from both studies is available in Appendix B.

The Training and Intervention studies show promising results. A number of subjects found conversing with the chatbot a pleasant experience (39.7% Training, 34.0% Intervention). In addition, more subjects expressed benefit (9.1% Training, 7.2% Intervention) than frustration (2.5% Training, 3.1% Intervention). We deem the frustration effects as negligible since the target audience are unmotivated subjects and continuing to smoke does not have a short term harmful effect. However, as will become apparent in the next limitation section of this study, we cannot say that all subjects were unmotivated to quit.

Category	Feedback
Benefit	The study actually made me think more about quitting smoking
Benefit	That was actually really very helpful. It was getting my thoughts out. I have been smoking for a long long time and this was the first time believe it or not that I actually got some insight to my behavior, LOVED IT.
Frustration	This chatbot really needs some redesign. Punctuation seems to throw it off “Yes” is accepted but “Yes.” is not. Also, it’s making assumptions of people which is going to make them combative, like me, when it just goes “obviously you aren’t able to stop yourself ever”.
Frustration	Frustrating, the questions made little sense. I had “it smells bad” and it asked me to describe a time when the action “it smells bad” caused you to smoke. A lot of self reflections kind of felt pointless as well. I smoke a pack a day, often without thinking about it., so pinpointing a time when something caused me to smoke is really hard.

Table 5.4: Feedback samples from subjects in Training study

Category	Feedback
Benefit	The repetitive nature of asking the same questions over and over got old. It didn’t take as long as I thought it would, so that’s great! I guess it’s because I’m a fast reader and writer. I thought it was great, and it encouraged me to continue trying to reduce my smoking. Thanks for the cool study. It was different from what you typically see. Also as a side note, chatbot understood me perfectly except about the bowel movement thing. I figured that was the closest he could get, since he can’t relate (not having bowels and all) so I let him have that one.
Benefit	I think the questions it asks are very good. I think they really help you to think a bit more deeply about the reasons behind why/when/where you smoke and how you’re able to abstain in other situations.
Frustration	I really do not understand the purpose of all the written responses it was asking for. If the aim of this bot is to help people quit smoking, it did a poor job in my opinion. It honestly made me think about the fact that I haven’t taken a break in a few hours and should go have a cig and take my dog for a walk. I like the concept and am curious to see how it is developed, but it still seems to be in the infancy stages of development in my opinion. Good luck on your research!
Frustration	i dont think it had any effect on me smokinng other than by talking about it it has made me crave a cigarette more

Table 5.5: Feedback samples from subjects in the Intervention study

5.2.2 Reflection

Another qualitative measurement of the effectiveness of the chatbot is the amount of reflection elicited from subjects, which can happen at multiple points in the conversa-

tion. One example point is when subjects express what is good and bad about smoking. Another one is when subjects answer the exception case questions. To get a sense of how much reflection is happening in the conversation, we count the total number of words in the subjects' conversations. We hypothesize that more words indicate more reflection in the conversations since subjects are expressing more good or bad things about smoking or using more words in their individual responses. Figures 5.1 and 5.2 show the word count distributions for the Training and Intervention studies respectively. The results in the two figures indicate that a significant number of subjects are going beyond 250 word count. Keep in mind that chat conversations tend to have shorter utterance than spoken dialog.

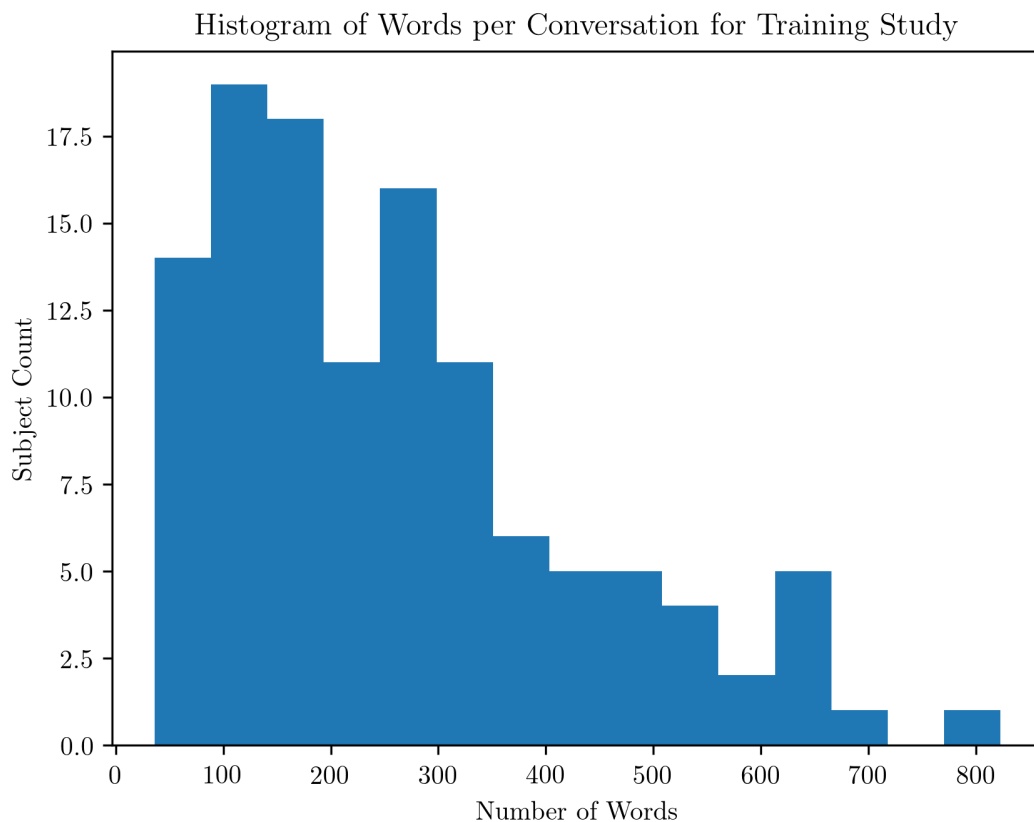


Figure 5.1: Histogram of word count for the Training study

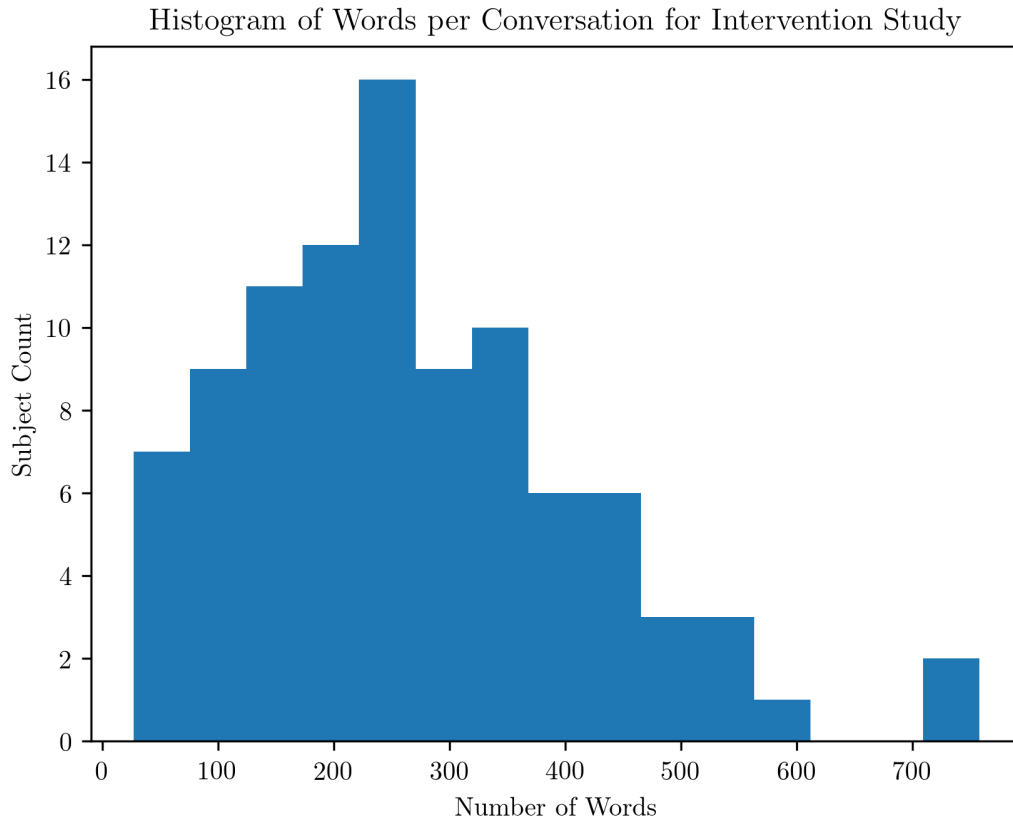


Figure 5.2: Histogram of word count for the Intervention study

5.2.3 Readiness Ruler

The explicit feedback and the reflection word count measurements described above do not directly measure subjects' motivation to quit. To quantify subjects' motivation to quit, we use the readiness ruler as described in Section (2.2.2). Specifically, subjects were asked the readiness ruler questions three times: just before conversing with the chatbot, immediately after the conversation, and one week after the conversation. The three self-reported set of scores (i.e pre, post, and one-week) are compared and used to measure the effectiveness of the chatbot on increasing subjects' motivation to quit.

The first measured outcome of the chatbot's effectiveness is the difference of the readiness scores immediately after conversing with the chatbot and after one week. Figure 5.3 shows the percentages of subjects who had a positive, negative, and no impact. The first stacked bar is the difference of scores between immediately after and before the

conversation, whereas the second is between one week after and before the conversation. The figure shows that the majority of subjects did not see a significant increase right after conversing with the chatbot. However, the one-week reporting results show that more subjects had a positive impact on all three scores (i.e confidence, importance, readiness). Figure 5.3 illustrates that a noticeable percentage of subjects experienced a negative impact in both immediately after the one-week reporting.

The second result is a paired two tailed t-test conducted to compare the differences between the self-reported readiness ruler scores before and after the conversation. Table 5.6 shows the t-statistic, p-value, and the means of each of two sets compared. It can be observed that the averages of most of the scores immediately and one week after are increasing. The only exception is Importance in the immediately after scores as shown in Table 5.6. The notable result here is that the positive changes in Confidence and Readiness are statistically significant in both the immediately after and one-week reporting scores ($p < 0.05$). This means a significant number of subjects in both the Training and Intervention groups felt more confident and ready in their ability to reduce or quit smoking after conversing with the chatbot. We note that, of the three scales in the ruler, the confidence one is said to be the most important and predictive of ultimate success [32].

Measured		t-statistic	p-value	Pre (μ)	Post (μ)
Immediately after	Importance	-0.58	0.56	6.34	6.25
	Confidence	4.25	0.00005	4.11	4.67
	Readiness	2.17	0.03	4.93	5.24
After 1-week	Importance	1.01	0.31	6.34	6.53
	Confidence	4.25	0.00005	4.11	4.88
	Readiness	2.9	0.005	4.93	5.57

Table 5.6: Paired t-test values for readiness ruler measurements

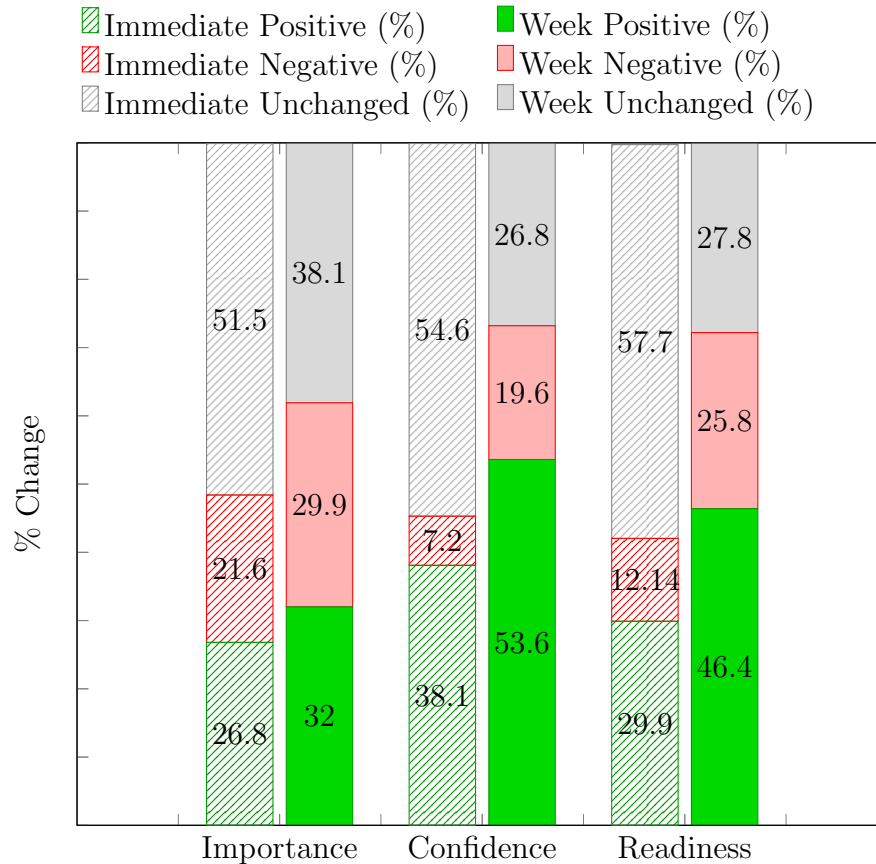


Figure 5.3: Net increase in the readiness ruler scores for immediately after and one week after the conversation

5.2.4 One-Week Actions

The final type of result is the self-reported actions taken to reduce smoking. After one week, subjects in the Intervention study were asked the following question in addition to the readiness ruler questions: *“Have you taken any steps to reduce smoking since you’ve talked with the chatbot? Select all that apply or add your own”*. Subjects were provided six check boxes to choose from, and they were told to give new answers if they don’t see a representative step in the list. The check boxes presented answers are the following:

- Visited a website for quitting smoking
- Used NRT (Nicotine Replacement Therapy)
- Used a self-help book
- Talked with a health professional

- Called a smoking help telephone line
- Got a medical prescription
- Other: *specify*

Out of the 97 subjects, 57.7% (56) reported taking steps to reduce smoking while 42.3% (41) reported that no steps have been taken. Table 5.7 shows the number of subjects who took each provided and other steps. The majority of subjects (57.7%) in the study reported taking action to reduce smoking. The most common action taken is visiting a website for quitting smoking as shown in Table 5.7. In addition, the one-week action also shows that many subjects tried or thought about trying e-cigarettes or vape sticks. A significant number of subjects also tried NRT. Furthermore, three subjects said that they have successfully reduced their smoking and two more made reduction attempts. These actions seem to be directly related to the chatbot intervention, and we take them as very promising. Of course, to make direct conclusions we would have to compare the actions taken in a controlled trial in which another group was given a baseline intervention. That said, we also know that there are many ways to improve the chatbot, which could lead to more significant results, and this is just the beginning.

5.3 Limitations

There are three main limitations in this research. The first limitation is the chatbot's assumption about subjects' motivation to quit. The chatbot assumes that all subjects are unmotivated to quit; however, we know from the demographics in Tables 5.1 and 5.2 that some of the subjects are currently trying or recently tried quitting. Furthermore, the chatbot uses the running head start MI strategy to elicit change talk in subjects. However, this strategy can be a double edge sword. It might elicit sustain talk in subjects who understand the pros and cons of their behaviour and are still unmotivated [25].

The second limitation is subjects' self-reported demographic data on the Prolific platform [29]. The collected demographics in Table 5.1 and 5.2 might be stale. One important example is the "When was your last quit attempt" information, which is reported once

Action	Count
Visited a website for quitting smoking	27
Used NRT (Nicotine Replacement Therapy)	13
Used a self-help book	7
Talked with a health professional	3
Called a smoking help telephone line	1
Got a medical prescription	1
Other: Bought e cig	1
Other: Bought vape stick	1
Other: I have cut back.	1
Other: I priced up some E-ciggarettes	1
Other: I've smoked a bit less	1
Other: Just tried to cut down	1
Other: Looked into Vaping but have not tried	1
Other: Read a few articles online	1
Other: Talked to partner	1
Other: Tried to cut down	1
Other: Using Vape	1
Other: Vaping	1
Other: charged up ecig kit today	1
Other: downloaded hypnosis MP3s	1
Other: reduced daily # of cigarettes from 3 to 2	1
Other: talked to friends about quitting	1

Table 5.7: Action taken by subjects in the Intervention study to reduce smoking

subjects join the platform. This information can be stale and not indicative of the current state of the subject.

The third limitations is the chatbot's ability to characterize utterances. It can reasonably detect the good and bad reasons for smoking, however, it does not use NLU to characterize and response to the exception case questions mentioned in Section (3.1.3). This lack of response to the exception case questions or elsewhere in the conversation can frustrate subjects and possibly lead to negative unintended effects.

5.4 Summary

In this chapter, we reported on the two different Training and Interventions studies. We examined the study details as well as the participants' demographics. In addition, we

presented four different measurements to gauge the effectiveness of the chatbot: free-form feedback, reflection through word count, readiness ruler, and the actions taken by subjects a week after. Finally, we observed in the results that more subjects are having a positive impact than a negative one across most scores of the readiness ruler.

Chapter 6

Conclusion

More than 90% of cigarette smokers are unmotivated to quit [6]. These unmotivated smokers need counselling help but do not seek it. The long-term goal of this research is to reach and counsel those smokers online using chatbots and motivate them to quit on a large scale. The contribution of this thesis is that it is the first step toward achieving and iterating over the goal of motivating smokers to quit on-scale.

In this research, we presented Motivational Interviewing (MI) as a successful counselling style for increasing smokers' motivation to quit and discussed possible Natural Language Processing (NLP) approaches for creating MI-capable chatbots. Then, we showed a conversation designed to increase subjects' motivation to quit using MI techniques. We also discussed the technical design of the chatbot and how it delivers the designed MI conversation. Finally, we presented the results of two different studies engaging 221 subjects in a conversation discussing what is good and bad about smoking with the chatbot.

The Training and Intervention studies showed that subjects observed more positive than negative impact in their motivation to quit smoking. In addition, the results of the Intervention study showed that a statistically significant ($p < 0.05$) number of subjects observed an increase in their confidence and readiness to reduce or quit smoking one week after conversing with the chatbot. Nevertheless, some subjects experienced a negative impact after conversing with the chatbot and more work should be done to investigate why these negative impacts are observed.

6.1 Future Work

Excitingly, there are multiple avenues to take to move our research forward. The first one is more in-depth analysis of the collected data in both the Training and Intervention studies. More questions should be asked to understand the negative effects observed in some subjects. For example, asking questions to discover the correlations between the change in the readiness ruler scores and specific demographics in the subjects' population.

The most difficult task in building the chatbot was collecting the training data for the Natural Language Understanding (NLU) models. The amount of training used in the current NLU models is small by today's standards. There should be more effort to train the NLU models and make them as robust as possible. The performance of NLU models are important since they directly relate to the experience of conversing with the chatbot. This experience needs to be improved because it might cause subjects to become frustrated, and have negative rather than positive effects on their smoking habit.

Another possible avenue is to improve the conversation by detecting MI's '*sustain*' and '*change*' talk. Detecting this information using NLU models can give great insight into the subjects' motivation to quit. The chatbot can choose different strategies other the running head start to account for the subjects' position in the transtheoretical model (TTM) process of change. In addition, the chatbot could be using more *Affirmation* in the conversation to get closer to subjects as MI practitioner will first try to do with their clients.

Furthermore, MI is used to counsel subjects in different behavioural change domains. We could try generalizing the chatbot so that it provides MI counselling across different behaviour-change goals. Using a chatbot in the mental health space is interesting and there is no shortage of possible future work in using MI in smoking cessation or other behaviour change domains.

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Appendix A

Three Example Conversations

The following sections illustrate conversation between subjects and the chatbot. All personally identifiable information has been removed from the conversations.

A.1 Conversation 1

Bot Hey! I am a computer chatbot created in a research project by the University of Toronto and CAMH. Our goal is to help smokers understand and reflect on their cigarette smoking, with the ultimate goal of helping them make the decision to quit

Bot In our conversation, I will ask you to teach me what you find good and bad about smoking cigarettes

Bot In this project we will record what you say, but only for the purposes of learning how to engage in better conversations

Bot Would you like to chat?

Subject yes

Bot Much appreciated!

Bot Before we begin, I just want to let you know that currently my knowledge is limited, so I might ask you to clear things up for me

Bot Don't worry though, I'll get better by talking to you

Bot Ok. Let's begin!

Bot Are you a smoker?

Subject yes

Bot Do you like smoking?

Subject yes

Bot What do you like about smoking?

Bot Please take your time and think about your answers and tell me about them one at a time

Subject I enjoy the calming feeling and something to do with idle hands

Bot Ok, just the act of holding a cigarette is what you enjoy

Bot Don't worry If I understood you incorrectly, I'll give you a change to correct me when I summarize back to you what I've learned

Bot What else do you enjoy about smoking?

Subject they are nice when I'm getting tired as well

Bot I'm sorry, I don't understand; I am in the process of learning but I don't get what you mean by "they are nice when I'm getting tired as well". Can you write it in a different way

Bot Don't worry, I'll give you options if I can't get what you're saying

Subject when I'm tired they are a good pick me up

Bot Let me see if I get it, you feel that smoking gives you energy and keeps you going

Bot Do you have more positive things about smoking? Tell me if you can think of any

Subject yes

Bot Could you please give me more details

Subject no i don't have more positive things

Bot I see, you have no more good things to say about smoking

Bot Are you sure you told me everything that is good?

Subject yes

Bot Ok, let me summarize what you said

Bot You said "I enjoy the calming feeling and something to do with idle hands", which I believe can be classified as Having something in my Hand

Bot You also said "when I'm tired they are a good pick me up", which I believe is essentially Stimulation

Bot Did I summarize everything back correctly?

Bot Yes, No

Subject yes

Bot Awesome

Bot Ok. Let's now chat about the bad things about smoking

Bot What is it about smoking that you don't like?

Subject the smell

Bot I get it, you don't like that smoking makes you smell badly

Bot I appreciate you making things simple for me, but please use more words in your sentences

Bot What else do you dislike about smoking?

Subject The health risks due to hurting family, moreso than myselff

Bot I understand, you worry about the consequences of smoking on your health

Bot Do you have more negative things about smoking? Tell me if you can think of any

Subject no

Bot I see, you have no more bad things to say about smoking

Bot Are you sure you told me everything that is bad?

Subject no

Bot What else do you dislike about smoking?

Subject the cost is also problematic

Bot I understand, you think that cigarettes are expensive

Bot Do you have more negative things about smoking? Tell me if you can think of any

Subject no

Bot I understand, you have no more bad things to say about smoking

Bot Are you sure you told me everything that is bad?

Subject yes

Bot Ok, let me summarize what you said

Bot You said "the cost is also problematic", which I believe can be classified as Cost

Bot You also said "The health risks due to hurting family, moreso than myself", which I think is related to Health

Bot You also said "the smell", which I believe is essentially Smell

Bot Did I summarize everything back correctly?

Bot Yes, No

Subject yes

Bot Awesome!

Bot For the next part of our conversation, I want to discuss every bad and good thing you mentioned about smoking.

Let's begin

Bot Which of these reason(s) is the most important one for us to discuss

Bot Cost, Health, Having something in my Hand, Smell, Stimulation

Subject cost

Bot Before we begin with your first reason, I want to explain what I'm going to ask you next

Bot My next set of questions will require you to remember some of your experiences in dealing with the reasons we're going to discuss

Bot Don't worry, it will become clear momentarily. Okay?

Bot Okay

Subject ok

Bot Okay, so you associate Cost as something negative about smoking

Bot Please describe a time where you thought about the cost of smoking but continued to smoke a cigarette

Subject This is a feeling I have almost every time I buy a pack. I realize how many other things I could do with the money I spent but have the conflict with genuinely enjoying smoking.

Bot Please describe a time where you thought about the cost of smoking and it prevented you from smoking a cigarette

Subject I recently took a trip to Europe and in preparing to have enough for the trip I drastically cut back on my smoking

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject I had something very worthwhile to quit for in the near future

Bot Which reason should we chat about next

Bot Health, Having something in my Hand, Smell, Stimulation

Subject health

Bot Let me see if I recall correctly, so you think of Health as something bad about smoking

Bot Please describe a time where you contemplated the consequences of smoking on your health and ended up smoking

Subject When I was in Europe I saw my nephews and they were very adamant about wanting me to quit but I didn't want to be cranky on my trip so I continued to smoke and the cigarettes were less expensive where I was

Bot Please describe a time where you contemplated the consequences of smoking on your health and then did not smoke that time

Subject I think about it but so far there hasn't really been a moment where my health has actually helped me not smoke

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject It usually is cost related, as I get older my health is more of a concern but it still hasn't truly slowed me down

Bot Which reason would you like to chat about next

Bot Having something in my Hand, Smell, Stimulation

Subject inmyhand

Bot Ok, so you associate Having something in my Hand as something positive about smoking

Bot Please describe a time where you smoked because you enjoy the feeling of holding a cigarette

Subject Every time I drive or a lot times when I'm working online

Bot Please describe a time where you wanted to enjoy holding a cigarette and didn't end up smoking

Subject I have never experienced this

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject considering all of the factors and having good reason to quit right in front of me, I have a hard time controlling my addiction for long term factors that I don't see yet

Bot Which reason should we chat about next

Bot Smell, Stimulation

Subject smell

Bot Ok, so you associate Smell as something negative about smoking

Bot Please describe a time where you were worried about the smell of cigarettes but ended up smoking

Subject I am actively working to not smoke inside my home but sometimes I get tied to work on the computer and have a craving so even though I don't want the smell in my house I often give in

Bot Please describe a time where you were worried about the smell of cigarettes and you didn't smoke

Subject I have been much better lately, I was craving a cigarette earlier and had to be at my computer for an hour, i wanted to light one up but I was able to hold off until I could get outside

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject Again its all the factors added up but typically if I have the money and can get a pack I have a hard time stopping myself

Bot Which reason would you like to chat about next

Bot Stimulation

Subject stimulation

Bot From what I gather, it seems that you think Stimulation is something good about smoking

Bot Please describe a time where you smoked because you wanted to feel stimulated

Subject Usually at the end of the day if I'm very tired but want to stay awake just a little while longer I will smoke a cigarette

Bot Please describe a time where you wanted to feel stimulated and didn't get that through smoking

Subject I usually always want to feel more stimulated so often I'll smoke more cigarettes but am searching for something else

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject Having something to quit for in the near future, thinking about my health and money in my pocket and realizing its something I don't need even though it often feels like I do

Bot Thanks, we covered all the good and bad reasons you have for smoking

Bot Thank you for your time, I enjoyed chatting with you. Bear with me while I tell you a few things before we finish here

Bot Here are some resources online if you're interested in getting help to quit smoking

1. Smokefree UK (<https://www.nhs.uk/smokefree>)
2. Smoker's helpline (<https://smokershelpline.ca>)
3. Stop Smoking US (<http://www.lung.org/stop-smoking>)

Bot To finish your participation, complete the last step by clicking the finish button below

Bot Bye for now

Table A.1: Conversation 1 from the Intervention study

A.2 Conversation 2

Bot Hello! I am a computer chatbot created in a research project by the University of Toronto and CAMH. Our goal is to help smokers understand and reflect on their cigarette smoking, with the ultimate goal of helping them make the decision to quit

Bot In our conversation, I will ask you to teach me what you find good and bad about smoking cigarettes

Bot In this project we will record what you say, but only for the purposes of learning how to engage in better conversations

Bot Would you like to chat?

Subject Yes

Bot Wonderful, thank you very much

Bot Before we begin, I just want to let you know that currently my knowledge is limited, so I might ask you to clear things up for me

Bot Don't worry though, I'll get better by talking to you

Bot Ok. Let's start!

Bot Have you ever smoked?

Subject Yes

Bot Do you enjoy smoking?

Subject Most of the time

Bot Apologizes, I'm not sure I got it

Bot Do you enjoy smoking?

Bot Yes, No

Subject yes

Bot What do you like about smoking?

Bot Please take your time and think about your answers and tell me about them one at a time

Subject I like that it relaxes me and keeps me stress-free.

Bot I see: smoking relieves you of stress

Bot Don't worry If I understood you incorrectly, I'll give you a change to correct me when I summarize back to you what I've learned

Bot What else do you find positive about smoking?

Subject Nothing else

Bot Let me see if I understand, you have no more good things to say about smoking

Bot Are you sure you told me everything that is good?

Subject Yes

Bot Let me see if I get it

Bot You said "I like that it relaxes me and keeps me stress-free.", which I believe is essentially Stress

Bot Do you agree with my summarization of you said about smoking?

Bot Yes, No

Subject Yes

Subject yes

Bot Great

Bot Interesting, thank you. Let's now switch to the bad things about smoking

Bot What is it about smoking that makes it bad?

Subject Health issues

Bot I get it, you worry about the consequences of smoking on your health

Bot What else do you dislike about smoking?

Subject Social image

Bot Ok, so smoking can be a problem in social situations

Bot What else do you find negative about smoking?

Subject Nothing else

Bot I get it, you have no more bad things to say about smoking

Bot Are you sure you told me everything that is bad?

Subject Yes

Bot Ok, let me summarize what you said

Bot You said "Health issues", which I believe can be classified as Health

Bot You also said "Social image", which I think is related to Socializing

Bot Do you agree with my summarization of you said about smoking?

Bot Yes, No

Subject Yes

Subject yes

Bot Great!

Bot For the next part of our conversation, I want to discuss every bad and good thing you mentioned about smoking. Let's begin

Bot Which of these reason(s) is the most important one for us to discuss

Bot Health, Socializing, Stress

Subject stress

Bot Before we begin with your first reason, I want to explain what I'm going to ask you next

Bot My next set of questions will require you to remember some of your experiences in dealing with the reasons we're going to discuss

Bot Don't worry, it will become clear momentarily. Okay?

Bot Okay

Subject ok

Bot Ok, so you associate Stress as something positive about smoking

Bot Please describe a time where you experienced stress and ended up smoking

Subject Mostly before, during, or after work, when I have to deal with many customers, some of whom are difficult to work with, and I end up smoking to relieve that stress and anxiety.

Bot Please describe a time where you experienced stress and didn't end up smoking

Subject When I was in college, I experienced stress before midterm exams and didn't smoke.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject I was too busy to smoke, I had other things on my mind.

Bot Which reason should we chat about next

Bot Health, Socializing

Subject social

Bot Let me see if I recall correctly, so you think of Socializing as something bad about smoking

Bot Please describe a time where you were with other smokers and ended up smoking

Subject I was with my girlfriend and we smoke sometimes.

Bot Please describe a time where you were with other smokers and you didn't smoke

Subject I was with some smokers on a train, people I didn't know, and I didn't feel comfortable smoking around them.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject Didn't feel comfortable smoking around them.

Bot Which reason do you want to discuss next

Bot Health

Subject health

Bot Let me see if I recall correctly, so you think of Health as something bad about smoking

Bot Please describe a time where you contemplated the consequences of smoking on your health and ended up smoking

Subject I went to the doctor and he showed me if I keep smoking at my current pace, it could lead to negative health repercussions in the future.

Bot Please describe a time where you contemplated the consequences of smoking on your health and then did not smoke that time

Subject I was reading an article about lung cancer and the probability of getting it and didn't smoke.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject I felt fear about my health in the future.

Bot Thanks, we covered all the good and bad reasons you have for smoking

Bot Thank you for your time, I enjoyed chatting with you. Bear with me while I tell you a few things before we finish here

Bot Here are some resources online if you're interested in getting help to quit smoking

1. Smokefree UK (<https://www.nhs.uk/smokefree>)
2. Smoker's helpline (<https://smokershelpline.ca>)
3. Stop Smoking US (<http://www.lung.org/stop-smoking>)

Bot I enjoyed chatting to you. I have to go now. Bye

Table A.2: Conversation 2 from the Intervention study

A.3 Conversation 3

Bot Hi there! I am a computer chatbot created in a research project by the University of Toronto and CAMH. Our goal is to help smokers understand and reflect on their cigarette smoking, with the ultimate goal of helping them make the decision to quit

Bot In our conversation, I will ask you questions to try to understand what you like and don't like about cigarette smoking

Bot In this project we will record what you say, but only for the purposes of learning how to engage in better conversations

Bot Would you like to chat?

Subject Sure

Bot Wonderful, thank you very much

Bot Before we start, I just want to inform you that unfortunately my understanding is limited, so I might ask you to repeat things for me

Bot Don't worry though, I'll get better at understanding with your help

Bot Okay. Let's get started!

Bot Do you smoke?

Subject Yes

Bot Do you enjoy smoking?

Subject Yes

Bot What do you like about smoking?

Bot Please take your time and think about your answers and tell me about them one at a time

Subject It relaxes me throughout the day--a good way to take breaks and reflect about what has been done and what needs to be done.

Bot I'm sorry, I don't understand; I am in the process of learning but I don't get what you mean by "It relaxes me throughout the day--a good way to take breaks and reflect about what has been done and what needs to be done.". Can you write it in a different way

Bot I'm trying to learn what you say, I'll give you options if I can't figure it out

Subject It helps me relax and reflect.

Bot I understood "It helps me relax and reflect." as something related to "Stress"

Bot Did I get it right?

Bot Right, Wrong

Subject right

Bot I appreciate you confirming my knowledge

Bot I get it: smoking relieves you of stress

Bot Are there other things that are good about smoking? If so, please tell me

Subject In some cases, it helps socialize with other smokers.

Bot I understood "In some cases, it helps socialize with other smokers." as something related to "Socializing"

Bot Is that correct?

Bot Right, Wrong

Subject right

Bot I appreciate you confirming my understanding

Bot Let me see if I get it, smoking is a social habit for you

Bot Can you think of more things that you enjoy about smoking? If so, please tell me

Subject Possibly, it is unique in this day--"looks cool"

Bot I apologize, I don't get what "Possibly, it is unique in this day--"looks cool"" means. Can you give more details

Bot I'm trying to learn what you say, I'll give you options if I can't figure it out

Subject Identifies me as a person.

Bot I apologize, I still don't understand what you're saying

Bot Is it on of the following options?

Bot Boredom, Being cool or sophisticated, Distraction, Feeling good, Flavour, Focus, Health, Having something in my Hand, Routine, Smell, Socializing, Stimulation, Stress, Other

Subject cool

Bot Okay, you think it is cool to smoke

Bot Are there other things that are good about smoking? If so, please tell me

Subject Just habit.

Bot Sorry, I don't understand what you mean by "Just habit.". Can you write it in a different way

Bot Don't worry, I'll give you options if I can't get what you're saying

Subject Addiction to feel normal.

Bot Apologizes, I still don't understand

Bot Is it on of the following options?

Bot Boredom, Being cool or sophisticated, Distraction, Feeling good, Flavour, Focus, Health, Having something in my Hand, Routine, Smell, Socializing, Stimulation, Stress, Other

Subject routine

Bot Let me see if I get it, smoking is part of your routine

Bot Can you think of more things that you enjoy about smoking? If so, please tell me

Subject That would be all my reasons.

Bot I apologize, I don't get what "That would be all my reasons." means. Can you give more details

Bot I'm trying to learn what you say, I'll give you options if I can't figure it out

Subject I can't think of anything else.

Bot I understood "I can't think of anything else." as something related to "Nothing more to say"

Bot Did I get it right?

Bot Right, Wrong

Subject right

Bot I appreciate you confirming my knowledge

Bot Ok, let me summarize what you said

Bot You said "Identifies me as a person.", which I believe is essentially Being cool or sophisticated

Bot You also said "Addiction to feel normal.", which I believe can be classified as Routine

Bot You also said "In some cases, it helps socialize with other smokers.", which I think is related to Socializing

Bot You also said "It helps me relax and reflect.", which I believe is essentially Stress

Bot Did I summarize everything back correctly?

Bot Yes, No

Subject yes

Bot Cool

Bot Okay. Let's now chat about the bad things about smoking

Bot What is it about smoking that you don't like?

Subject Waking up with the craving--first thing I have to do in the morning.

Bot I'm sorry, I don't understand; I am in the process of learning but I don't get what you mean by "Waking up with the craving--first thing I have to do in the morning.". Can you write it in a different way

Bot I'm trying to learn what you say, I'll give you options if I can't figure it out

Subject Forces me to do something.

Bot Apologizes, I still don't understand

Bot Is it on of the following options?

Bot Nicotine dependence, Cost, Dirty or messy, Distraction, Fire hazard, Flavour, Focus, Health, Physical appearance, Poor role model, Routine, Smell, Socializing, Stigma or shame, Stress, Other

Subject addiction

Bot I see, you feel compelled to smoke

Bot Can you think of more things that you dislike about smoking? If so, please tell me

Subject Health, coughing.

Bot I understood "Health, coughing." as something related to "Health"

Bot Is that correct?

Bot Right, Wrong

Subject right

Bot I appreciate you confirming my understanding

Bot Let me see if I get it, you are concerned about your health

Bot Are there other things that are bad about smoking? If so, please tell me

Subject People look down upon it sometimes.

Bot I understood "People look down upon it sometimes." as something related to "Stigma or shame"

Bot Am I right?

Bot Right, Wrong

Subject right

Bot Thank you for confirming my knowledge

Bot Let me see if I get it, you don't like how other people treat you when they know you're a smoker

Bot Do you have more negative things about smoking? Tell me if you can think of any

Subject That is all.

Bot I understood "That is all." as something related to
"Nothing more to say"

Bot Is that correct?

Bot Right, Wrong

Subject right

Bot Thank you for confirming my understanding

Bot Ok, let me summarize what you said

Bot You said "Forces me to do something.", which I think is
related to Nicotine dependence

Bot You also said "Health, coughing.", which I believe is
essentially Health

Bot You also said "People look down upon it sometimes.", which
I think is related to Stigma or shame

Bot Do you agree with my summarization of you said about
smoking?

Bot Yes, No

Subject yes

Bot Awesome

Bot For the next part of our conversation, I want to discuss
every bad and good thing you mentioned about smoking.
Let's begin

Bot Which of these reason(s) is the most important one for us
to discuss

Bot Nicotine dependence, Being cool or sophisticated, Health,
Routine, Socializing, Stigma or shame, Stress

Subject routine

Bot Before we begin with your first reason, I want to explain
what I'm going to ask you next

Bot My next set of questions will require you to remember some of your experiences in dealing with the reasons we're going to discuss

Bot Don't worry, it will become clear momentarily. Okay?

Bot Okay

Subject ok

Bot Okay, so you associate Routine as something positive about smoking

Bot Please describe a time where you smoked routinely without thinking about it

Subject Every morning--also after I complete a job or task, I use it as a break to reflect and reward myself.

Bot Please describe a time where you missed your routinely smoke

Subject When I'm at a time and/or place where I absolutely cannot smoke or get outside to smoke. It feels stressful which makes me want to smoke even more--therefore I cannot concentrate or get back on track.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject Same goes for not being a reward but to relieve stress during a struggling period.

Bot Which reason do you want to discuss next

Bot Nicotine dependence, Being cool or sophisticated, Health, Socializing, Stigma or shame, Stress

Subject --oops. Previous question?

Bot Please select one of the options specified

Bot Nicotine dependence, Being cool or sophisticated, Health, Socializing, Stigma or shame, Stress

Subject stress

Bot Let me see if I recall correctly, so you think of Stress as something good about smoking

Bot Please describe a time where you experienced stress and ended up smoking

Subject Every time I have to interact with another individual--phone call or in person--or while in the middle of a report and need to focus.

Bot Please describe a time where you experienced stress and didn't end up smoking

Subject This time right now. Haha. But also when I am overwhelmed with work and have no time for an escape.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject It felt harder, more rushed, not as focused.

Bot Which reason would you like to chat about next

Bot Nicotine dependence, Being cool or sophisticated, Health, Socializing, Stigma or shame

Subject addiction

Bot Let me see if I recall correctly, so you think of Nicotine dependence as something bad about smoking

Bot Please describe a time where you had a compelling feeling to smoke and actually smoked

Subject Usually I am able to smoke freely--mainly though in the mornings and right before bed. After meals on a break, of course, as well.

Bot Please describe a time where you had a compelling feeling to smoke but didn't end up smoking

Subject Back to being overwhelmed by individuals and just stuck through it to finish the job.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject Once again: it felt harder, I wasn't as focused, and felt rushed.

Bot Which reason should we discuss next

Bot Being cool or sophisticated, Health, Socializing, Stigma or shame

Subject cool

Bot Let me see if I recall correctly, so you think of Being cool or sophisticated as something good about smoking

Bot Please describe a time where you smoked because you felt it is sophisticated to smoke

Subject This one isn't really a big deal. I just realize most people don't smoke now (good thing) but it is part of my identity it seems.

Bot Please describe a time where you wanted to smoke because you felt it is sophisticated to smoke but didn't end up smoking?

Subject When I was around a family gathering. I could have but snuck away to do so in private.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject I felt outcasted, but to my own will.

Bot Which reason do you want to discuss next

Bot Health, Socializing, Stigma or shame

Subject social

Bot Okay, so you associate Socializing as something positive about smoking

Bot Please describe a time where you were with other smokers and ended up smoking

Subject On the job--it is nice to have other smokers around to discuss things as we all relax. It is also nice to simply meet a new person over a cigarette whom you never would have interacted with otherwise.

Bot Please describe a time where you were with other smokers and you didn't smoke

Subject --I can't think of a time like that.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject I haven't prevented myself in a social situation.

Bot Which reason should we chat about next

Bot Health, Stigma or shame

Subject stigma

Bot Let me see if I recall correctly, so you think of Stigma or shame as something bad about smoking

Bot Please express a time where you experienced social stigma but still ended up smoking

Subject My little nephews get after me anytime they see me smoking--kinda makes me feel bad. But they are young and do not understand addiction, etc at this point.

Bot Please express a time where you experienced social stigma and didn't smoke

Subject I usually do smoke but will leave the area and do so in private.

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject --again, I haven't really prevented myself due to social stigma.

Bot Which reason should we chat about next

Bot Health

Subject health

Bot Let me see if I recall correctly, so you think of Health as something bad about smoking

Bot Please describe a time where you contemplated the consequences of smoking on your health and ended up smoking

Subject Being sick, coughing way too much for someone my age. Yet, I still did so to a lesser degree though, because it made me feel normal again.

Bot Please describe a time where you contemplated the consequences of smoking on your health and then did not smoke that time

Subject I attempted to wear a patch for a day and did not smoke for 24 hours. Once I was feeling better though, I went back to it...

Bot Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?

Subject I felt a bit of relief and thought I could continue using helpful items like the patch. Just wasn't the same though.

Bot Ok, we've gone through all the good and bad reasons you have for smoking

Bot OK. Thanks very much for your conversation. I just have a couple of last things to say

Bot Here are some resources online if you're interested in getting help to quit smoking

1. Smokefree UK (<https://www.nhs.uk/smokefree>) 2. Smoker's helpline (<https://smokershelpline.ca>) 3. Stop Smoking US (<http://www.lung.org/stop-smoking>)

Bot I enjoyed chatting to you. I have to go now. Bye

Subject Thanks--intriguing study. I hope the bot gets developed and helps others out there.

Bot I left my AI somewhere else. Can't talk right now

Table A.3: Conversation 3 from the Training study

Appendix B

Subjects' Feedback

The following appendices include all the feedback received from subjects in the Training and Intervention study. In the Training study 72.72% (88) of the subjects provided feedback while 90.7% (88) did in the Intervention study. All personally identifiable information has been removed from the feedback.

B.1 Training Study Feedback

Study	Feedback
Training	It was very good at points i found it hard as the bot asked for longer sentences but only seemed to understand simple words but overall was easy and worked fine
	I actually like it. Was very different.
	It was probably just me but I felt rushed and so therefor my sentences were not complete. I was stressing and I didn't smoke through the chat so that's what happened I suppose. Wow I don't want to be this dependant that I have consequences when I am craving a cig. I think the chat was really really nice though. I like the choices you get if you need to explain further. Maybe the questions asked us could be a little more clear. I wasn't sure I was answering correctly or not.

The study actually made me think more about quitting smoking
It may be an idea to have a bar to measure your progress during the study, Other than that it was all good.
I liked the chat box way to take surveys. Much more engaging than simply filling out empty boxes. I think you'll get better participation this way.
Excellent
Just to learn a few more phrases other than that it was interesting.
little repetitive with the last question of each topic, asking to think back to a time when i didnt smoke, and what was different
Make the questions clearer regarding smoking scenario questions.
the bot sometimes doesn't understand plain english. I didn't know how to make it any plainer.
It was good. I dont know what could be done.
It would be easier if it understood more of the words i was saying but i found the study very unique and enjoyable.
it worked fine and understood everything i said
I liked that the system got me to think about the reasons I enjoy smoking and the reasons I do not. I was able to see that that were more reasons I dislike smoking. However, the questions in the second half of the conversation were awkward and weren't able to take into account that for some of the situations, I wasn't able to prevent myself from smoking. I felt like the responses were not really 'listening' to what I was saying.
I wonder if it's possible to make the responses audio
It seems like it's on the right direction to being able to assist someone
thank you for the help and advice, i try to quit but find it difficult at times and other times i have more will power
It seemed very good and understood how to put everything together

Quite an interesting experience but frustrating the bot only understands short terms but then asks me to expand upon my answers. Very worthwhile though if it helps myself and other people quit.

Putting in choices at the end of questions to help with starting points

I enjoyed the study. it was different to the usual type of surveys.

I found it very useful as it made my think of why at certain times I smoke. Maybe if the bot gave out reasons to quit better after I had given my postive answers to why I smoke.

That was actually really very helpful. It was getting my thoughts out. I have been smoking for a long long time and this was the first time believe it or not that I actually got some insight to my behavior, LOVED IT.

I won't let you copy and paste your ID from the prolific page which is tough because if you type it wrong it could effect you getting credit for the work you have done.

No advice for improvement. The chatbot was very easy to deal with and seemed to understand mostly everything I told it.

I know how hard it is going to be to be able to develop its ability to understand—but I think nonetheless having a way for a smoker to speak his mind is therapy enough in itself. Very intriguing and I enjoyed it. The language used like 'cool' and whatnot give it a slight human element. I'm not sure I can add any additional advice though. Best wishes though and I hope it develops more and ultimately helps others out. Thank you.

I enjoyed trying it out. Maybe give it the ability to offer advice to those hoping to quit. Thank you

n/a

It was pretty solid, other than when I seemed to respond too fast at the beginning before I got used to it.

it was enjoyable and it had a better understanding of what i said than i expected, i can't offer any advice I'm sorry.

I think I probably didn't answer some of the questions properly. The ones where is asked what was different, I was not thinking of the specific instance I had mentioned, but rather what wa different in general from when I used to not have the urge so much.

this was a really good survey about smoikng i really enjoyed it

You definitely need a better context engine, and some help on grammatical analysis.

The chat was interesting and fluent,it's the first conversation I've had with a chat bot.

The only real criticism was the repetitiveness. Otherwise it seemed to work well.

I think you did a really good job with bot! I certainly didnt expect that good understanding and interaction! :)

A few grammatical errors but other than that everything was fine, maybe change up the responses so they're not just all "i understand" etc.. Great job guys.

It needs to be less repetative.

It's really a great experience and I surprised the bot behavior. The bot is Very smart and understandable but the bot is needed more training for providing a more realistic response .

loved this kind of study. so easy to complete and fun to do.

to improve i think questions should be more succinct and precise

Nothing I can think of at the moment. I think this is a very intelligent and creative way to help people quit smoking. I will be following the progress of this study. I appreciate the opportunity to help.

I enjoyed this questionnaire found the questions a difficult to understand at times but eye opener and yes today was my first stop smoking day!!

The ability to give more options would be nice. Also the repetitive questioning was a bit confusing - was it talking about the last time I didn't smoke in general, or due to the perceived positive/negative effect?

I really enjoyed it :)

The program still feels too much like a bot. Outside of simply understanding, the bot seems to follow a specific formula in how it asks questions and formulates responses. This will probably smooth itself out as the AI learns more about interacting with people. I did like how it made me identify things that have prevented me from smoking before. I mentioned my family more than a few times as being the reason that I didn't smoke. It would be useful for the bot to notice those kinds of patterns and to follow up on it.

I thought that it went pretty well. My only problem was at some point in the beginning i got confused and typed out yes and it wanted me to talk about "yes" being something i thought was good or bad about smoking.

The chat let me put in a custom reason under other earlier in the chat which it doesn't recognize and I got stuck on the 'Which reason would you like to chat about next' stage of the study. It recognized my answers quite well with guidance, but it didn't understand straight away almost every time.

It was ok im CITY so i talk different than say someone in CITY

This is Good Study

i think i may have answered one question wrong and i wasnt able to correct it

Overall it understood my responses really well and the conversation seemed very natural. I can't think of any advice on how to improve it more.

Everything worked fine and it was easy to communicate.
it tends not to understand sentences with many examples of the same thing.
it seemed odd that i was being asked to describe a time when the good reasons to smoke prevented me from doing so. other than that, i cant think of any other ways to improve the study i hope my participation was helpful!
none it was easy to follow and type in own thoughts and ideas
the smell question was wrong. I am not worried about the smell on mecaused by smoking , BUT by my lack of sense of smell.
beside making it more clear how to tell the machine that i am out of reasons to describe, i'm not sure. that survey is very timely for me as i have been agitating for our household to quit for the past couple months and it's coming to a head this week. so i would say it was a pretty effective exercise as far as my thinking about smoking goes, so thanks for that.
Good interesting
It had a hard time understanding what I was trying to write and would tell me to use larger sentences even though it didn't understand them
N/A
The questions it asked were very tedious and repetitive. It felt like the bot was mechanically taking down information, and I got very bored because many of the questions had the same or similar questions and I knew exactly what it was going to ask. It would be nice if it were more responsive to the specifics of what the user said. A faster response time would also help to mitigate the boredom.
I messed up and was unable to get the system to respond to that. I could not correct myself

You might want to get someone who actually smokes to brainstorm some of the good/bad reasons to programme into the bot; think it might need more british/irish english language input; need to provide a break-free mechanism for when the conversation goes round in circles (you actually had to send me a rescue email - thanks, by the way).

This chatbot really needs some redesign. Punctuation seems to throw it off "Yes" is accepted but "Yes." is not. Also, it's making assumptions of people which is going to make them combative, like me, when it just goes "obviously you aren't able to stop yourself ever".

Can't think of any, I had fun chatting

I thoroughly enjoyed this task as it was very different to any other I have done in the past. I think the only improvement would be to make the chatbot send their messages a little slower. When it sends more than one in a row it can be a little difficult to catch up so you need to scroll up the page to continue reading.

I really enjoyed the concept of this study. It was engaging and kept me interested throughout. I don't think there is any need for improvement :)

It is good to be nourished with this type of surveys, I love it! Thank you

I found it had trouble understanding the context of the smell of cigarettes on your clothes and just related it to cigarette smoke smelling bad.

Obviously some of the responses didn't make sense with the answers I had given but I could see what it was meant to be getting at and it did make me think about my motivations, etc. for smoking, it was interesting and I think I did find it quite helpful actually :-)) just the act of having to spell out things that are usually automatic/subconscious really, makes you realise how daft a lot of it is! There were one or two typos, think one was the socialising bit, it said 'where you didn't smoked' or something similar, nothing important though. The responses I got after it was finished made me laugh :-D some of the wording could do with being changed maybe I think, where it asks you to think about the time where you 'prevented yourself' from smoking - the questions prior to that weren't phrased like that, so the answers it was referring to didn't really fit then. Glad I got the chance to try it, given me some food for thought! Thank you.

i like smoking. it is my medicine.

I don't think I'm qualified to give any advice on how to build an AI chatbot. I thought it was a really interesting and potentially helpful exercise though, especially having to repeat certain things so they became almost like a mantra. If you need anyone for more of these in the future, I would absolutely be interested in helping to test. Like I said near the beginning of the chat, I really need to stop smoking in the next year anyways. My email is EMAIL if you ever need anything else from me. That was very interesting. Thanks!

I liked chatting with a bot. I didn't feel judged for it like I would have if it was a human.

it was very interesting , felt like i was talking too a real person :)

was a nice way to put things down but tech can not replace human interaction

It was an interesting chat with the conversational system. Very smart and quick responses. I would suggest slowing down just a bit, that way it would feel more like a chat rather than being rushed through a computer system.

Very interesting study! It was different chatting to a bot about my smoking habits, it did make me think about my reasons for smoking more clearly than if I try to justify it to myself.

In response to the reasons given for positives and negatives of smoking, it asked the same questions for every reason given. Because the responses given will be quite varied, they do not all warrant the same questions asked. Maybe have it respond based on a few keywords, so the questions it asks are more relevant to the specific subject.

Hello! I think you may want to add "laxative" or something like that as a keyword for your bot to pick up. Also, it seems like it can only pick one topic to assign to a conversation at a time. Perhaps if it could roll them together that would be better. I don't know. That's all!

I feel the study was well equipped and the system worked brilliantly

At one point, the bot stopped responding and I had to refresh the page. I don't know if this was a problem on my end or yours, but if it shows a break in the conversation, that's why.

i enjoyed this study

I'm not really sure. I guess the questions where it asked what made it different from when you did smoke. They felt too repetitive and I was struggling to come up with answers. Maybe it was just me overthinking it.

it could be made more attractive maby with some sounds possibley a funky chat bubble

the chatting bot need to understand more than basic English

Make the feed back a way to type in a response as an answer instead of clicking yes or no because it messed up part of my session cause I clicked it when I shouldnt of. Besides that it was interesting.
Get better questions
Really interesting....hadnt done anything like this before....not sure if i gave u enough info....mabe if u could have specified just how much detail u wanted...if u want more detail let me no
Don't just give a generic question to "thinking to a time when you didn't smoke what made it different" a lot of the time that question was not applicable so I stated not applicable. I think if it could conform to the conversation a little bit better on that question that would be good. Maybe have it recognize someone putting N/A or not applicable and have it give a different response, maybe even something like Why have you never had a time? or something to that extent.
it was great and gave me enough time to response
It's different. Very black and white - no grey areas. It seemed to work well
Frustrating, the questions made little sense. I had "it smells bad" and it asked me to describe a time where the action "it smells bad" caused you to smoke. A lot of self reflections kind of felt pointless as well. I smoke a pack a day, often without thinking about it., so pinpointing a time when something caused me to smoke is really hard.
I think the chatbot was really intuitive and did a good job of understanding most things. I only had to rephrase a couple of times.

Table B.1: Training study feedback

B.2 Intervention Study Feedback

Study	Feedback
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Intervention	all was ok
	I really do not understand the purpose of all the written responses it was asking for. If the aim of this bot is to help people quit smoking, it did a poor job in my opinion. It honestly made me think about the fact that I haven't taken a break in a few hours and should go have a cig and take my dog for a walk. I like the concept and am curious to see how it is developed, but it still seems to be in the infancy stages of development in my opinion. Good luck on your research!
	Its was nice and good. The chatbot understand me very good and it was easy to chat. Only few things he couldn't understand but find the right solution of it.
	The chatbot seemed pretty intuitive. It had a very "friendly" demeanor and seemed very natural.
	it was fine no problems at all with it
	Nothing the only it didn't understand was me answering stupidly.
	It seemed very smart. He/she asked asked the same question often, but I feel thats actually part of the study. So nothing. Well done!
	I think that it understands me really well. I don't know if I can think of anything other than maybe to not have the questions be so repeative sounding.
	a little more information on the bad side of smoking without being scary to people or patronising - us smokers know how bad it is, but being reminded gently can help
	It felt a bit stiff. This one's not exactly going to pass the Turing test, but it wasn't all that unpleasant either.

It was quite apparent i was chatting with a bot. The questions made sense initially but when we reached a point where the bot didn't understand what i was saying it became a little nonsensical from there. I have been asked and advised to stop smoking by health professionals in the past and this has made no difference o if you feel this bot will assist people with giving up smoking a LOT of work is required. There was a question asked which was the 3rd question after each of the positive / negative experiences of smoking which made no sense yet i was asked the same question about each reason. It became a chore talking to the bot. The presumption was that i smoke pre-made cigarettes yet I don't - I smoke rolling tobacco and roll my own.

the responses seemed pre-scripted

I liked the chatbot, but it did get too repetitive. It seemed to pick up on some of the things I was typing but did not with others. Overall I did feel like it was similar to talking to a person in certain aspects.

I put stress relief as a positive thing but the Bot just picked up on the word stress and used it as a bad experience.

It might be helpful with things like "socializing" to discuss who we are socializing with, so you can better understand the barriers. For instance, does one smoke at work on breaks with coworkers? Is it at home with other family members who smoke? Or maybe it's just when you drink? These are all different ways to socialize, and some might be easier to overcome. For instance, it may be easier to quit socializing if you take a break at a different time than your co-workers.

I thought the bot was incredibly smooth. The final question of each topic became repetitive but all in all I was very surprised by the ease of conversation and how it brought out some important thoughts and really got me thinking more about quitting. The benefits much outweighed the small annoyance of answering the one question multiple times. I really enjoyed the experience and I think you are working on something very valuable.

none

The habits formed in my brain giving me positive feedback from smoking I believe is one of the key aspects as to my continued tobacco use. It is something that is difficult to fluently explain to a human, let alone type out, im not sure how to overcome this. I think it is difficult for a bot to understand the psychological reasons why we smoke but im sure someone will work out a way and I wish you the best of luck if that is actually what this study is about.

It felt more like a one way conversation. Bot asks and I answer. It was good but did react like a bot.

The chatbot made me think more critically about how I really feel about smoking and whether or not it's worth it to truly quit. I think the bot was very helpful in guiding my responses and didn't seem to judge me based on my behavior.

It was quite good at understanding what I said,once I adapted to use less sayings and turns of phrase.

it help talking to the chatbot as it felt i could talk about my smoking habit, would of helped if the chatbot gave some more advice about why i smoke

It struggled on some of my sentences but by and large did a very good job of understanding me. I found it friendly and even expressed some humour, Maybe try and adopt some sort of thesaurus it can employ for better comprehension?

more advice post question, maybe some tips to help replace the habit

It was an interesting experience and really made me think about the ways I enjoy and dislike smoking.

Maybe include some more question variations and include some more humour

I found the chat bot very clear and easy to understand. i cannot think of a way to improve it

The bot did a pretty good job understanding what I meant when I was listing my reasons for why smoking is good or bad. My only issue was going through all the reasons individually with the same questions being asked became rather redundant and it no longer felt like a conversation or like the bot was really trying to make sense of anything I was saying. It was more like a simple checklist. So maybe it would help if there was a way to break up the monotony or to make that part of the chat feel more like a real conversation.

The questions were to recall a single occassion but in many cases there would be endless occurrences, such as thinking of or experiencing the consequences of the negatives of smoking (the bad smell or mess or concerns about health). Also my answer to the reason (or a positive) for smoking is to stop the withdrawal symptoms and I'm not totally sure this can be regarded as 'health'.

I thought chatting with the BOT was very interesting. It made me think more clearly about the reasons that I smoke and promoted a mindfulness for me about the habit that I didn't have previously so I think that's very positive.

Teach it sarcasm!

It would be useful to have some "ice breaker" questions at the beginning so you could understand how the bot responded to the language you used. It might be better with current limitations to ask people to select from a list of good/bads e.g pick three good things and three bad things. It might help the interchange with the chatbot flow better before the free format answers.

It's quite long-winded, and the questions are not very easy to answer especially if you haven't experienced the situations.

I thought it worked pretty well. I don't know how it can be improved

The questions were very repetitive so I kept having to repeat myself for some of them. It was helpful to list all the negative things about smoking but it didn't motivate me to want to quit smoking. Some responses to my answers with advice would have been more helpful rather than repeating questions but just changing the topic. It could be useful it just needs more.

i guess maybe make the chatbot more approachable and give it a larger database of friendly words because it felt like i was interacting with a chatbot and not a person

It was very good. I would recommend mixing up the responses a bit. It seemed like the same pattern of questions and answers it was giving. Make it seem more human or natural like.

The bot works very well during long sentences but it struggles with short ones. I would rate it 8 of 10* At times i forgot i was speaking with a bot! Thanks

the chatbot was not very easy to communicate with. didn't seem intelligent

THOUGHT IT WAS VERY SKILLED, UNDERSTOOD MOST SIMPLE RESPONSES. VERY CLEVER BOT

I think it needs to ask more diverse questions. Perhaps go into more detail regarding health and cost, which as a smoker I believe to be the biggest two factors of getting people to quit.

i thought it was pretty neat how it could categorize my responses. only thing is that it didnt understand some of my responses

I like the Chatbot, and I feel that once it can understand more of the responses it will be very effective. I would think that if it could go into a little more detail about certain issues with smoking that would be helpful.

The questions were too open ended.

I actually was impressed with this chatbot. It seemed to understand more than any other ones I have had to communicate with.

I found it very easy to work with. It had very quick responses, perfect English and explained everything thoroughly

i dont think it had any effect on me smoking other than by talking about it it has made me crave a cigarette more

It moved on extremely fast to the next question while I was still attempting to answer the previous one. He should ask if we are ready to proceed. To the next question

it was ok, needs to be improved. it didnt understand all words.

Give an option to fix things when you press enter by accident.

It didn't seem to understand anything outside of its preset reasons and was quite rigid in the responses I could give. It was a very tedious conversation with the same questions repeated for every reason.

I beg you to use the research from Pandora Project. And also perhaps add to the database of known things with smoking. Unless your intent was to make me roll my eyes and be frustrated so I now will go smoke to clear the frustration of this whole situation?

I'm not too sure on how to improve it, I'd suggest personally add some humor however I understand that it won't work for some people. I'd also suggest that it uses more informal language.

It was okay, the bit was a bit off the mark at times but generally very intelligent of course, Perhaps more empathy the bit could be more friendly

There were a few spelling errors in its opening statements. "Chance" was misspelled as "change" for example.

I think it is useful to have people repeat all their own feelings good and bad but if someone is compelled to quit but list a long list of good things, this process will not help them because it applies no weighting to anything. Sure it's a thing that smoking smells, but is it really just one equal thing alongside the health issues?

that it would understand longer responses from me, otherwise it worked really good

It was very easy and straightforward, an enjoyable way of completing the study

I'd like to have some useful tips on routine and distraction and how to break the cycle, so it is no longer a habit, as sometimes I'd like to be able to consider options outside of the box, rather than focus on specific common websites, as what works for one doesn't always work for another

The repetitive nature of asking the same questions over and over got old. It didn't take as long as I thought it would, so that's great! I guess it's because I'm a fast reader and writer. I thought it was great, and it encouraged me to continue trying to reduce my smoking. Thanks for the cool study. It was different from what you typically see. Also as a side note, chatbot understood me perfectly except about the bowel movement thing. I figured that was the closest he could get, since he can't relate (not having bowels and all) so I let him have that one.

This was very pleasant thank you and I'm very impressed with how it recognises how I was explaining things thank you

I think that the chatbot actually understood things pretty well overall, and it was nice to think about why I did or did not smoke, but it would be nice if the chatbot perhaps gave some useful statistics in relation to those areas to encourage quitting.

very good and surprising

The conversation felt a little repetitious, as if it were following the exact same pattern for each reason, making it feel quite robotic. However, I enjoyed recounting my experiences and analyzing them with the bot.

A lot reasons it was hard for it to understand had to reword but got there

It worked well and understood most of what I said. I can't think of any improvements.

It was very understanding of what I was saying. Maybe add terms like others opinions so it would understand

Being more personalized

Nothing I only think that refining some of its understanding is needed

An option to refine keywords or choose your own category if the bot does not recognize the reply

Perhaps give it a name , an avatar or picture may be neat also.

i feel that the robot was just repeating back to me what I had said rather than providing advice or information

The chatbot didn't make any suggestions.

I felt that it was friendly enough, but could be a bit more friendly. Maybe have the chatbot use an emoji or two. Also, maybe add a bit of levity to the chat bot. That entire chat took quite some time, and a bit of humor mixed in would have made it a better experience for the user. I think I also would have enjoyed it if there were text to speech options, just so the chat bot felt a bit more human.

it was okay but pre assumed some things like the health bit about smoking

maybe if there was a picture of the chatbot net toits chatbox

I think the questions it asks are very good. I think they really help you to think a bit more deeply about the reasons behind why/when/where you smoke and how you're able to abstain in other situations.

i think the chatbot did a pretty good job at understanding me and i dont know what you could do to improve it.

I was actually very impressed. It seemed to understand my responses very well and only asked me to rephrase one answer. Only suggestion is it goes quite fast in its reply which is difficult on a tablet to keep up with

I liked it. Thank you

It was slow and asked the smae repeated question

just try and make it more natural and more intelligent.

It was ok i made a mistake in it that confused it but other than that it was pretty natural

"Think back to the time when you were able to prevent yourself from smoking. What made it different from when you did smoke?" This question kept coming up after each of the positive and negative reasons questions and I eventually ran out of response for it, perhaps I was misunderstanding the question. In which case this could potentially be reworded to be more specific or clearer.

it didn't really feel like talking to a chatbot. There were a few times I forgot it wasn't another person.
It was a good experience by listing the pros and cons. I would ask different questions about each topic and not the same three.
I'm not sure how the chatbot would be with quitting. I was just asked what I liked and disliked. No quitting was discussed.
Offer more options in forms of sentences, like, "You dont like smoking because of the cost", instead of just "you think they are expensive", other than that i wouldnt change anything else, it was fine
On one occasion the bot gave a reasonable response to what I said but I would have chose differently . I stated cost or similar and it classed it in dependence. It did seem to hae a problem with the expense side of smoking. At times I struggled to keep up as new chat boxes were added.
Some of the features of the chatbot, it didn't understand a more "conversational" tone, and whilst talking like I would talk another person, it associated "enjoying nicotine" with having it in my hand which I wouldn't associate. As I was talking conversationally I also tried to defend a reason by suggesting it wasn't the most important, which the chatbot took as a reason for smoking
more friendly less formal
It was a good experience with the chatbot, was all easy to understand.
it was fine, I can't think of any improvements
Make it less repetitive by using different responses. maybe also use a face to feel like you know who you are talking to

Table B.2: Intervention study feedback