INTERACTIVE COMMUNICATION TECHNOLOGY AND PROCESSING OF BEHAVIORAL HEALTH CHANGE MESSAGES

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Dedication

I would not have been able to complete this work without the help of many people. This work is dedicated to:

my husband, John, you are the "Bobola" to my "Tish".

my identical twin daughters, Josephine and Abigail. You are the lights and joys of my life.

> Josie, thank you for reminding me that there is more to life than homework, school projects, and grades. My favorite moment of each day is when we wear our "swishy" pants and dance to the *Law & Order* theme song.
>
> Abbie, my tiny baby who was called Home to be with her Savior at 28 days old, I miss you with every breath that I take. I will continue to hold you in my heart until that joyous day when I can once again hold you in my arms.

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my parents, Leonard and Peggy McCracken, thank you for teaching me to set a goal and work toward achieving it.

> Dad, the cancer survivor and at whose hospital bedside most of this work was written, you profoundly influenced me. Thank you for my fighting spirit and the tenacity to go after my dreams.
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> Mom, who wanted a better life for her children and instilled in them the importance of getting an education, thank you for using every car ride to Harrison as an opportunity to encourage me to go to college.

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Abstract

Consumer processing of interactive communication technology (ICT) messages is an understudied area. It is incumbent upon the Informatics community to partner with various health content and population domain experts to design healthcare information products that increase reach, improve awareness, and meet consumer needs. This research is a secondary analysis of a larger study to develop and pilot test an interactive, multimedia computer program as an adjunct to usual clinical care in an effort to reduce smoking in low-income rural Indiana communities. The objective of this research was to measure the degree of consumer processing of health behavioral change messages delivered by ICT.

The sample size for this research was 30 subjects. Degree of consumer message processing was high (mean processing score=80.5, SD=6.837). Instruments to assess the number of actionable cessation responses (ACRs) and cognitive changes were completed at the 3-month follow-up. A relationship was observed between degree of message processing and making a quit attempt (r_{bis}=.384, p=.044). Knowledge scores improved over baseline measures (t=3.123, p=.004). These results suggest that ICT is feasible for promoting the processing of cessation messages and increasing consideration of ACRs in low-income rural Indiana populations.

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Introduction

Introduction of Subject

More than ever before, consumers are searching for health care information in a variety of media. The spectrum of media is vast, encompassing everything from one-dimensional brochures to multi-modular computer programs. The caveat to this vast array is that only some consumers will receive the embedded message "some of the time from some media and under some conditions" (Street & Rimal, 1997, p. 2). In an effort to increase consumer reach and awareness, the Informatics community must further develop its current understanding of the human factors influencing message processing. It is incumbent upon the Informatics community to partner with various health content and population domain experts to design health information products that address consumer needs. Collaborative products will address user population characteristics, provide useful content, and utilize the media most conducive to message processing (Lieberman, 1997).

Human factors, as a discipline, grew out of the psychology and engineering domains (Faiola, 2003). The term human factors is defined as the incorporation of human performance, abilities (National Aeronautics and Space Administration [NASA], 2005), expectations, and limitations (United States Food and Drug Administration [FDA], 2003) into all phases (design through evaluation) of a product's life cycle. Applied to message processing, human factors can be described as the consumer's affective response toward the delivery medium and message, selection of pathways through the information environment, and cognitive involvement (Street & Rimal, 1997).

The first human factor, affective response toward the medium and message, is the consumer's reaction to the delivery medium attributes and message content. Consumers can have reactions to the medium and message that are independent of each other. For example, a consumer uses a multimedia computer program designed to increase lung cancer knowledge. The consumer is comfortable using a computer (medium) to view the program but apprehensive about the messages (content) delivered. Given this example, consumers' affective responses to the medium and message will be discussed separately.

Medium attributes can either enhance or detract from the message's representation. Attributes utilized for representation include disseminating equipment and the peripherals for navigation, operation, and output (e.g. monitor, speakers, or printer) generation. Degree of medium satisfaction can vary by attribute. Building upon the example of the lung cancer computer program, the consumer may be comfortable (satisfied) using a mouse to navigate through the program but dislike (dissatisfied) using a keyboard to enter data. Further, satisfaction with the medium can vary by consumer. Consumers can also assign varying degrees of satisfaction to discrete media elements, such as preference of one graphic over another, within the medium.

Content is an overarching term used to describe the message's subject matter. The consumer's affective response to the content is not dependent upon the medium. Degree of content comfort level can vary by consumer. Further expanding upon the lung cancer computer program example, suppose that two consumers with different family histories of cancer use the computer. Consumer #1 has no family history of cancer. Consumer #2 has three first-degree relatives with lung cancer. The increased risk of lung cancer may make Consumer #2 feel more vulnerable and less comfortable than Consumer

#1 with the content. Affective response application to the medium and message are shown in model (Figure 1).

The second human factor, selection of pathways through the information environment, describes the consumer's choice (or ability to choose) if, when, and in what order the content is delivered. Selection stimuli have been noted to positively impact the consumer's perception of medium responsiveness, which correlates with increased medium engagement and enhanced message processing (Rimal & Flora, 1997). Although pathway selection is an important factor in message processing, it will not be an examined as an outcome for this research.

Also influencing pathway selection is the consumer's comfort level with medium and navigational familiarity. For example, if a consumer is nervous about using the medium, they are likely to be cautious when interacting with it. Designing media that are in line with consumer expectations and allowing time for building familiarity help to increase comfort levels.

The third human factor, cognitive involvement, describes the consumer's perception of the message's relevance to self and the cognitive exertion expended to process its content. Crucial to this component is the consumer's establishment of associative connections to the delivered message. More than mere information accumulation, connection establishment is the incorporation of new content with existing knowledge and skill sets (Jones, Nyhof-Young, Friedman, & Catton, 2001). Associative connections efficiently and effectively enhance content comprehension because connections are assigned by the consumer based upon their frame of reference. Further, assigning many connections during the processing of the message increases the

likelihood recall and amount content remembered (Nelson, Zhang, & McKinney, 2001). Refer to the model (Figure 1) for the human factors applied to message processing.

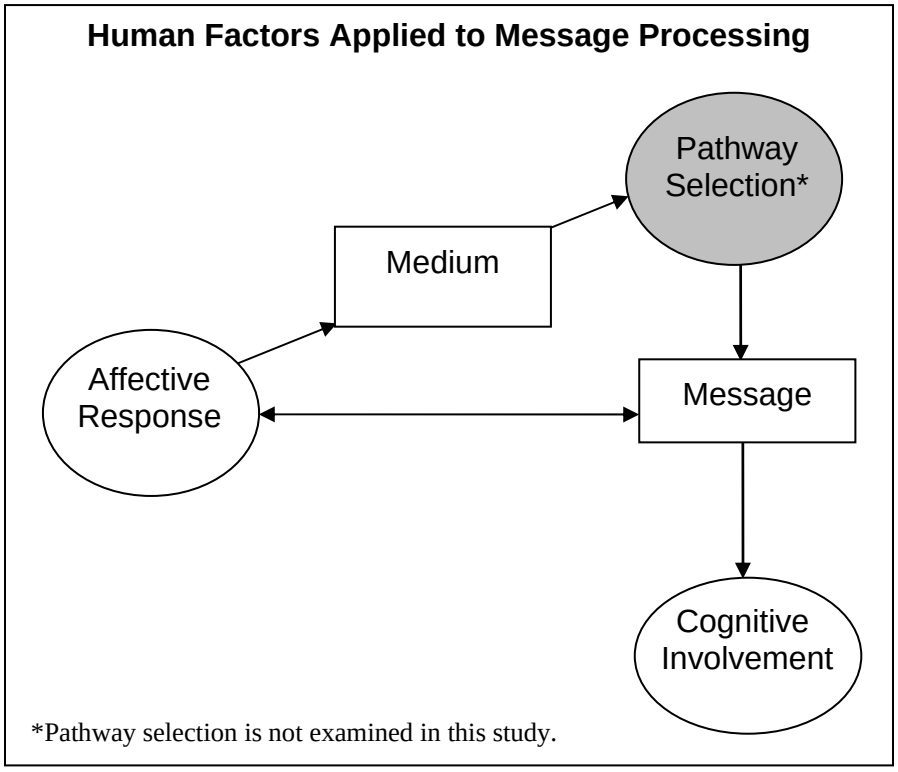

Figure 1. Model of the Human Factors Applied to Message Processing

Cognitive involvement can be enhanced by designing messages with a high degree of verbal immediacy, content framing, and consideration of time horizon (Holtgrave, Tinsley, & Kay, 1995; Parrott, 1995). Verbal immediacy is the degree of directness between the communicator and message content with regard to linguistic use (Parrott, 1995; Wiener & Mehrabian, 1968). The most efficient method of creating immediacy is to design messages that appeal to the consumer through self-references (Moreno & Mayer, 2000). Self-referencing messages are often utilize words like “you” and “your” in their content, increasing perception of the message as personally relevant and generating opportunities for consumers to make associative connections.

Elstein (1987) defined framing as the variation in consumer responses to comparable messages when content is worded differently (Holtgrave et al., 1995). Intrinsic to framing is that seemingly inoffensive wording of messages may negatively impact consumers. Wood (1996) and Holtgrave et al. (1995, p. 32) assert that messages should be framed (e.g. "gain or loss-framed") to match the desired behavior.

The time horizon is the notion of time as applied to consequence realization (Holtgrave et al., 1995). Content designers can cue consumers to time and consequence by using time referencing phrases to assist in message processing. For instance, time referencing phrases include "next time", "in a couple of days", and "in a few years" (Holtgrave et al., 1995, p. 34).

Importance of Subject

Consumer ownership of personal health is evolving into individual responsibility for well-being. Messages promoting proper care and self-maintenance support this evolution by empowering consumers to make behavioral choices that enhance personal health (Anderson, Eysenbach, & Rainey, 2003; Jones et al., 2001). Understanding how consumers process messages is vital to designing effective products (Patel, Arocha, Kaufman, 2001). It is incumbent upon the Informatics community to partner with various health content and population domain experts to design health information products that address consumer needs. Collaborative products will address user population characteristics, provide useful content, and utilize the media most conducive to message processing (Lieberman, 1997).

Knowledge Gap

Interactive computer technology (ICT) is widely recognized as an effective way to increase consumer access to information, knowledge of the domain content, and "standard of health" (Bush, 2000, p. 72; Lewis, 2003). However, merely increasing access and knowledge does not necessary translate into a deeper understanding of a domain or a measurable behavioral change (Lewis, 1999). Perceived as a novelty, designers can capitalize on consumer interest in ICT and build programs that deliver cognitively engaging messages. In order capitalize on consumer interest in ICT, developers must also build products that satisfy consumers from a design perspective (Brown, Powell, Battersby, Lewis, Shopland, Yazdanparast, 2002). Multimedia capabilities provide consumers with digitally-enhanced, simulated learning environments, allowing consumers to rehearse behaviors and assess consequences (Lewis, 2003). Rehearsal and assessment influence message processing and can prompt a real-world actionable response to the message, potentially leading to a positive behavioral change.

Consumer processing of ICT messages is an understudied area. This research seeks to add to the existing body of ICT message processing of health behavioral change content. Foreseeable outcomes resulting from ICT message processing are positive actionable responses leading to deeper understanding of domain knowledge, healthier consumer behavior, and proper utilization of health support services (Jones et al., 2000; Mayer & Chandler, 2001).

As previously described, the consumer's associative connections to the content underpin the processing of ICT messages. Assuming that virtual environments are comprised of domain-specific content, the act of message processing is analogous to a driver getting or asking for directions to a destination from a passenger in the same

vehicle. For example, the driver (consumer) has never been to the destination before but is somewhat familiar with the area (associative). The passenger (the medium designer) has been to the destination before and has a map of the area (domain content). The passenger can only guide and suggest destination routes the driver (domain constructs). The driver is influenced by his surroundings, his interactions with the passenger, and he is empowered to decide destination variables such as direction, speed, and route from the existing network of travel systems (connections). Therefore, message processing will vary by individual because of differences in the consumer's ability to relate content with sense of self and assign unique associative connections to the message.

Background

Related Research

ICT is an acceptable medium of message delivery for health care consumers (McDaniel, Casper, Hutchison, & Stratton, in press). Contrary to the linearity of one-dimensional media such as a brochure, ICT programs increase consumer perception of medium response and the ability to choose by facilitating determination of pathways and exploration. Although one-dimensional media allow pathway determination and exploration, the underlying programming and audiovisual cues within ICT programs make the consumer's experience of selection and discovery appear seamless. Designed to stimulate multiple senses, cues engage and increase consumer interest through the use of elements such as text, audio, graphics, animation, and video. Further, cues ease cognitive exertion and assist processing, without adding to the content by indicating relevant information in the message (Mautone & Mayer, 2001; Mayer, Mathias & Wetzell, 2002).

Interactivity with multimedia elements can strengthen content for low domain knowledge consumers (Rimal & Flora, 1997). Disparities between learning styles are eased through the use of multimedia elements, interactivity, and narrated text (Jones et al., 2001; Mayer et al., 2001). Furthermore, ICT capabilities allow the presentation of messages to be augmented to suit the consumer's learning style. For instance, text size can be increased for those with decreased vision capacity. Another example would be to provide visual learners a mute button when audio-complemented text messages are delivered. However, some experts contend that audio-complemented text draws attention to message constructs for consumers with higher domain knowledge (Rimal & Flora, 1997).

Multimedia outputs stimulate cognitive rehearsal of the behavior depicted in the message. The virtual experience is enhanced when the message delivered is tailored to characteristics of the consumer or depicts "someone just like me" in real-world situations (McDaniel et al., in press; Jones, 2001). This approach is perceived to be "more conversational rather than didactic" (Parrot, 1995, p. 11). Further, Moreno and Mayer (2000) contend that processing is facilitated when messages adhere to societal norms and sensibilities. This contention is complementary when applied to the notion of virtual experiences enhancing message processing, because active processing of the behavior, rehearsal, and consequences are stimulated.

ICT differentiates itself from other delivery media through complex medium composition, influenced by usage setting, and message customization. Medium composition is a term used to describe the parts comprising structure. In the case of an ICT structure, hardware, software, peripherals, and any residing consumer-centric

program comprise the medium. Setting describes the atmosphere and location of where the medium is used.

Generic media, such as a printed handout or video, tend to be broad in domain scope and market reach and are thereby inadequate to appeal to diverse consumer audiences (Jones et al., 2001). Message customization is made possible by targeting and tailoring content based upon consumer-specific data. Automated capabilities such as capture, store, and save enable ICT to collect consumer data. ICT can be programmed to target and tailor content by embedding scientifically documented algorithms in the medium and running them against captured or stored data. Resulting messages and content reflect consumer perceived needs or interests rather than sender desires. Providing consumers with targeted and tailored content removes extraneous information, increases the likelihood that the user will process the message, and enhances the potential of an actionable response (Kreuter, Bull, Clark, & Oswald, 1999).

Easing cognitive exertion and load is another benefit of message customization through targeting and tailoring methodologies. Human faculties limit the available attention and content absorption resources in consumers (Coiera, 2000). With extraneous information removed and cognition obligations eased, consumers have more resources to process content and form associative connections to messages (Mayer et al., 2001).

Targeting is the process of addressing population or domain-specific criteria. For example, messages regarding adherence to mammography screening for women need to be designed for a female audience. Tailoring further distills content based upon criteria unique to a specific consumer. Expanding upon the mammography screening example, a woman's age can be a unique criterion used to tailor messages about

screening. Research comparing the efficacy of tailored and generic health materials have shown that content can affect a behavioral outcome in a given domain when content is customized to the individual consumer (Kreuter et al., 1999).

The multimedia and customization capabilities afforded by ICT are ideal for delivering health behavioral change messages to consumers. In her review of attitude change and resistance articles, Wood (1996) found that studies utilizing messages that reflect the appeal of the desired behavior have a greater likelihood of consumer consideration of the content. For example, an ICT program could include a video clip of a person brushing his teeth, then going to the dentist and having a cavity-free check-up.

The overarching goal of ICT is to promote consumer message processing of a domain topic. Messages should not elicit behaviors, but they empower consumers to make decisions based upon their own processing of the content (Manning, 1997). Good ICT design respects the rights and abilities of the consumer to make choices while providing opportunities to seek assistance**.**

Current Understanding

Consumers want to participate in the process of deciding upon preventive strategies, help plan treatment courses, and manage actionable responses governing their own health (McDaniel, 2004; Parrott, 1995). Demand exists for more consumer-centric health education media aimed at prevention and self-management. Providers have also indicated their desire for prevention programs that re-affirm their care suggestions to consumers (Anhöj & Jenson, 2004). Consumer health education is gaining recognition for its value (Anderson et al., 2003). However, delivery media and presentation of information are merely stimuli for message processing.

Consumers interact with ICT in more purposeful ways if they are enabled to choose to seek more domain information of interest to them (Jones et al., 2001). Further, a strong body of psychological literature supports the notion that the ability to choose lends itself to perceived self-control and leads to positive outcomes such as enjoyment, learning, improved health behavior (Rimal & Flora, 1997).

In addition the documented benefits of computer-based patient education in Lewis' literature review (2003), ICT offers the ability to assume control over the medium, content redundancy and repetition (Rimal & Flora, 1997), promote learning in populations with varying domain knowledge (Jones et al., 2000), and increase comprehension of terminology (Zeng, Kogan, Ash, Greenes, & Boxwala, 2002).

Self-pacing offers consumers control over ICT. This is of significant note from a medium design perspective as message delivery is thus not predetermined for the consumer by the developer (Chamberlain, 1996). One-dimensional media permit self-pacing through the content; however, consumers expend time and cognitive resources manipulating the physical medium, seeking and remembering location of specific pages, before reviewing the content. Unique to ICT delivery media is the ability to pace through content without the loss of interactive benefits. Consumers can decide when messages are displayed, control speed of content delivery locally, and determine the interaction between self and the technology. Determining the pace allows the consumer time to make personally-relevant, associative connections between his existing domain knowledge and ICT delivered content necessary for message processing (Chamberlain, 1996; Kreuter et al., 1999; Lewis, 1999; and Mayer et al., 2001). Pacing permits the

consumer to “review, pause, and reflect” on delivered messages (Mautone et al., 2001, p. 387), which aids in knowledge construction.

Tactics such as content redundancy and repetition are employed to promote knowledge construction and expose consumers to key domain constructs in an effort to increase comprehension and promote deeper understanding (Martin & Halstead, 2003). Repetition and redundancy are also used to compensate for variations in consumer learning styles and message processing (Parrott, 1995). ICT is a malleable media, offering designers the ability to deliver redundant and repetitious messages while accommodating a variety of learning styles.

Respecting the consumer’s ability to choose, ICT design should enable message repetition as determined by the individual. However, a line exists between designer-intended redundancy and excessive content repetition. Appropriate care in the ICT design process will help to alleviate excessive information repetition.

Health care provider time with consumers is limited and negatively impacts satisfaction during the provider visit and the consumer’s need for more information (Anderson et al., 2003). Although generic content media can reduce delivery disparities and length of time at provider visits, they tend to be passive in nature and are not designed for illiterate members of the audience (Jones et al., 2001). ICT media can be designed with an active tone and provide consistent delivery of content regardless of consumer literacy (Horan, 1996).

Consumer and provider discrepancies in health care terminology only complicate concerns with the limited time for interaction (Zeng et al., 2002). Miscommunication between providers and consumers can lead to negative outcomes (Campbell, Oliver,

Spackman, Shortliffe, 1998). For consumers unable to effectively communicate with their health care providers, ICT is an innovative way to improve consumer comprehension of terminology. Through increased terminology comprehension, providers and consumers can begin to communicate on common ground, facilitating precise and more meaningful dialog about care and treatment plans (Coiera, 2003).

It is important to keep the focus on the act of message processing rather than the delivery media. Message processing is influenced by the consumer's comfort level with the medium and familiarity with navigational functions. Media's sole function is to support the content environment as consumers explore, process, and potentially integrate health behavioral change messages into their lifestyle**.** Chamberlain (1996, p.49) so succinctly wrote, "the medium does not replace the message….the ultimate goal is communication".

Research Question

The purpose of this research is to examine how effectively consumers process health behavioral change messages delivered by ICT. The research will examine the relationships between ICT message processing and actionable cessation responses (ACRs), cognitive changes, and demographic characteristics. ACRs are positive actionable responses associated with smoking cessation. It is important to note that actionable responses can be negative, too. For example, after using an ICT program about the health problems caused by smoking, a consumer may conclude that quitting now will not help his health and decide to continue to smoke.

Intended Research Project

Resources proven to educate and aid smoking cessation attempts are limited for economically-disadvantaged rural smokers. Documented barriers for rural residents include lack of health insurance coverage, geographic isolation, the stigma of seeking treatment counseling (Booth & McLaughin, 2000), and low income (Booth & McLaughin; Zang, Tao, & Anderson, 2003). Perception of barrier severity can influence consumer actions to overcome them (Skinner & Kreuter, 1997). ICT has the potential to reach at-risk populations, overcoming barriers by improving consumer efficacy through vicarious experience (Skinner & Kreuter, 1997) and increasing access to educational materials. This research is a secondary analysis of data from a larger study developing and pilot testing an interactive, multimedia computer program as an adjunct to usual clinical care in an effort to reduce smoking in low-income rural Indiana communities.

Methods

Overview of Original Study

Original study inclusion criteria were current smoker or recently quit (within six months of study enrollment), age 18 or older, and English speaking. Potential subjects were excluded if they were pregnant and enrollment was limited to one subject per household to minimize cross-contamination. Upon completing a comprehensive self-administered, pencil-paper baseline instrument packet assessing smoking influence constructs, such as cultural, population identity, physiological, psychological, societal and structural, enrolled subjects received a standard care brochure. Intervention subjects used the "Quit for Life" (Q4L) program in a private clinic room. After Q4L use, intervention subjects completed an 18-item questionnaire measuring degree of message processing (Appendix A). Three month follow-up interviews were conducted by phone to

assess knowledge, social norms, self-efficacy, and ACRs (Appendices B-E, respectively). Perceived smoking risk was also measured at follow-up; however, it was not assessed in the secondary analysis. All subjects received an incentive for completing the baseline and follow-up, respectively, for a total of two possible incentives. Also, subjects enrolled in the study were eligible for up to 8 weeks of free nicotine replacement therapy (NRT).

Materials

Building the Q4L program.

Q4L was designed to deliver computer-based messages targeted to rural population cultural norms and tailored to discrete variables such as gender, age, reasons for smoking, nicotine addiction, and perception of health risk. Messages used "gain-framed" appeals to empower consumers to make decisions about ACRs. Gain-framed messages focus on the potential for more realized positive consequences or decreases in negative ones (Holtgrave, Tinsley, & Kay, 1995). Prior to program development, an advisory panel consisting of rural community members and domain experts in smoking cessation and rural cultural norms were consulted to ensure appeals were gain-framed, content was accurate, and a consumer-centric design was used. A usability test was conducted in a naturalistic setting to assess feasibility and the results were favorable. Average time to complete the program in the usability study was 23.88 minutes and overall program satisfaction was high (mean satisfaction score was 90.4 with 110 indicating highest possible satisfaction) (Stratton, McDaniel, & Wewers, 2004). Participant feedback was used to refine and enhance program features in the final design of the program.

Final medium composition.

The final medium composition included a Toshiba Portégé® 3505, stylus, portable speakers, and a high-fidelity version of the Q4L program. The Toshiba Portégé® 3505 was selected for its portability and touch screen capabilities. The intuitive nature of touch screen technology (TST) alleviates the technological experience discrepancies between users. Consumers of all expertise levels have reported high TST satisfaction (McDaniel et al., in press). Pathway selection was achieved by using the stylus to touch large, functionally-labeled icons on the screen. Icons that are not clearly labeled detract from the program's effectiveness by negatively impacting the degree of message processing and creating confusion for consumers (Walker, Lee, Skov, Berger, & Athley, 2002). Macromedia Director® Version 8.5 was chosen to build the program because of its ability to handle complex algorithms. Consumer responses to embedded, computer-prompted questions such as demographic information and smoking history (10 items), reasons for smoking (8 items), nicotine dependence (4 items), and social impact of smoking (3 items) were captured and stored in a comma-delimited file on the medium's hard drive (Appendix F). Captured data drove the underlying algorithms derived from a review of smoking cessation domain literature. All text adhered to industry serif recommendations. Audio-complemented text messages compensated for potential discrepancies in literacy level within the population. Video elements have consumer tolerances of 45 seconds or less.

Message bank.

There are 46 discrete multimedia ICT messages in the program's message bank. The minimum number of messages that any one consumer would receive is 16 and the maximum is 40. Messages are categorized as either program-driven (PD) or consumer-

driven (CD). All PD messages (n=14) target on rural community life and provide information on the program's organization, pathway selection, and general domain content in a manner consistent with the population's cultural norms. CD messages (n=32) are derived from the program's underlying algorithm and the consumer's responses to Q4L prompted questions. Total number of messages delivered and a summary of the program's message categories are provided in the Q4L Program Message Bank Breakdown (Table 1).

Table 1. Q4L Program Message Bank Breakdown

Messages	n
Total messages in bank	46
Maximum number of messages delivered	40
Minimum number of messages delivered	16
Program driven (PD)	14
Consumer driven (CD)	32
Computer-tailored	21
Self-tailored	11

Two sub-categories, computer-tailored (n=21) and self-tailored (n=11), emerged from within the CD messages while building the message bank. The sub-categories separate CD messages by their method of delivery. Computer tailored messages are delivered automatically as a result of the consumer's responses. Self-tailored messages are delivered only if the consumer chooses to receive the message. To indicate their choices, consumers are provided a link to the specific messages. Please refer to the model (Appendix G) for the message flow in the Q4L program. Message categories are indicated at the component level.

Instruments

A comprehensive baseline instrument packet to collect data assessing constructs that may influence a consumer's decision to smoke, such as cultural, population identity, physiological, psychological, societal and structural, was developed for use in the larger study. The baseline had a self-administered, pencil-paper format design. As previously noted, three-month follow-up data was collected for specific constructs by a research assistant over the phone. This research examined constructs core to message processing. For instrument name, appendix location, instruments descriptions, sample questions, and response schema of instruments utilized for this research, see Appendix H.

Sample and Subjects

The original study had a randomized sample size of (n=50) consisting of a control group (n=20) and intervention group (n=30). For this research, only the intervention group data was considered.

Procedures

Secondary research study.

Data for the intervention group was queried from the original study's database and exported and saved in a Microsoft® Excel 2002 spreadsheet. The newly created spreadsheet was imported into SPSS® for Windows version 12.0.2 for analysis. After saving the successfully imported spreadsheet as an SPSS® data file, reversed scored baseline and follow-up items were recoded into new variables.

Statistical Analysis

The 18-item message processing questionnaire was a self-administered, pencil-paper survey with a 5-point Likert scale response schema. Questionnaire items were designed specifically for the original study and were developed from advisory group

responses, primary investigator experience, and current message processing literature. No previous reliability estimates were available. The questionnaire measures consumer perceived time expenditure (two items), ICT comfort level (two items), engagement (one item), relevancy (six items), and self-reported cognitive processing (seven items). Four of the 18-items were reverse-scored. Using Cronbach Alpha Reliability Analysis to assess internal construct consistency, reliability of the questionnaire was found to be .878.

Descriptive statistics were used to assess demographic characteristics and smoking history for this study (Appendices I and J, respectively). A sum function was utilized to measure the degree of Q4L message processing. Five ACRs were measured at follow-up. Please refer to the ACRs Description Table (Table 2) for specific ACRs, descriptions, and measurement methods.

Table 2. ACRs Description Table

ACRs	Description	Self Reported	Clinic Verified
Smoking Abstinence	Remained smoke free for the seven consecutive days (or more days) prior to follow-up interview.	X	
Quit Attempt	Went at least 24 hours without a cigarette during the 3 months prior to follow-up.	X	
Talked to Provider	Spoke to their provider about quitting smoking during the 3 months prior to follow-up.	X	
NRT Use	Used NRT at least once during the 3 months prior to follow-up.	X	X
Cessation Counseling	Enrolled cessation counseling at the healthcare facility during the 3 months prior to follow-up.		X

Correlation techniques were used to examine relationships between degree of message processing and ACRs, cognitive changes, and demographic characteristics. Paired t-tests were used to explore differences in knowledge, social norms, and self-efficacy pre- and post-program use.

Expected Results

Anticipated outcomes of this research are positive correlations between degree of message processing and engagement in ACRs. Higher processing scores are expected to positively correlate with increases in the number self-reported ACRs. Other outcomes include higher domain knowledge, positive social norms, and increased cessation self-efficacy scores.

Results

Sample Demographics

Demographic information for the sample was collected at the baseline. Both genders were almost evenly represented with 56.7% female (n=17) and 43.3% male (n=13). Two subjects (6.7%) were lost to follow-up. In both cases, the reason for attrition was because research assistants were unable to reach subjects for follow-up after multiple attempts. The majority of the subjects (93.3%) were Caucasian (n=28), with 6.7% (n=2) identifying themselves as "Other". The mean age of subjects was 43.45 years old (ranging from 24-66, SD=10.927). Employment status of the sample was found to be 43.4% (n=13) full-time, 13.3% (n=4), and 40.0% (n=12) reported to not work for pay. One subject (3.3%) refused to provide employment status. The majority, 80% of subjects (n=24), reported to have at least completed high school or received a general educational development (GED). Of those subjects reporting an education level of at least high

school completion or GED, 58% (n=14) reported having at least some college or vocational training. Demographic observations are summarized in the Population Description Table (Table3).

Table 3. Population Description Table

	n	%	Mean	Range	SD
Gender					
Female	17	56.7			
Male	13	43.3			
Race					
Caucasian	28	93.3			
Other	2	6.7			
Age (at time of baseline in years)			43.45	24-66	10.927
Employment					
Full-time	13	43.4			
Part-time	4	13.3			
Do not work for pay	12	40.0			
Refused	1	3.3			
Education					
< high school diploma or GED	6	20			
=>high school diploma or GED	24	80			
=>some college or vocational training	14[a]	58[a]			

Note. [a]*Findings are a subset of =>high school diploma or GED.*

Smoking History

Subjects reported a mean smoking initiation age of 16.77 years old (range 9-36 years old, SD=5.250) and average of 25.77 years of smoking (range of 8-50 years, SD=9.975). Further, 73.3% of subjects (n=22) were regular smokers by the age of 18. The average number of cigarettes smoked on a daily basis was slightly more than a pack at 23.70 cigarettes (SD=9.154) and ranged from 10-60 cigarettes per day. Smoking histories for the sample are summarized in the Smoking History Table (Table 4).

Table 4. Smoking History Table

	n	%	Mean	Range	SD
Initiation age (in years)			16.77	9-36	5.250
Number of years smoked			25.77	8-50	9.975
Regular smoker by age 18	22	73.3			
Number of cigarettes smoked per day			23.70	10-60	9.154

Message Processing

Degree of consumer processing of Q4L messages was high (mean processing score=80.5, SD=6.837) with scores ranging from 71-90 (possible range 18-90). A highly significant positive correlation exists between message processing score and the total number of measured ACRs (r=.505, p=.004). There was a significant correlation observed between degree of message processing and making a quit attempt (r_{bis}=.384, p=.044). No correlations between degree of message processing and the other discrete ACRs, cognitive changes, and demographic characteristics were found.

Actionable Cessation Responses (ACRs)

Using NRT (n=28, 93.3%) was the most frequently reported discrete ACR. Subject enrollment in cessation counseling at the healthcare facility was high (n=24, 80%). Descriptive statistics found 73.3% of subjects (n=22) spoke to their providers about quitting smoking. The majority, 76.7% of subjects (n=23), did make a quit attempt. This is significant when compared to only 40% of subjects (n=12) reporting a quit attempt within the 12 months prior to the study enrollment. At follow-up, 3 subjects (10%) self-reported to have quit smoking. There were no correlations between discrete ACRs. These findings are summarized in the ACR Outcome Table (Table 5).

Table 5. ACR Outcome Table

ACR	n	%
Using NRT	28	93.3
Enrolled in cessation counseling	24	80
Spoke to physician about quitting smoking	22	73.3
Making an attempt to quit smoking	23	76.7
Quit smoking	3	10
Multiple actionable responses		
=>2 actionable responses	29	96.7
=>3 actionable response	22	73.4

Of the five measured ACRs, 96.7% of subjects (n=29) reported 2 or more and 73.4% of subjects (n=22) reported 3 or more ACRs. These results are included in the ACR Outcome Table (Table 5).

A correlation between gender and receiving cessation counseling revealed that women were more likely than men to get counseling to stop smoking (p=.027). No other correlations were observed between ACRs and demographic characteristics.

Cognitive Change Outcome

As expected, mean knowledge scores improved over the baseline after Q4L use (t=3.123, p=.004). Follow-up knowledge score was positively correlated with talking to a provider about quitting smoking (r=.521, p=.004) and the total number of measured ACRs (r=.430, p=.022). Subject self-efficacy mean scores improved dramatically over the baseline after Q4L use (t=3.953, p=.001). A highly significant correlation was found between follow-up self-efficacy score and using NRT (r_{bis}=.575, p=.001). No measurable change was observed for social norms.

Conclusion

Overview of Significant Findings

Q4L does not replace the need for provider cessation consultation. It was designed to be an adjunctive to clinical care in an effort stimulate message processing of cessation content and help rural community residents make informed decisions about quitting smoking. While the program aided knowledge construction, Q4L usage did not guarantee translation into measurable ACRs. This finding is supported by the increase in domain knowledge and low number of subjects reporting smoking abstinence.

Consideration of Findings in Context of Current Knowledge

Although limited in nature, the current research demonstrates the potential of ICT message processing and increasing consideration of ACRs in low-income rural Indiana populations. It is likely that using Q4L in this setting increased consumer perception of the program as a credible source and encouraged thoughtful processing of messages because the healthcare facility promotes and accepts cessation attitudes. Q4L appears to be effective in promoting processing of cessation messages and encouraging ACRs, especially those easily executable in the setting. This finding is supported by Street and Manning's (1997) assertion that interventions empowering the consumer to take action increase the likelihood of positive outcomes. For example, consumers used Q4L during a visit to the healthcare facility. During their visit, consumers had the opportunity to talk with their provider, schedule an appointment for cessation counseling, and had access to free NRT.

Theoretical Implications of the Findings

The goal of an ICT product is to present relevant content to the consumer,

stimulating active message processing and knowledge construction, and promoting informed decision-making. As adjuncts to care, ICT offers options of provider recommended use during the visit or facility-wide incorporation into clinic flow. ICT holds potential for delivering messages for other health behavioral changes such as obesity, diabetes management, and prenatal care.

Discussion

Limitations of the Study

It is acknowledged that several limitations exist in the current research design. Although some outcomes are statistically significant, the small sample size, lack of a control group, and no data on the message processing of the standard care brochure preclude the ability to generalize beyond this research setting. This research was also limited by the relative immediacy in which consumers completed the Message Processing Questionnaire after completing the Q4L program.

Of significant note is the limitation of a one-time intervention and its effectiveness for smoking cessation. Further, by virtue of being a secondary analysis, the researcher had no control over how data was collected. For example, with the exception of enrolled in cessation counseling and NRT usage, all collected data was self-reported and were not independently validated by a provider or clinic record.

Limitations of Q4L program

Due to budgetary and time constraints, consumer pathway selection was not captured or saved. The current program design prevents further research of selection patterns, data on message delivery, and message repetition requests. Having this data would provide information on improving ICT programs.

Q4L does not allow consumers to customize the program to individual preferences to learning styles. Enabling consumers the flexibility to dynamically change their feature's attributes helps to promote processing by facilitating different learning styles (Walker, Lee, Skov, Berger, & Athley, 2002). True consumer-centric design is taken from the consumer's perspective, not a technical one (Sjöberg & Timpka, 1998).

The current program design does not provide consumers with the overall structure of the ICT (Walker et al., 2002). Thus, Q4L is not readily available for use by repeat consumers. For example, Q4L does not allow consumers to skip the introduction and go to a specific module if they have previously used the program.

Recommendations for Further Research

Three recommendations to improve the original study design are: capturing message processing data for the brochure, increasing the number of possible ACRs, and increasing the amount of time between Q4L program use and completion of the processing questionnaire. Collection of message processing data for the brochure would allow researchers to develop an understanding of what media are best suited for promoting and enhancing message processing. One way to assess consumer processing ICT messages is to examine which actionable responses presented in messages were acted upon. The current study design collected data on five discrete ACRs. Future studies could increase the number of measured ACRs to equal the number of ACRs presented in the Q4L program. Researchers could then begin to make inferences as to the degree of message processing and how consumers use what they have learned to make decisions regarding smoking cessation.

The immediacy in which consumers used the Q4L program and completed the processing questionnaire precludes any degree of message processing analysis at follow-up. Modifying the original study's design to collect ICT message processing data at follow-up would allow researchers to assess message retention. Further, it would be interesting to examine the degree of message processing and the number of reported ACRs if the immediacy of questionnaire completion were negated.

Specific enhancements to the beta version Q4L are recording consumer pathway selection and enabling more consumer control over features. Collecting data on consumer pathway selection, order of selection, and actual message delivery is crucial to developing a better understanding of ICT message processing.

Consumer-centric program enhancements that would offer control over features include enabling on-screen text size scalability, providing a mute button when audio-complemented text messages are delivered, and offering a menu to facilitate repeat consumer usage. Providing consumers with the flexibility to dynamically change their feature's attributes helps to promote processing by facilitating different learning styles (Walker et al., 2002). Text scalability allows consumers to customize the text to their individual readability comfort levels. This feature is particularly helpful when the population is vision impaired or if the developer did not adhere to industry serif recommendations.

There is some debate over whether audio customization should be offered. Some experts contend that if consumers can turn off audio features, it will lessen message engagement because sensor stimulus is decreased (Street & Rimal, 1997). However, providing a mute button when an audio-complemented text message is delivered does not

change the content. Instead, it gives consumers control over features and is more practical than forcing repeated use of a peripheral volume dial.

The Q4L program would benefit from a menu feature. Menus promote repeat usage by offering consumers the ability to skip modules that they have already completed or move directly to module that they wish to view. If Q4L were incorporated into a clinic setting, this functionality would facilitate staff preparation of the program for the consumer.

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Figure Caption

Figure 1. Model of the Human Factors Applied to Message Processing.

Appendix A

Message Processing Questionnaire

Please mark only one answer per question.

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	I could understand the messages I heard in the program.	☐	☐	☐	☐	☐
2.	The computer program took too much time.	☐	☐	☐	☐	☐
3.	Using the computer made me nervous.	☐	☐	☐	☐	☐
4.	I enjoyed using the computer.	☐	☐	☐	☐	☐
5.	The information I received was important to me.	☐	☐	☐	☐	☐
6.	I was very interested in the information from the computer program.	☐	☐	☐	☐	☐
7.	The computer program made me think about quitting smoking.	☐	☐	☐	☐	☐
8.	The messages in the computer program made sense to me.	☐	☐	☐	☐	☐
9.	The information in the computer program doesn’t relate to me.	☐	☐	☐	☐	☐
10.	The information in the computer program was interesting.	☐	☐	☐	☐	☐
11.	I have thought about the messages in the computer program	☐	☐	☐	☐	☐
12.	Time passed quickly when I completed the computer program.	☐	☐	☐	☐	☐

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
13. I listened carefully to the messages in the computer program.	☐	☐	☐	☐	☐
14. The information in the computer program was easy to understand.	☐	☐	☐	☐	☐
15. I can use the information from the computer program in my daily life.	☐	☐	☐	☐	☐
16. The computer program seemed like it was meant just for me.	☐	☐	☐	☐	☐
17. I would like to learn more about how to quit smoking.	☐	☐	☐	☐	☐
18. I don't really need the information in the computer program.	☐	☐	☐	☐	☐

Appendix B

Knowledge

We would like to know what your opinion is for the following statements about tobacco and smoking. Please tell us if you agree or disagree with the following statements.

		Agree	Disagree	Don't Know (Not Sure)
1.	Smoking is a cause of lung cancer.	A	D	DK
2.	Smoking is a cause of Tuberculosis (TB).	A	D	DK
3.	Tobacco is a cause of heart disease.	A	D	DK
4.	Tobacco is a cause of liver disease.	A	D	DK
5.	Being near someone while they smoke may cause heart disease.	A	D	DK
6.	Being near someone while they smoke may cause liver disease.	A	D	DK
7.	Being near someone while they smoke may cause lung cancer.	A	D	DK
8.	Using tobacco is addicting/habit forming.	A	D	DK
9.	If a person already has health problems caused by smoking, quitting smoking will not help.	A	D	DK
10.	Using nicotine patches or gum could cause cancer or a heart attack.	A	D	DK

Appendix C

Social Norms

Please circle the letter to answer each of the following questions using the scales provided for each group of questions.

Do you think advertising of tobacco products should be allowed in:

	Always allowed	Always under some conditions	Not allowed at all
Restaurants	1	2	3
Hospitals	1	2	3
Bar and cocktail lounges	1	2	3
Indoor sporting events	1	2	3
Indoor shopping malls	1	2	3
Indoor work areas	1	2	3

Appendix D

Self-Efficacy

We would like to know HOW TEMPTED you may be to smoke in each situation on questions 1-9.

Please circle the answer using the following five responses. For Question 10, please use the responses given right before the question.

		Not at all tempted	Not very tempted	Moderately tempted	Very tempted	Extremely tempted
1.	With friends at a party.	1	2	3	4	5
2.	When I first get up in the morning.	1	2	3	4	5
3.	When I am very anxious and stressed.	1	2	3	4	5
4.	Over coffee while talking and relaxing.	1	2	3	4	5
5.	When I feel I need a lift.	1	2	3	4	5
6.	When I am very angry about something or someone.	1	2	3	4	5
7.	With my spouse or close friend who is smoking.	1	2	3	4	5
8.	When I realize I haven't smoked in a while.	1	2	3	4	5
9.	When things are not going my way and I am frustrated.	1	2	3	4	5
		Not at all	A little	Some	A lot	Very much
10.	If you decided to quit smoking, how confident or sure of yourself are you that you could stay off cigarettes?*	1	2	3	4	5

*For statements 1-9: Velicer, W.F., DiClemente, C.C., Rossi, J.S., & Prochaska, J.O. (1990). Relapse situations and self-efficacy: An integrative model. Addictive Behaviors, 15, 271-283.

Appendix E

3-Month Follow-Up Interview Outcomes

Please rate your agreement or disagreement with the following statements.

1. In the past 7 days, have you smoked a cigarette, *even a puff*?
   - ☐ Yes (go to #3)
   - ☐ No (go to #2)

2. How long has it been since you smoked a cigarette?
   Days _____ Weeks _____ Months _____

3. In the past 3 months, have you quit smoking cigarettes for at least 24 hours?
   - ☐ Yes
   - ☐ No

4. In the past 3 months, have you discussed quitting smoking with your doctor or healthcare provider?
   - ☐ Yes
   - ☐ No

5. In the past 3 months, did you use any nicotine replacement therapy (patch/gum)?
   - ☐ Yes (if yes, go to #6)
   - ☐ No (end of survey)

6. Are you currently using any nicotine replacement therapy (patch/gum)?
   - ☐ Yes
   - ☐ No

7. Did you use the patch?
   - ☐ Yes - how long did you use the patch? _____
   - ☐ No

8. Did you use the gum?
   - ☐ Yes - how long did you use the gum? _____
   - ☐ No

Appendix F

Q4L Prompted Questions

Demographic Information and Smoking History

1. How old are you?
   (18-39, 40-49, over 50)

2. Are you a man or woman?
   (Man, Woman)

3. Do you live with other people who smoke?
   (Yes, No)

4. Of the people you are around every day, about how many smoke cigarettes?
   (None, A Few, About Half, Most, All)

5. How many of your friends or relatives who are smokers have ever tried to quit?
   (None, A Few, About Half, Most, All)

6. Of the people you know who have tried to quit smoking, how many have quit smoking for good? (None, A Few, About Half, Most, All)

7. How many cigarettes do you smoke on a typical day?
   (1/2 pack or less, between ½ pack to 1 pack, between 1 to 1-1/2 packs, between 1-1/2 packs to 2 packs, more than 2 packs)

8. How soon after you wake up do you smoke your first cigarette?
   (As soon as I wake up – within 5minutes, After 5 minutes but within the first half hour, Within the first half hour to hour, More than one hour)

9. Have you ever gone without cigarettes for more than 24 hours because you were trying to quit? (Yes, No)

10. Do you live in the same house with children under the age of 18?
    (Yes, No)

Reasons for Smoking

Responses to these statements are: Always, Frequently, Occasionally, Seldom, or Never

1. Smoking cigarettes is pleasant and relaxing.

2. When I feel angry or upset about something, I light up a cigarette.

3. I am very aware of the fact when I am not smoking a cigarette.
4. I smoke cigarettes as a substitute for food.
5. I want a cigarette when I am comfortable and relaxed.
6. When I feel blue or want to take my mind off cares and worries, I smoke cigarettes.
7. I get a real gnawing hunger for a cigarette when I haven't smoked for a while.
8. I smoke cigarettes to prevent myself from overeating.

Nicotine Dependence

Responses to these statements are: Strongly Agree, Agree, Disagree, or Strongly Agree.

1. Quitting smoking is all about will power.
2. If a person wants to quit smoking bad enough, he/she just has to make his/her mind up to do it.
3. Using nicotine patches or gum doesn't really help the problem, you are just substituting one addiction for another.
4. Using nicotine patches or gum could cause cancer or a heart attack.

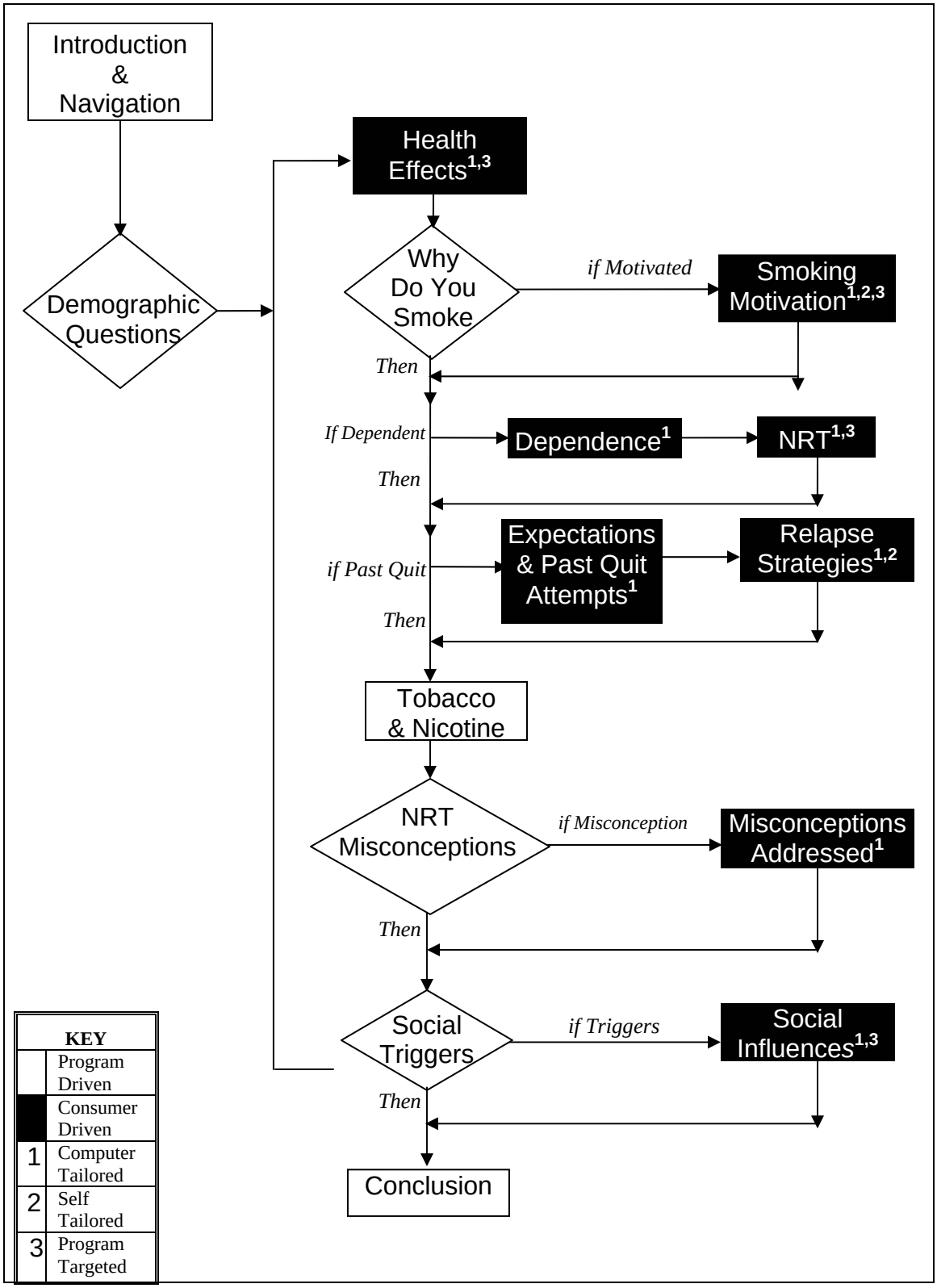
Social Impact of Smoking

Responses to these statements are: Not Hard, A Little Hard, Somewhat Hard, or Very Hard.

1. When I'm out with friends.
2. When people I work with take a "smoke break".
3. With a close friend or relative who is smoking.

Appendix G

Model of Message Flow in the *Quit for Life* Program



Appendix H

Description of Study Instruments

Instrument	Appendix	Description	Schema
Message Processing Questionnaire	A	Completed only by intervention subjects. Measures ICT message processing.	5-point Likert scale
Knowledge	B	Assesses knowledge of smoking health effects and beliefs.	True/False
Social Norms	C	Describes perceived social norms.	3-point Likert scale
Self-Efficacy	D	Assesses belief in oneself to handle relapse situations. Velicer, DiClemente, Rossi, & Prochaska (1990)	5-point Likert scale
3-month Follow-up Interview	E	Describes smoking status and actionable cessation responses (ACR) at the 3-month follow-up interview.	Yes/No
Demographic Information	I	Describes population identity.	Closed question
Smoking History	J	Describes smoking experiences.	Closed question

Appendix I

Demographic Information

The following questions will help us compare information among men and women of similar characteristics, such as age and education. No one will be identified individually

1. How many people are in your household? _____

2. Please choose the income category that matches your total household income for the last year. This information is used for statistical purposes only.
    1. Less than $15,000
    2. At least $15,000 but less than $25,000
    3. At least $25,000 but less than $35,000
    4. At least $35,000 but less than $50,000
    5. $50,000 or more
    6. Don't know

3. Do you work for pay?
    1. Yes, full time
    2. Yes, part time
    3. No

4. What is your current marital status?
    1. Single
    2. Married
    3. Not married, but living together
    4. Separated
    5. Divorced
    6. Widowed
    7. Other: _____

5. What is the highest grade of formal education that you have completed?
    1. None
    2. Elementary school (1-8 years)
    3. Some high school (9-11 years)
    4. High school graduate (12 years)
    5. GED
    6. Some college
    7. College graduate
    8. Some graduate school
    9. Graduate or professional degree
    10. Other: _____

6. What is your race?
    1. Caucasian
    2. African American
    3. Asian / Pacific Islander
    4. American Indian / Alaskan native
    5. Eskimo and Aleut
    6. Other: _____

7. Are you of Hispanic origin?
    1. Yes
    2. No

8. In what year were you born? _____

9. Are you:
    1. Female
    2. Male

Appendix J

Smoking History

This section of questions asks about your smoking history. Don't worry if you're not sure about an answer. . .we're simply interested in finding out what you think. Place a check in the box next to your answer.

1. How many years have you smoked? _____ years

2. How old were you when you first started smoking on a daily basis? _____ years

3. **In the past six months,** how many cigarettes did you smoke on a typical day? ____

4. Do you live with other people who smoke? ☐ Yes ☐ No

5. Among other people you come in contact with on a *daily* basis, how many smoke cigarettes? ☐ None ☐ Few ☐ About half ☐ Most ☐ All

6. Have you ever quit smoking for at least 24 hours? ☐ Yes ☐ No

If you answer "No" to Question #6, please skip to Question #10

7. What is the longest amount of time you have ever gone without smoking?

_____ ☐ Days
☐ Weeks
☐ Months
☐ Years

8. When was the most recent time that you went without smoking for more than 24 hours (not counting being in the hospital)?

_____

9. **In the past 12 months**, how many times have you quit smoking for at least 24 hours?

_____

10. Has your doctor ever told you that you should quit smoking? ☐ Yes ☐ No

11. If you tried to quit smoking, how much support or help with quitting would you expect from your friends and family?

☐ None ☐ A little ☐ Some ☐ A lot ☐ Very Much