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Development of a Conversational Agent for Individuals Ambivalent About Quitting Smoking: Protocol for a Proof-of-concept Study

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Developing a Conversational agent (Chatbot) for Individuals Ambivalent about Quitting Smoking: A Study Protocol

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Abstract

Background: Cigarette smoking is the leading preventable cause of disease and death in the US. Despite availability of a plethora of evidence-based smoking cessation resources, less than a third actively seek cessation services. For example, free "quitlines" are available in all US states, but less than 3% of smokers—those motivated to take action to quit smoking—utilize them. Lacking are low-cost, scalable interventions that support smokers unready to quit (ambivalent smokers) to gradually promote smoking behavior changes until motivation to quit arises, at which time they can be navigated to evidence-based smoking cessation interventions. Conversational agents or chatbots could provide cessation education and support to ambivalent smokers to build motivation and navigate them to evidence-based resources when ready to quit.

Objective: The goal of our study is to develop and pilot test preliminary feasibility and acceptability of a smoking cessation support chatbot.

Methods: We will accomplish our study aims in two phases: In Phase 1, we will survey 300 ambivalent smokers to determine their preferences/priorities for a smoking cessation support chatbot. Using conjoint analysis, data gathered will be used to program a prototype chatbot. In Phase 2, we will assess the prototype chatbot's acceptability in N=25 smokers using semi-structured interviews.

Results: We are initiated data collection for Phase 1 of the study and anticipate that all study aims will be completed by June 2023.

Conclusions: Study results will yield a smoking behavior change chatbot prototype developed for ambivalent smokers that will be ready for efficacy testing in a larger study

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Title: Developing a Conversational agent (Chatbot) for Individuals Ambivalent about Quitting Smoking: A Study Protocol

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Abstract

Background: Cigarette smoking is the leading preventable cause of disease and death in the US. Despite availability of a plethora of evidence-based smoking cessation resources, less than a third of individuals who smoke seek cessation services and individuals utilizing these services are often those actively contemplating quitting smoking. There is a distinct dearth of low-cost scalable interventions to support smokers not ready to quit (*ambivalent smokers*). Such interventions can assist in gradually promoting smoking behavior changes in this target population until motivation to quit arises, at which time they can be navigated to existing evidence-based smoking cessation interventions. Conversational agents or chatbots could provide cessation education and support to ambivalent smokers to build motivation and navigate them to evidence-based resources when ready to quit. **Objectives:** The goal of our study is to develop and pilot test preliminary feasibility and acceptability of a smoking cessation support chatbot. **Methods:** We will accomplish our study aims in two phases: In Phase 1, we will survey 300 ambivalent smokers to determine their preferences/ priorities for a smoking cessation support chatbot. A “forced-choice experiment” will be administered to understand participants’ preferred characteristics (attributes) of the proposed chatbot prototype. Data gathered will be used to program the prototype. In Phase 2, we will invite N=25 individuals who smoke to use the developed prototype. For this phase, participants will receive an overview of the chatbot and be encouraged to use the chatbot, engage, and interact with the programmed attributes and components for a 2-week period **Results**: At the end of Phase 1, we anticipate identifying key attributes that ambivalent smokers prefer in a smoking cessation support chatbot. At the end of Phase 2, chatbot acceptability and feasibility will be assessed. **Conclusion**: Study results will yield a smoking behavior change chatbot prototype developed for ambivalent smokers that will be ready for efficacy testing in a larger study.

INTRODUCTION

Cigarette smoking continues to be the leading preventable cause of disease and death globally and in the United States (US) [1].Cigarette smoking kills more than 480,000 Americans each year and more than $240 billion in healthcare spending and nearly $372 billion in lost productivity. [2]Thus, promoting smoking behavior change with the long term goal of achieving successful cessation is critical to reducing the public health impact caused by tobacco use. Within the US, the past few decades have seen a groundswell of evidence-based interventions to quit smoking. These have included a wide range of strategies such as mHealth applications[3, 4], availability and increased access to effective pharmacotherapy for cessation[5], text messaging support [6,7], evidence-based behavioral counseling [8], and comprehensive state-based programs such as tobacco quitlines [9,10]. However, despite their widespread availability, less than a third of people who smoke cigarettes actively avail themselves to cessation strategies [11]. For example, tobacco quitlines—free, evidence-based smoking cessation programs providing telephone-based behavioral counseling combined with cessation pharmacotherapy available in all 50 U.S. states—are utilized by less than 3% of people who smoke [12]. One potential reason for low uptake of existing services for cessation may be that strategies to promote cessation differ according to an individual's readiness and motivation to quit [13].Whereas smokers actively committed to quitting respond positively and engage with cessation services, ambivalent smokers (i.e., those not actively seeking treatment) may benefit from approaches that promote modest changes or "behavioral *nudges*" toward smoking behavior change (but not cessation)[14,15]. Most cessation research is focused on those expressing an intention to quit and research on promoting behavior change in ambivalent smokers (not actively

thinking about quitting) is scant.

A conversational agent or “chatbot” is an inexpensive and scalable approach to deliver personalized health information in a human-like manner. Common in the consumer-service sector, chatbots are increasingly being deployed in the health sector to provide education, support, service navigation, and interventions for a range of health issues from COVID-19 to asthma [16,17]. Human-delivered interventions for smoking behavior change are effective but are resource-intensive, lack scalability, and can be expensive to implement. Chatbots have the intuitive appeal of being low-cost, automated interventions that can widely reach ambivalent smokers. Moreover, chatbots can provide “virtual accompaniment” at the frequency and duration preferred by the smoker until the motivation to quit arises, at which time they can be swiftly connected to an existing, evidence- based cessation intervention. The few studies on chatbots for smoking behavior change target participants actively intending to quit smoking [18–20] and while important, only address the tip of the iceberg in terms of reaching the smoking population. Since motivation to quit smoking is dynamic and occurs along a continuum [21], strategies to engage ambivalent smokers may be most helpful if they are tailored to accommodate smokers’ changing preferences and responsive to rapid changes in motivation (e.g., connecting smokers to quitlines when ready to quit), while focusing on evidence-based strategies that have been effective for smoking reduction leading to cessation (e.g., quit tips, self-monitoring, tracking savings). Since interventions to assist smokers ambivalent about quitting are in their infancy, little is known about key elements of a chatbot-based smoking behavior change intervention tailored for this target population.

To overcome these gaps in the field, the goal of our study is to develop and pilot test for feasibility and acceptability a novel chatbot prototype to support and engage smokers who are not actively engaged in a quit attempt (ambivalent smokers). We propose

accomplishing our aims in two phases: In *Phase 1*, we will identify the key attributes that will guide development of the chatbot prototype. We will survey ambivalent smokers to determine their preferences/priorities for a smoking cessation support chatbot. Using conjoined analysis, we will systematically elicit participant preferences for the proposed chatbot prototype (see details below) . Grounded in macroeconomic principles [22], conjoint analysis is a quasi-experimental approach that decomposes a product or service into its key attributes, then poses the attributes to patients to understand patient-determined values for each attribute [23,24]. These preferences will be programmed into the chatbot prototype. In *Phase 2*, we will invite participants to use the prototype over a two-week period to assess Feasibility and acceptability of the developed chatbot prototype.

METHODS

Study overview

To develop the chatbot prototype (Phase 1), we will recruit n=300 people that identify as current cigarette smokers to complete an online survey. The survey will collect demographic, smoking behavior history, e-cigarette use, and solicit preferences for the most important features of the proposed chatbot. The top five preferred attributes will be used to design and develop the chatbot prototype. In Phase 2, n=25 participants will be recruited to engage with the developed prototype for a 2-week period. Preliminary acceptability and feasibility data will be collected via validated questionnaires at the end of two weeks. For both study phases, participants will be recruited using an established survey panel (Prolific). Study eligibility criteria are: ≥18 years of age; self-report any smoking in the last 7 days; and no current intention to quit smoking in the next 30 days (score of ≥5 on a 10-point Likert scale assessing likelihood to quit smoking).

Ethical Considerations

All study procedures have been approved by the University of South Florida's Institutional Review Board. For Phase 1 of the study, the data are de-identified with participants only providing a Prolific ID. For Phase 2, participant name and phone numbers will be stored on a password protected computer only accessible to study staff. All participants will be identified by a study ID and any identifying information will be removed from interview transcripts prior to beginning qualitative data analysis. Participants will be compensated for both phases of the study. Participants will receive $6 for completing Phase 1 and $70 for completing Phase 2.

Phase 1: Development of chatbot prototype

This phase is designed as a cross-sectional survey to develop a prototype of the proposed chatbot by assessing preferred attributes in a r sample of individuals ambivalent about quitting smoking. To do so, we will recruit n= 300 eligible individuals who will be invited to complete an online survey. Participants will be recruited online using established study panel (Prolific). After completing an online informed consent, participants will provide information on demographics and smoking history after which they will be provided with a brief explanation of chatbots (what they are/how they work). They will also be asked about their previous and current experience with chatbots and interest in a chatbot designed to support people who may decide to quit smoking in the future.

Next, we will administer a choice-based conjoint analysis (CBC) experiment to understand participants preferences for a smoking cessation chatbot. Using Sawtooth Software's online choice analytics survey platform, we will construct hypothetical smoking cessation chatbot "scenarios" comprising six attributes (i.e., potential chatbot features) with

varying levels: (1) number of cigarettes smoked per day tracked (yes/no), (2) smoking quit-tips provided (yes/no) (3) money saved by reducing smoking tracked (yes/no), (4) mood tracking (yes/no), (5) smoking cravings tracked (yes/no) and, (6) mental health screening and resource provision (only depression screening / only anxiety screening / no mental health screening). These attributes were chosen *a* priori based on published smoking cessation literature identifying evidence-based strategies to promote and support smoking behavior change. The sixth attribute, mental health screening, was added given the comorbidity between smoking and mental health [25,26] In the CBC experiment, participants will be presented with a series of tasks; each task will display three different chatbot configurations comprised of identical attributes but differing combinations of attribute levels. A total of 10 tasks will be presented to participants. Each question will contain three panels that present a combination of the attributes and associated scenarios, and participants will be asked to choose the chatbot configuration they would most prefer (i.e., the chatbot that contains the combination of chatbot attribute levels most desired). Participants may also choose "*none*" if no chatbot configuration presented is desirable. Figure 1 displays examples of the CBC tasks. Finally, desired frequency of chatbot messages will be assessed and at the end of the survey, interest in participating in Phase 2 will be elicited.

Measures

For Phase 1, assessments will include demographics (e.g., age, sex, gender identity, education) and smoking history (age of smoking initiation, number of previous quit attempts in the past year).[27]Nicotine dependence will be measured by the Fagerstrom Test of Nicotine Dependence,[28] which is a validated and ubiquitous instrument assessing dependence on nicotine. Smoking cessation self-efficacy using the validated Smoking Abstinence Self-Efficacy Questionnaire. [29] This 12-item questionnaire measures an

individual's self-reported confidence in resisting the urge to smoke in various settings and conditions. Given the high prevalence of e-cigarette usage among individuals who smoke, [30] current e-cigarette use will also be assessed.[31] In addition to these measures, we will also collect information on current usage and frequency of marijuana/cannabis [32] and alcohol use.[,33]

Data analysis

Summary statistics [(mean ± S.D. or frequency (%)] will be calculated for demographic and smoking characteristics. For the CBC data analysis, also completed using Sawtooth Software (https://sawtoothsoftware.com), utility scores will first be computed to determine the relative desirability of each level within each attribute. These data will inform which of the chatbot feature levels were most desired (e.g., whether cigarette tracking feature is desired). Next, the relative attribute importance scores—that is, the relative impact of each attribute in respondent choices—will be computed; these data will indicate the order of importance of each of the six chatbot features (most important to least important). We will also compute the 95% confidence internals for each of the attribute scores Finally, CBC data will be examined for variance by select socio-demographic variables (e.g., sex, gender, education, number of quit attempts, etc.) to determine possible chatbot preference differences by population segments. The combined data will inform the prioritization of chatbot features programmed into the prototype chatbot tested in Aim 2.

Phase 2: Acceptability and feasibility testing of the chatbot prototype

For Phase 2, n=25 eligible individuals expressing interest to participate at the end of Phase 1 will be recruited to engage with the developed chatbot prototype. Participants will be contacted by the study staff to explain study procedures and complete informed consent, following which the participant will receive a link to complete a baseline survey. Following

completion of the survey, they will be scheduled for an appointment to participate in a 45–60-minute interview conducted via secure videoconferencing. During this time, study staff will share a link with the participants to activate the chatbot prototype. An overview of the chatbot will be provided following which participants will verbalize their thoughts and reactions while interacting with the chatbot, based on the think-aloud usability testing technique [32] and provide initial feedback while interacting with the chatbot. The interview will be audio/video recorded and participant interactions with the chatbot will be observed. At the end of this session, participants will be encouraged to use the chatbot over a two-week period, engage and interact with the programmed attributes and components. To increase retention during this period, data entry and chatbot engagement will be monitored on a frequent basis and all participants will receive daily reminders to engage with the chatbot. At the end of the two-week period, participants will complete acceptability and feasibility assessments, provide feedback to open-ended questions to identify any aspect of the chatbot that was confusing, what they liked or disliked, perceived helpfulness of the chatbot, feedback on features they would like included, and aspects that would help keep them engaged with the chatbot. Participants will receive a total of $70 for Phase 2 ($20 for the interview and $50 after completion of the follow-up surveys).

Measures

In addition to the measures used in Phase 1, Phase 2 measures will include intervention acceptability using the Acceptability of Intervention Measure (AIM), Intervention Appropriateness Measure (IAM), and Feasibility of Intervention Measure (FIM),[33] as well as intervention usability using Health Information Technology Usability Evaluation Scale (Health-ITUES).[34]

Data analysis

Quantitative data will be cleaned and analyzed to generate summary tables and limited to descriptive analyses due to the small sample size, which prevents tests of association. Qualitative data (i.e., recorded transcripts from the videos during which participants interact with the chatbot and the qualitative interviews after interacting with the chatbot) will first be transcribed verbatim resulting in text transcripts. Next, the transcripts will be loaded into the qualitative software, Dedoose [35], and analyzed using a Framework Analysis approach [36]. Transcripts will be first read in their entirety and coded using a preliminary codebook derived from the interview guide, adding *de novo* codes as new themes are detected. Reports will be generated for all codes and related text extracted into tables for deeper analysis during which cross-cutting themes will be identified and reported. The Consolidated Criteria for Reporting Qualitative Data Checklist (COREQ)[37] will be completed to enhance data rigor and methodological transparency [28][29][30][31].

RESULTS

Phase 1: The methodology described above will result in identification of key attributes that participants report a preference for in a smoking cessation support chatbot. This data will be used to program a chatbot prototype. Using SmartBot360 (www.smartbot360.com), a “point and click” chatbot development software, a prototype smoking cessation support chatbot will be programmed that contains the top preferences/features as expressed by the participants in Aim 1. In addition to the attributes, information on existing evidence-based smoking cessation resources will also be programmed to gauge participant preferences for existing evidence-based cessation resources. These will include but will not be limited to links to sign up for free text messaging services (e.g., smokefree TXT) or mHealth quit apps (e.g., QuitGuide), connecting to smoking cessation experts (e.g., National Cancer Institute’s LiveHelp, or a

state quitline), and information on pharmacotherapy.

At the end of Phase 2, we will obtain participant data on chatbot acceptability and feasibility.

DISCUSSION

The goal of our study is to develop and pilot test for feasibility and acceptability a novel chatbot prototype to support and engage smokers who are not actively engaged in a quit attempt (ambivalent smokers). The anticipated main result of our project is a pilot tested conversational agent ready to be tested for efficacy in a larger study. To our knowledge, this is the first study to develop a conversational agent (chatbot) for ambivalent smokers using a novel methodology.

[11], Interventions to engage individuals ambivalent about quitting smoking are an unexplored area in smoking cessation research.. This study will begin an innovative line of research on strategies to optimize and personalize smoking behavior change services for individuals ambivalent about quitting smoking. Of specific mention is the use of conjoint analysis as an innovative strategy to assess and incorporate user preferences in the development of a mHealth intervention. Methodologies to systematically assess and incorporate individual preferences in the delivery of healthcare services are in their infancy[38] and little is known about the preferences of ambivalent smokers for chatbots as they navigate the motivation to quit continuum. While conjoint analysis has been increasingly employed in the health sector—including in the smoking cessation field [39, 40], to our knowledge no mHealth interventions for smoking behavior change has utilized this methodology for design and implementation. Our investigative team has successfully used conjoint analysis for other health issues, including determining consumer preferences for oral and topical HIV chemoprophylaxis [41,42].If acceptable in this pilot study, our

chatbot could be a low-cost and low-resource intervention that fills a much-needed gap in the field.

The study has a few limitations. First, the study design does not lend itself to test effects of the chatbot on smoking behavior change outcomes. However, given the dearth of research in this area, development of the chatbot and acceptability and feasibility testing are the first steps. At the end of the study, we will have a developed chatbot that will be ready for efficacy testing in a larger randomized controlled trial. Next, our participant recruitment methodology uses an online survey panel which may reduce generalizability. While such survey panels utilize purposive sampling to gain a representative sample of participants [43], we anticipate using a combination of social media, community-based recruitment efforts, and online recruitment panels for larger efficacy trials, which will increase the generalizability of our results.

Our intervention that uses a chatbot to promote smoking behavior change in a sample of ambivalent smokers fills a distinct gap in the field. Ours is a scalable and pragmatic model that can be adopted by cessation services (quitlines) and is designed for easy accessibility to the broader population of individuals who are not actively contemplating quitting smoking. It could additionally serve as a tool for healthcare providers as they recommend quit smoking resources to their patients. In the long run, our study design and methodology can be utilized to develop chatbots that can increase access to other evidence-based interventions within the context of substance use disorders (e.g., cannabis, opioids) or compulsive behaviors (e.g., eating disorders, gambling).

Data Sharing: The data sets generated during and/or analyzed during the current study will be available from the study investigators (UN & JG) on reasonable request.

Figure 1: Examples of a Conjoint Analysis Task

Question 1: Each of the boxes below represents a different chatbot. If these were your only options, which would you choose?

Question 2: Each of the boxes below represents a different chatbot. If these were your only options, which would you choose?

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