An Interactive Software-Agent Smoking Cessation Program

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Abstract

Health communication researchers have shown that tailored health communication messages outperform non-tailored materials. Non-tailored materials are typically "one-size-fits-all" messages designed to reach as much of the total audience as possible. Tailored materials are designed to match the needs and other factors of individuals. The technology used to perform this tailoring has traditionally been expert systems. This project suggests that a software agent approach will improve the delivery of tailored messages. Specifically, this work-in-progress paper discusses (1) the health communication and behavior change theories that apply to smoking cessation, (2) how those theories would be used in a software agent system, and (3) a proposed efficacy test of the system.

1. Introduction

Health information is increasingly computer-mediated, such as via the Web or interactive kiosks. These technologies are becoming increasingly sophisticated, especially in the ability to tailor information for individuals based on demographics and personal preferences. As this functionality improves, health information technology designers can increasingly use complex human behavior models to develop systems with more effective message delivery.

This article will summarize four health behavior change models: (1) Health Belief Model, (2) Theory of Reasoned Action, (3) Elaboration Likelihood Model, and (4) Stages of Change Theory. These theories and models have been used in many studies and their strengths and weaknesses will be discussed. Also, examples of how the theories would be used in tailored smoking cessation programs will be presented.

The key to using behavior change theory in smoking cessation is to deliver messages that match the factors of individual smokers identified as important in the theory. Some of these factors include readiness to quit, addiction to nicotine, barriers to quitting, motives for quitting, self-efficacy, quitting history, social support, demographics, use of other substances, quitting strategies preferred, physical environment, and medical conditions. Health communication researchers (e.g. [9, 3]) have shown that tailored health communication materials outperform non-tailored materials. Non-tailored messages are typically "one-size-fits-all" materials designed to reach as much of the total audience as possible usually through mass media channels.

A conventional tailoring message system is an expert system that takes into account several different types of data. Each of these data types can have a few to several values, making the number of possible combinations of messages in the many thousands. Expert tailoring systems have been shown to be successful in nutrition, breast cancer, smoking cessation, and other health areas. For example, Brug and colleagues [3] showed higher satisfaction with tailored nutritional materials as measured by: (a) reading the material completely, (b) saving the material, (c) discussing the material with others, (d) rating the material as personally relevant, (e) rating the recency of the information, (f) judging that the material was written for them, and (g) rating the materials as interesting.

Software agent technology can be used to further refine the message tailoring process by interacting with system users to obtain a higher level using individual factors, reactions, and preferences. The agent system can also refine its tailoring ability by learning as it works with users. The design considerations that integrate the health behavior change theory and the agent technology will be discussed in this article. Finally, a procedure for testing the efficacy of the software agent system will be outlined. The section will present the testing population, variables to be controlled or measured, and experimental procedures.

2. Health behavior change theories and models

Human behavior change is a difficult process to describe and assess, largely because of the many individual and social factors involved. The theories or models that have been developed largely from psychology attempt to capture general patterns of empirical research results. Each of four theories will be briefly introduced and its uses and limitations discussed. This section is not an exhaustive review of the theories, but illustrates the

many factors that must be considered and how difficult it is to capture the mechanisms of human behavior change to use in computer-mediated systems.

2.1 Health Belief Model

The Health Belief Model (HBM) was developed in the 1950s to explain and predict health behaviors using the attitudes and beliefs of individuals. Key variables of the HBM [16] include (a) perceived threat of a health condition, (b) perceived susceptibility contracting the condition, (c) perceived severity of the condition, (d) perceived benefits of reducing the threat of illness, (e) perceived barriers of particular health actions, and (f) demographic, sociopsychological, and environmental variables that affect an individual's perceptions and self-efficacy (belief in being able to successfully execute the behavior required to produce the desired outcomes).

HBM research has been used to explore a variety of health behaviors including smoking cessation in diverse populations. Perceived barriers have been identified as the most influential variable for predicting and explaining health-related behaviors [7]. Other significant HBM variables are perceived benefits and perceived susceptibility, with perceived severity identified as the least significant variable. Using this model for smoking cessation would indicate focusing messages on overcoming perceived barriers toward smoking cessation, as well as the benefits of quitting. Focusing on the severity of cancers that are attributed to smoking would have a lesser effect.

Limitations of the HBM include: (a) the usefulness of the model as a whole has not been tested as researchers have tested only selected variables, (b) other factors such as environmental or economic are not included in the model, and (c) the model does not incorporate the influence of social norms and peer influences on people's decisions regarding their health behaviors [4].

2.2 Theory of Reasoned Action

The Theory of Reasoned Action (TRA), developed in the 1960s, is based on the premise that humans are rational and that the behaviors being explored are under volitional control. The theory links individual beliefs, attitudes, intentions, and behavior [5]. The theory's variables are (a) behavior, defined in terms of action, target, context, and time, (b) intention to perform the behavior, (c) attitude toward performing the behavior, (d) beliefs about the potential outcomes of a defined behavior, and (e) norms and normative beliefs regarding a person's beliefs of how the behavior is viewed by others.

The TRA proposes a linear process in which changes in an individual's behavioral and normative beliefs will affect the individual's actual behavior. Behavioral and normative beliefs influence individual attitudes and subjective norms, which shape a person's intention to perform a behavior. Intention, in this theory, is the strongest indicator that the desired behavior will be achieved. To develop appropriate interventions for a specific population and behavior, the variable and its corresponding beliefs and norms that exerts the greatest influence on the population should first be determined [5]. For example, in the case of smoking cessation, intention toward quitting smoking may be the most important indicator behavioral change, and are dependent on an individual's beliefs about the behavior and norms associated with it.

Some limitations of the TRA include the inability of the theory, due to its individualistic approach, to consider the role of a person's environmental and the linearity of the theory components [8]. Specifically, individuals may first change their behavior and then their beliefs and attitudes about it.

2.3 Elaboration Likelihood Model

The Elaboration Likelihood Model (ELM) developed in the 1980s is a framework for organizing and understanding the basic processes of attitude change. ELM incorporates many of the major classic approaches to attitude and persuasion. According to ELM, people take either the central route (attributed to highly motivated individuals) or the peripheral route (less motivated) to attitude change [11]. Attitude change via the central route, based on a thoughtful consideration of the issues presented, is relatively permanent, resistant to counter-argument, and predictive of behavior. Factors of the central route include (a) motivation to pay attention to the message, (b) ability to understand the message, (c) prior attitude to accept messages, and (d) the argument strength.

The peripheral route results in an attitude change that is relatively temporary, susceptible to counter-argument, and less predictive of behavior. Factors of this route include (a) reciprocation or prior obligation, (b) consistency in feelings, (c) social proof that others think or feel a certain way, such as liking the message deliverer, (d) authority of the message deliverer, and (e) scarcity of opportunity.

High motivation and high ability are necessary for a high probability of following the central route. Under other circumstances, where either one is absent, the peripheral route will likely be followed. People taking peripheral route might change to the central route, but this is not usual considered when using ELM, ignoring possible dynamic interaction between steps. The model also assumes people can be classified into categories such as having the ability to process a message or not having the ability. An individual likely understands some portion of messages or issues, and partially understands other

portions of the messages. For smoking cessation, ELM indicates that messages should be understandable and focused on increasing motivation and ability.

2.4 Stages of Change Theory

Psychologists developed the Stages of Change Theory in the 1980s to compare smokers in therapy and self-changers along a behavior change continuum. The rationale behind the theory was to tailor therapy to individual's needs at their stage in the change process. The five components of the Stages of Change Theory (precontemplation, contemplation, preparation for action, action, and maintenance) were identified and presented as a linear process of change.

A description of each stage are [12]: (a) precontemplation—an individual has the problem, recognized or not, and has no intention of changing, (b) contemplation—the individual recognizes the problem and is seriously considering changing, (c) preparation for action—the individual recognizes the problem and intends to change the behavior within the next month, (d) action—the individual has enacted consistent behavior change for less than six months, and (e) maintenance—the individual maintains new behavior for six months or more. Stages of Change indicates messages should be tailored to an individual's current stage to move them toward the next.

As a psychological theory, the Stages of Change focuses on the individual without assessing the role that environmental issues may have on a person's ability to enact behavior change. Because the theory presents a descriptive rather than a causative explanation of behavior, the relationship between stages is not always clear. Indeed, the stages are no longer considered linear; rather, they are components of a cyclical process that varies for each individual. Finally, each of the stages may not be suitable for characterizing every population.

Table 1 summarizes the four theories and models.

Table 1. Major health behavior change theories and models

Theory/model	Description	Smoking cessation use	Limitations
Health Belief Model	explains and predicts health behaviors using the attitudes and beliefs toward disease, especially perceived barriers, perceived benefits, and perceived susceptibility	focus messages on overcoming perceived barriers toward smoking cessation, as well as the benefits of quitting	not tested as a whole, environmental or economic factors are not included, does not incorporate the influence of social norms and peer influences
Theory of Reasoned Action	links individual beliefs, attitudes, and intentions, and assumes that behaviors are under volitional control, and intention of quitting smoking is the most important indicator of behavioral change	focus messages on an individual's beliefs and attitudes to increase intention of quitting smoking	does not consider environmental issues, and assumes linearity of the theory components when they may be cyclical
Elaboration Likelihood Model	attitude change via the central route (individuals are highly motivated) is relatively permanent, resistant to counter-argument, and predictive of behavior; the peripheral route (individuals are less motivated) is less so	create messages that are understandable and focused on increasing motivation and ability	high motivation and high ability are necessary for a high probability of following the central route, dynamic interaction between steps, assumes people can be classified into categories
Stages of Change Theory	five stages are precontemplation, contemplation, preparation for action, action, and maintenance; no longer considered linear; rather, stages are components of a cyclical process that varies for each individual	tailor messages to an individual's cyclical stage of change process	doesn't account for environmental factors, presents a descriptive rather than causative explanation of behavior, each stage may not be suitable for characterizing every population

2.5 Theory use in tailoring systems

Computer-mediated health message tailoring systems are relatively new technologies and extensive use of the theories and models has not occurred. While it is possible and may be desirable to consider more than one theory or model, the Stages of Change Theory has been used mostly in tailoring systems because of the relative ease of identifying the stage of a user. Identification can occur with the answers to a few questions such as length of time smoking, desired timeframe to begin quitting, or length of time having quit.

A representative example of a tailored cessation Web site using the Stages of Change is the Quit Advisor (http://www.quitnow.info.au/quitterspage.html) developed by Ron Borland of the VicHealth Centre for Tobacco Control (Australia) and his colleagues. This expert system uses an online assessment of a smoker's characteristics and provides tailored advice that can be read online and printed out. In preliminary studies, this system increases outcome variables such as the likelihood to quit by 15% over non-tailored messages (Borland, personal communication of unpublished data). The following is an excerpt from advice generated by the Quit Advisor:

> You have got through the period of physical withdrawal from the nicotine, and have shown yourself that you can overcome any temptations your addiction can throw at you. You have every right to be feeling really good about yourself. However, be aware that there are two challenges in becoming a non-smoker: firstly, overcoming temptations to smoke and secondly, learning how to live without cigarettes. You are now well on the way to mastering the first task, but you are only at the start of the second.

Conventional tailoring systems in use based on Stages of Change do not account for many of the individual differences within a stage, such as the limitation of the stages as components of a cyclical process that varies for each individual. The agent-based system being developed in this project differs from these expert systems by being more dynamic and interactive, ideally delivering more finely-tailored messages that more closely match the individual's needs, desires, and preferences. If this indeed occurs, the advice given will be more relevant and usable. The development of the system for this project is described next.

3. Software agent system design

Software agents are programmed with knowledge and the ability to reason and communicate to some degree [17, 18, 19, 21]. They can receive information available in their software environment, such as answers that users provide in response to questions, the preferences users express, and other actions users perform while interacting with the software. Software agents use this information and their knowledge and reasoning abilities to display context-specific messages, ask for clarification or more information, request feedback, and other communication acts. This ability allows software agents to further refine the tailoring process to deliver more relevant messages for a given user of the system.

Software agents can use the same data as other tailoring systems to begin the message tailoring process; however, the agents also use feedback and other user information to more finely tune message selection while the user is interacting with the system. The agent also learns from each user it interacts with and continually refines user models. The following sections discuss these design factors.

3.1 Interactivity and social presence

Besides refining the tailoring process, agent technology allows for increased user interaction and increased perceived social presence. Interactivity has been defined many ways. Rogers & Albritton [15] define it as the degree to which participants in a communication process have control over and can exchange roles in their mutual discourse. Rogers [14] defines interactivity as the capability of new communication systems (usually including a computer) to "talk back" to the user as do individuals participating in a conversation. The components of a conversation include (a) mutual discourse—the degree to which a particular communication act is based on a prior series of communication acts, (b) exchange of roles—the ability of individual A to take the position of individual B and thus to perform B's communication acts, and vice versa, and (c) control—the degree to which an individual can choose the timing, content, and sequence of a communication act, search for alternatives, enter message content into storage, and other actions.

According to Heeter [6], interactivity consists of six main dimensions: (a) complexity of choices available, (b) effort required of users, (c) responsiveness to user, (d) monitoring information for the user, (e) ease of adding information, and (f) facilitation of interpersonal communication. Table 2 shows potential differences in Heeter's dimensions of interactivity between conventional expert tailoring systems and an agent-based system.

Table 2. Comparing conventional tailoring and agent-based interfaces across interactivity dimensions

Interactivity dimension	Conventional tailoring system	Agent-based tailoring system
(1) complexity of choice available	User answers specified questions of multiple choice or short answer	User can enter open-ended questions or answers (although limited by what agent can understand)
(2) effort required of users	Generally point-and-click or entering one word	More effort required to enter text or open-ended responses
(3) responsiveness to user	Provides some feedback such as when user doesn't provide an answer or a valid response	Provides more types of feedback such as clarification requested by user, or through graphical expressions
(4) monitoring information for the user	Uses answers to build a user profile	Uses answers and feedback to build profile, can keep track of time and other user interactions
(5) ease of adding information	System sends messages based on user profile	User can request different kinds of information based on personal preferences communicated to agent, agent "learns" user profiles and models
(6) facilitation of interpersonal communication	Must use another channel (such as email, phone, or chat room)	Provides some communication with agent, can relay other messages

By increasing interactivity, the user's perceived social presence (the feeling of interacting with a person) should increase. A high degree of social presence has shown to increase desirable outcomes such as recall, satisfaction, and behavioral change intentions [20]. Social presence is the degree of salience of the other person in the interaction and consequent salience of the interpersonal relationships. Biocca [1] further defines the amount of social presence as the degree to which a user feels access to intelligence, intentions, and sensory impressions of another. In other words, a face-to-face conversation will have a higher degree of social presence than reading a printed document for a mass audience.

3.2 Program modules using Stage of Change Theory

The agent-based system with have an introductory module that will ask users to provide their name (or number code) and demographic information (e.g., age, gender, education level, ethnicity). They will be asked what tobacco products they use and whether they are interested in quitting smoking. They will complete questions to assess their readiness to quit, number of prior quit attempts, and previous use of primary cessation counseling and its success. The scripts will begin to classify smokers according to stage of change as previously discussed. For example, *precontemplators* will be defined as those smokers who do not express an interest in quitting within the next 30 days. *Contemplators* are those smokers who are thinking about quitting in the next 30 days. *Preparers* are those definitely planning to quit in the next 30 days, while those in the *action* stage are recent quitters.

In general, the messages will attempt to move precontemplators to contemplation and beyond with targeted motivational messages. The first messages will list reasons for quitting, e.g., health, cost savings, environmental tobacco exposure within the home and work place, being a role model for the family, smell, appearance factors, food tasting better, among others. Participants will be asked to identify reasons for quitting that most appeal to them. Another screen will remind precontemplators that health benefits from quitting will occur almost immediately, even if they have been using tobacco products for many years, and that thousands of people quit each year, oftentimes after repeated quit attempts (i.e., a self-efficacy message). Subsequent messages will remind them that tobacco use is linked to highly significant and compelling short-term or acute risks, longer-term chronic risks, as well as environmental risk. These smokers also will list concerns related to withdrawal symptoms and be provided with information on nicotine replacement therapies (NRT) and other pharmacological aids and for healthy changes in lifestyle.

For tobacco users in *contemplation* and *preparation*, the goal of the messages will be to move them to action. The design and programming will concentrate on (a) reasons for quitting, (b) concerns about quitting, (c) development of a quit plan, (d) NRT and pharmacological

treatment, and (e) development of a plan for relapse prevention. The first message will list potential reasons for quitting. Smokers will be asked to select their reasons for quitting. A subsequent message will describe additional reasons included on the checklist not mentioned by the user. Next, a message will list concerns the smoker might have related to withdrawal symptoms, stress, and weight gain and subsequent screens will provide information on over-the-counter NRT to control withdrawal symptoms. Another message will remind smokers that two interrelated action plans need to be developed—a quit plan and a relapse prevention plan—and drive the majority of the counseling in this stage. A message will display a checklist of recommended strategies for quitting such as brand switching, setting a definitive quit date, reducing consumption approaching quit date, environmental restructuring, quitting with a friend or family member, use of NRT, among others. Smokers will be asked to select which strategies they intend to use. Another message will present a relapse prevention checklist (with specific reference to NRT) and a list of high-risk situations where relapse is most likely to occur (e.g., after meals, first cigarette in the morning, while drinking coffee or alcohol, socializing with friends, stressful events). Smokers will be asked which of these situations may apply to them and a list potential coping strategies will be presented on subsequent screens (e.g., avoiding the situation itself, substitute behaviors, NRT, deep breathing, and changing one's lifestyle to promote healthy behaviors). A final message will summarize their personalized quit and relapse prevention plans.

For smokers in *action* (recent quitters), the messages will facilitate relapse prevention. The protocol described above for relapse prevention will be used here. A final message will summarize their personalized relapse prevention plans.

The smoking cessation messages will be formatted in XML to classify them according to smoker stage of change categories, and element types will be created. For example, a given strategy element can be specified as part of one of the three stage-specific counseling modules defined in Project 3 such as <stage title="preparation"> </stage>.

3.3 Creating the artificial intelligence programming

The main program components, seen in Figure 1's dashed box, are: (a) agent language and information processing, (b) agent script, (c) agent knowledge base, and (d) agent actions.

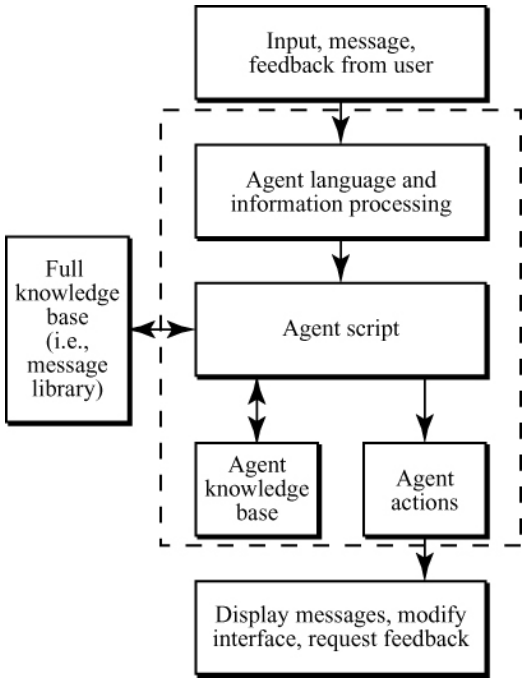

Figure 1. Flowchart of software agent programming

The agent receives information from its such as the text a user sends to the agent, or user actions such as the buttons clicked on ("send" or "search"). The information processing step parses the text the user sends, develops a keyword list, and marks the list according to user action such as "send." For example, a user may send this message: "What is the success rate of using an NRT?" The parser develops a list of the matching words it finds in its lexicon, and marks the list according to user action: [(#keywords: "success", "rate", "NRT"), (#user_action: "send")]. The agent script (described in the next paragraph) will use the list to determine an appropriate response. This keyword parsing used in previous agent systems (e.g., [17]) is not intended to be a sophisticated natural language methodology.

The agent script is the main reasoning engine for the agent. The algorithms in the reasoning engine act like "scripts," similar in concept to scripts that telephone counselors are trained to use. Its three main functions are to (a) evaluate the processed information, (b) determine the current state (or context), and (c) decide which actions to take. For example, the agent asked a participant at what age she began smoking, and she replies "Yes." The agent script evaluates the response, finds it is expecting some number and that the response does not match the context. The agent script will send the message "Sorry, I didn't understand," and repeat the question. If the participant's

response matches the agent's expectations, the script enters the information in the agent knowledge base, and performs the next scripted action.

The agent script is goal-oriented in seeking to deliver a complete set of relevant messages to the participant; when it has accomplished this goal, the script finishes the session. Subgoals include (a) obtaining enough information about the participant to develop a profile that includes his or her stage of quitting, and (b) other information needed for the message tailoring described previously. The script also updates a participant's profile, and updates participant models by matching characteristics and preferences. For example, Participant A may find messages on the cost of smoking to be very relevant to him (determined by the agent asking for feedback). This information is included as part of the Participant A's profile, which then contributes to developing Participant Model A. If Participant B has a high degree of matching characteristics with Model A, then the script will assume that B will probably also find cost information to be relevant. In this way, the agent becomes more efficient as it works and learns with more participants.

When the agent script has enough information about a participant, it uses a search procedure to find the message or other action most relevant for the context and the participant. Relevancy is determined by an algorithm that incorporates several variables such as the participant's quit stage, the messages already provided to the participant, the preferences expressed by the participants, the participant's model type, and so on. For example, if a participant is in the preparation stage, likes scientific factual messages, matches the Participant A model, and has not yet received messages about NRTs, then an appropriate message can be selected for display. The participant may also ask for any information at any time, and so the agent script must first determine if the participant's profile is sufficiently developed to offer the information requested (and tailored for the participant). If it is not sufficiently developed, the agent will send a message such as "I do have some information about that, but I need to find out if you are thinking of quitting in the next 30 days."

The agent knowledge base seen in Figure 1 is somewhat analogous to long term memory. It contains a log of actions performed by the participant and the agent (which can be downloaded by the researchers for analysis), participant profiles, participant models, dialogue messages, and animated expressions (graphical files). This knowledge base will be created using the classification methods described previously. The agent script uses the agent knowledge base to determine which action to perform. The script can also update the knowledge base by adding information, or modifying the current content.

When the agent script determines which action should be performed, it sends a command to the "agent actions" component, which performs the appropriate action. Actions include displaying the selected message or messages in the message display field or the agent text field.

3.4 Designing the interface and testing

The agent-based system will use a relatively simple interface of a text message display, a text entry box, and a few clickable buttons. The usability of the Agent Quit Program will be tested throughout the design process. First, 10 adults smokers will be recruited and paid to interact with the alpha prototype Agent Quit Program. The usability participants will be asked to evaluate the content and instructions, errors made, ease of use, amount of unneeded information, information overload and frustration, comprehension, and likes and dislikes. Participants will "think aloud" (i.e. verbal protocol analysis) as they are videotaped using the agent interface. Of particular interest are the kinds of messages the participants send to the agents, which will be incorporated into the next version of the program. These messages will be automatically recorded by the program. The data from this usability test will be used to revise the Agent Quit Program. When the revisions have been made and a beta version has been developed, the Agent Quit Program will be subjected to a second usability test. The test of this beta version will follow the same procedures as with the alpha version.

After any revisions to the beta version, the software agent will be "trained." The number and types of participants are the same as in the usability testing. The procedures will differ, in that the participants will use the system as they will in the feasibility and preliminary efficacy testing. That is, they will not be evaluating the interface, told to think aloud, or be videotaped. Their interactions will be recorded by the program's log for evaluation, including verifying that the agent sends appropriate messages for a participant's profile. Any corrections needed will be made before the program is tested.

4. Efficacy testing

An efficacy test of the Agent Quit Program will be conducted, compared with the Web Quit Program. The purpose of the test is to see if the system produces significant effects in increasing behavior change (i.e., quitting or moving toward quitting) compared with the Web Quit Program. The target population is adult smokers from diverse populations such as undergraduates

and those recruited from clinics or other community organizations.

The test will be a repeated measures design. Each participant will receive smoking cessation messages in two ways: (a) using the Web Quit Program, and (b) using the Agent Quit Program. Each participant will take a pretest, use one of the smoking quit programs, and then evaluate their experience with the program. A week later, each participant will complete a recall posttest, use the other quit program, and evaluate their experience with the program. After another week, each participant will again take the recall posttest. At three months and six months after the test, the participants will be contacted and asked about their smoking behavior.

The order of program use will be randomized by participant. Because of the developmental nature of the software, the testing will be done in a computer laboratory to ensure a consistent and stable physical and technological environment.

The primary outcome will be a comparison between the Web Quit Program and the Agent Quit Program on each participant's reported relevance of the messages received. Secondary measures include process satisfaction, message recall, and intention to quit smoking. Mediating variables include number of interactions and perceived social presence. Demographic data will also be collected.

Primary outcome variable - message relevance: The personal relevance of the cessation messages is the primary outcome variable. It will be measured using multiple-item, seven-point Likert scales. Items shall be statements such as: "The information I received on quitting smoking was personally relevant to me." "The quit smoking strategies I received were the kinds of strategies I can use." A 1 (strongly disagree) to 7 (strongly agree) response format will be employed with each item.

Secondary outcome variable - process satisfaction: Process satisfaction variables will be measured using multiple-item, seven-point Likert scales. Items include: satisfaction with the messages, satisfaction with the process of obtaining the messages, and likelihood of recommending the system to other smokers. The response format shall be the same as for message relevance items.

Secondary outcome variable – message recall: Message recall data will be collected in the posttests. Participants will type their free recall responses to the request to input the quit smoking information they received the week before. The typed responses will be coded for number of propositions (a unit of meaning, such as "NRT helps x % of smokers quit.") that match the propositions in the messages they received.

Secondary outcome variable - intention to quit: As part of the posttest and followup at three months and six months, the participants' smoking behavior and intention to quit will be measured. Short-answer or multiple choice questions will be asked concerning when they would like to quit, or if they have cutback on their number of cigarettes smoked per day during the study. In all three measurements (pretest and both posttests), stage of readiness to quit [13], number of cigarettes smoked per day, desire to stop smoking [2, 10], and expectation (self-efficacy) of whether the smoker will be smoking three months in the future [10] will be assessed. The perceived support of the quit program in their efforts will also be measured with seven-point Likert scales.

Mediating variables – number of interactions and social presence: Interactions include the number of requests or responses a participant sends to the agent in the Agent Quit Program, and responses or clicks on links to information. The time spent on the system will also be recorded. The more interactions a participant has with the program, the more likely that participant will receive relevant messages. The number of interactions will be recorded by the programs. Similarly, the more a participant perceives a high degree of social presence when using a program, the more that participant might rate other variables higher such as process satisfaction. Based on past studies of communication channels [20], perceived social presence of the medium will be measured using a series of seven-point semantic scales such as: impersonal/personal, insensitive/sensitive, unsociable/sociable, cold/warm, passive/active. An example of the response format is:

Using the scale below rate the program you just used. Click on the box closest to how you feel:

Impersonal □ □ □ □ □ □ □ Personal

Demographic variables: The pretest will also ask the students for demographic information such as age, gender, ethnicity, and year in school. The pretest will also ask their prior experience using computers and the Internet.

5. Conclusions

This paper presents a theoretical approach to developing an agent-based smoking cessation message delivery system. Four major health behavior change theories were described and how they might be used in developing tailored smoking cessation message systems. The Stages of Change Theory was shown to have been used mostly by smoking cessation program development in expert systems.

The design considerations of a software agent-based system incorporating Stages of Change were described. Software agent technology was chosen for the system to improve the tailoring of messages for individuals through the artificial intelligence reasoning algorithms. The higher level of interactivity in the agent-based system should also

increase social presence when interacting with smokers. A methodology for testing the system using adult smokers comparing a Web-based expert system and the agent-based system was also presented.

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