Neural Responses to Elements of a Web-Based Smoking Cessation Program

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Abstract. An increasing number of smokers are obtaining information from the web to help them quit smoking. In this study, we examined how smokers process different types of messages similar to those from a web-based smoking cessation program: personalization/feedback (“Jane, you are a 23-year old female smoker”), motivational (“If you quit smoking, you could save $1200 a year”), and instructional (“When you feel angry, talk to someone instead of smoking”) messages. Using functional magnetic resonance imaging, smokers were exposed to the messages. On a later session, participants completed an online tailored smoking cessation program and started on a 10-week course of nicotine patch. Results show that participants indeed process the messages differently, activating brain regions associated with self-related processing (personalization/feedback), anticipated reward processing (motivational messages) and rules processing (instructional messages). This research is relevant for advancing web-based tailored interventions for substance use.

Keywords. Addiction, substance abuse, smoking, internet, neuroimaging.

Introduction

The Center for the Digital Future mentioned that the proportion of adults in the United States with Internet access now exceeds 78%. About 79% of American adults with Internet access (roughly 95 million) reported using the Web to obtain health information [1]. In this same survey, 7% of Internet users, or roughly 10 million individuals, reported using the Internet to help them quit smoking.

The Internet is currently the most prominent but only one of many emerging communications technologies enabling: (1) an assessment of characteristics relevant to the specific needs of the individual and (2) the tailoring of messages to the specific needs and interests of the individual. Web-based tailored interventions are more cost effective than traditional media for intervention. It reaches a greater number of people for a fraction of a cost. Web-based tailored interventions for smoking cessation have been developed extensively in the cigarette smoking area. Several tailored intervention systems are now available in general public domains (e.g., quitnet.com), some are provided by health care delivery systems (e.g., www.kponline.com), and pharmaceutical companies that make smoking cessation products (e.g., activestop.com).

In the past decade, tailored smoking cessation programs have demonstrated an overall positive impact when compared with generic, one-size-fits-all interventions [2-5]. In the present study, we examined how smokers process different types of messages from a web-based smoking cessation program: personalization/feedback messages
Jane, you are a 23-year-old female smoker), motivational messages (“If you quit smoking, you could save $1200 a year”), and instructional messages (“When you feel angry, talk to someone instead of smoking”). Personalization/feedback messages pertain to the relevance of the message to the self and motivation and instructional messages pertain to the adaptation of the message to the specific behavior change needs and interests [6].

1. Methods

1.1. Participants

Thirty-one male and 10 female right-handed smokers with mean age of 38.34 (SD ± 11.52) participated. Eligibility criteria included having smoked a cigarette within the last 7 days, having smoked a minimum of 10 cigarettes on average per day and at least 100 cigarettes in a lifetime, and interest in quitting within next 30 days from study enrollment. Participants were not enrolled in other cessation programs or taking pharmacological treatment for smoking cessation. Participants smoked on average 16.10 (SD = 5.94) cigarettes a day for an average of 20.06 (SD = 11.45) years. Ninety percent of the participants had previously attempted to quit. Participants were motivated to quit (M = 8.84 [SD = 1.15] on a 10-point scale). They were also confident about quitting (M = 8.32 [SD = 1.60] on a 10-point scale). Participants had no current or prior history of head injury and psychiatric illness. They were between 21-55 years old, native English speakers, and had normal hearing and good visual acuity. Participants had no medical conditions that would inhibit their use of nicotine patch.

1.2. Procedure

Participants completed an MRI safety screening form and gave written consent. They also completed a standard baseline assessment about their smoking history, psychosocial, health, and demographic characteristics relevant to smoking cessation. Responses were used to create the tailored messages. Scanning took place during a later session. Using functional magnetic resonance imaging (fMRI), smokers were exposed to different types of smoking cessation messages, similar to those from our web-based smoking intervention program (www.projectquit.org). The messages were personalization/feedback, motivational, and instructional messages, plus two control condition messages: targeted (“The average smoker smokes 15 cigarettes a day”) and neutral messages (“The true color of ocean water is neither blue nor white”). On a different day, smokers agreed to quit. They completed our tailored online smoking cessation program during their quit day and started on a 10-week course of nicotine patches. Participants were followed for four months after the quit date to determine abstinence rates.

2. Results

Prior work suggests that self-relevance of the messages appear to have a moderating effect of tailoring on quitting activity [7]. Indeed our previous neuroimaging study
showed that smokers process high-tailed messages differently from low-tailed messages, specifically it activates the areas of the brain associated with self-related processing [8]. The present work shows that exposure to personalization/feedback messages, relative to neutral messages, replicated the activations in the medial prefrontal cortex, [(−3, −60, 36), Z = inf, k = 1542], and precuneus/posterior cingulate, [(0, 45, 30), Z = 7.08, k = 3379], areas associated with self-related processing. See Figure 1.

We anticipate that motivational messages would elicit greater activation in areas associated with anticipated reward, including the ventromedial prefrontal cortex [9]. Figure 2 shows that when compared against neutral messages, exposure to high-tailed motivational messages indeed activated areas associated with anticipated reward, ventromedial prefrontal cortex, [(−3, 48, 3), Z = 5.72, k = 1025].

We anticipate that instructional messages would elicit greater activation in areas previously associated with rules and goals processing, including the dorsolateral prefrontal cortex [10]. Figure 3 illustrates that exposure to high-tailed instructional messages compared to neutral messages did activate areas associated with processing rules and instructions, dorsolateral prefrontal cortex, [(−48, 3, 54), Z = 6.55, k = 2218].

Figure 1. Brain responses to personalization/feedback messages showed increased activity in medial prefrontal cortex [mPFC] and precuneus/posterior cingulate [PC]. Activated voxels are displayed with \( p < .0001 \) uncorrected, cluster extent \( \geq 5 \).

Figure 2. Brain responses to motivational messages showed greater activity in ventromedial prefrontal cortex [vmPFC]. Activated voxels are displayed with \( p < .0001 \) uncorrected, cluster extent \( \geq 5 \).
3. Novelty/Discussion

The present study shows that people respond differently to different elements of a web-based smoking intervention program. In sum, the message types we provided the participants appear to show good validity—personalization/feedback messages activate areas of the brain associated with self-related processing. Motivation messages activate areas of the brain associated with anticipated reward, and instructional messages activate areas of the brain associated with instructions and rules processing. This is the first project that attempted to systematically examine how people respond to the different tailored intervention messages using fMRI. In the present study, we will also examine the follow-up responses to test if responders (successful quitters) process the message types differently from non-responders.

This research is relevant to a new generation of web-based tailored interventions for tobacco and other substance use in two broad ways. First, by identifying specific brain regions influenced by different tailored message types, the results should provide insight into cognitive responses to the messages. Second, by examining the relationship between brain activation patterns and subsequent smoking cessation activities, we take an important exploratory step toward identifying biomarkers of message efficacy.

References

