

SOCIAL INTERACTIONS ABOUT PICTORIAL CIGARETTE PACK WARNINGS

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ABSTRACT

Jennifer C. Morgan: Social Interactions about Pictorial Cigarette Pack Warnings
(Under the direction of Noel T. Brewer)

Introduction. Social interactions are a key mechanism through which health communication efforts, including pictorial cigarette pack warnings, may exert their effects. We sought to better understand social interactions elicited by pictorial cigarette pack warnings.

Methods. US adult smokers ($n=2,149$) participated in a controlled trial that randomly assigned them to have their cigarette packs labeled with pictorial or text-only warnings for four weeks. Surveys assessed the number of conversations, theoretical mechanisms, and conversational content during the baseline visit and each of the subsequent four weekly visits.

Results. Smokers with pictorial warnings had more conversations throughout the trial compared to those with text-only warnings (8.2 conversations vs. 5.0, $p<.01$). Smokers with pictorial warnings were more likely than those with text-only warnings to discuss the health effects of smoking and whether the warnings would make them want to quit (both $p<.05$).

The number of conversations about the warnings mediated the relationship between exposure to pictorial warnings and quit attempts ($p<.001$). In serial mediation analysis examining possible theoretical mechanisms, the number of conversations increased cognitive elaboration, which in turn increased quit attempts ($p<.001$). Conversations during the first week were more common among smokers who were younger, white, low-income, had greater perceived message effectiveness, and had stronger negative emotional reactions to the warnings (all $p <.05$). Conversations declined during the second week, but these declines

were more gradual for minority and older smokers, leading to more conversations throughout the study.

Conclusions. Pictorial warnings sparked more conversations about the warnings, the health effects of smoking, and quitting smoking than text-only warnings. These social interactions may extend the reach of pictorial warnings beyond the targeted smoker. These results indicate that cognitive elaboration is a possible theoretical mechanism that explains why conversations about pictorial warnings influence quit attempts. Conversations about cigarette pack warnings decreased over time. Greater perceived message effectiveness of the warnings and stronger negative emotional reactions to the warnings were associated with more conversations during the first week of smoking from packs with pictorial warnings. These results support designing warnings to increase conversations about the warnings.

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CHAPTER 1: OVERVIEW AND SPECIFIC AIMS

Social interactions are a key mechanism through which health communication campaigns influence behavior.¹⁻⁵ Of course, these campaigns may directly reach the members of the public, but it is the social sharing of this information that may be critical to a campaign's success. An important observation comes from, for example, the Katz and Lazarsfeld² two-step flow model that proposes that mass media campaigns can spread information through media channels to opinion leaders who pass it along through their social networks. The key insight with respect to my dissertation is that social interactions help disseminate or amplify campaign messages. Pairing this insight with several models of health behavior leads to three insights: social interactions may serve as a mediator of quit attempts by increasing cognitive elaboration about the warnings, exposure to subjective norms, and recall.^{1,4-6} In addition, the number of social interactions a person has about the warnings may follow different trajectories over time based on population characteristics.⁵

One context in which social interactions may be important, yet are understudied, is pictorial cigarette pack warnings. The Message Impact Framework⁷ proposes that social interactions prompted by messages can facilitate change in smoking attitudes and beliefs. Cigarette packs are an effective communication medium for tobacco companies,^{8,9} and they can be effective tools to communicate about the health risks of smoking too.¹⁰ Compared to text warnings, pictorial warnings elicit more concern about the harms of smoking and more negative attitudes towards smoking.^{10,11} Furthermore, pictorial warnings elicit greater quit intentions,¹¹

one of the strongest predictors of smoking cessation.^{12,13} Understanding the role these warnings play in cessation and the processes by which they exert their influence can help policy makers identify the most effective warnings as they implement the warnings mandated by the Family Smoking Prevention and Tobacco Control Act.¹⁴

Because smoking is often a social behavior, heavily influenced by peer and social networks, social interactions may be particularly important in the context of anti-smoking communication campaigns.^{15,16} Studies of anti-smoking campaigns have found associations between campaign-related interpersonal communication and both smoking behavior and its predictors.¹⁷⁻²² The few studies that have examined the role of social interactions about pictorial warnings have examined only the frequency, rather than the content, of these interactions.^{23,24} However, researchers are just beginning to study social interactions in the context of pictorial warnings.

In this dissertation, I will use data from an FDA/NCI-funded randomized controlled trial (P30CA016086-38S2) that assigned adult smokers ($n=2,150$) to receive a pictorial warning or a text warning on their cigarette packs for four weeks. I will characterize the frequency of social interactions about pictorial warnings, the people with whom the warnings were discussed, and the content of those discussions. I will explore whether the nature of the conversation about the warnings mediates a relationship between exposure to the warning and quit attempts, what the trajectory of the number of social interactions about pictorial warnings is over time, and if individual variability in the shape of the trajectory is influenced by certain demographic or psychological characteristics. Thus, the specific aims of this dissertation are to:

Aim 1. Characterize social interactions about pictorial cigarette pack warnings.

Aim 2. Establish whether social interactions about the warnings mediate their effect on quit attempts.

Aim 3. Identify trajectories of social interactions and characteristics associated with the trajectories.

The proposed research will provide communication researchers with a deeper understanding of the role of social interactions in the relationship between pictorial cigarette pack warnings and quit attempts. These findings could help policymakers design warnings that stimulate greater or specific types of social interactions with potential to improve public health by increasing quit attempts, and could contribute to the refinement of health behavior and communication theory.

CHAPTER 2: LITERATURE REVIEW

Communication campaigns may influence behavior by increasing social interactions related to the message.¹⁻⁵ Because of the social nature of smoking, social interactions may be particularly important for tobacco control efforts and campaigns.^{15,16,23,24}

Social interactions

Communication scholars have used various names for social interactions, including the term interpersonal communication.^{25,26} For this dissertation, I will use the term social interactions, which I define as an exchange between two or more people that is sparked by a health message.

Diffusion. In the 1930's the "magic bullet" or "hypodermic needle theory" was one way that people thought messages in the media reached their intended audience. Though not empirically based, this school of thought proposed that the media's message was a bullet fired from the "media gun" into the viewer's "head."²⁷ It suggested that the media injected its messages straight into the passive audience.²⁸

In 1955, Katz and Lazarsfeld identified social interactions about mass media campaigns as a potential influence on the effectiveness of those campaigns. Specifically, they proposed that social interactions mediate the relationship between the media's broadcasting of information and an individual's engagement and action upon that information. Their two-step flow model posits that messages flow from media sources to opinion leaders in the community, who pick up on and disseminate (or "diffuse") this message to the public.² They defined opinion leaders as

individuals with both the most access to media and the best understanding of its content. The two-step flow theory suggests that instead of the media having a generalized and direct influence, opinion leaders diffuse the information they have learned from the media to others via social interactions.²⁹ Empirical studies have shown opinion leaders to be effective at decreasing the rate of unsafe sexual practices³⁰ and decreasing the rate of cesarean births.³¹

Some scholars believe the process of diffusion of information cannot be viewed as a uniform occurrence. They believe that diverse contexts and situations contribute to different patterns in the spread of information, and that individual variables are likely to play a role.³² Among the variety of factors related to diffusion of messages from a media source to an individual, scholars have consistently found that interpersonal contacts within and between communities are important influences on behavior.³³ When it comes to anti-smoking campaigns, evidence suggests that whether people are hearing about campaigns from opinion leaders, or directly from the media sources, people talk about these campaigns to others in their social network.^{18,20,22,34-39}

Cognitive elaboration. Recent scholars have proposed new roles that social interactions may play in changing behavior, in addition to being a source of diffusion. Eveland tested three different hypotheses about the role of social interactions on levels of political knowledge.⁴⁰ The first was exposure, similar to the two-step flow model. The second was through the process of anticipatory elaboration, which suggests that the anticipation or expectation of a discussion about a topic provides internal motivation that then increases cognitive elaboration. That is, individuals who expect a conversation about a certain topic will invest more heavily in processing the initial information in order to prepare themselves for the conversation. The third was discussion-generated elaboration, which is similar to the previous hypothesis but suggests that the act of

engaging in the discussion is what prompts the meaningful processing of information and the increased knowledge that results is due to the information processed during the discussion.

Eveland found support for both elaboration-based hypotheses.⁴⁰ Thus, his findings suggest that the conversation itself may increase knowledge, but it is also possible that knowledge is increased when people seek out information in anticipation of a conversation. Both processes may increase knowledge or directly influence behavior.⁴

Subjective norms. People's behavior, like smoking, is influenced by a person's subjective norm about performing a behavior according to the theory of reasoned action,^{41,42} and the theory of planned behavior.⁴³ The content of campaigns may instigate conversations that then affect normative beliefs and subjective norms. Evidence suggests that talk about campaigns does have the ability to impact normative beliefs, even in a way unintended by a campaign. David et al. exposed participants to an anti-drug campaign message and randomly assigned some participants to chat with other participants in an online forum.⁴⁴ Those who were assigned to have social interactions reported attitudes and normative beliefs that were more strongly in favor of marijuana use than the participants who only watched the ad. The reasoning behind this was that those more likely to process the ads in a bias fashion were more likely to speak up in the discussions, and as a result, participants in the discussion arm heard more pro-drug viewpoints, which impacted both attitudinal and normative beliefs.

Hornik has proposed that social interactions can cause campaigns to influence the audience in two ways; the first is the two-step flow model, which he calls diffusion, and the second is that the campaign may prompt conversations among family and members of the community through which subjective norms and expectations are discovered, clarified, or changed, which in turn impacts the audience.^{1,45} Supporting this theory, Valente and Saba found

a positive association between media exposure to a contraceptive promotion campaign and a change over time in perceptions that other people in certain social networks use contraception.^{33,46}

Recall. Another mechanism by which social interactions about campaigns may be effecting behavior change is by increasing recall or memory of the campaign. Literature on the connection between conversation and memory⁴⁷⁻⁴⁹ suggests that, in addition to hearing and storing information directly from the media to be retrieved at a later date, conversation about the campaign's message may increase recall. Support for this argument comes, indirectly, from Southwell who found a positive relationship between the frequency that an anti-drug advertisement was on television and remembering the ad.⁴⁹ By extension, conversations may act in a similar way to facilitate message recall. The extent that the prevalence of the ad translated to memory depended on the conversations about drugs that people were having. People who had conversations about drugs tended to be those who later remembered the campaign advertisements.⁴⁹

Tobacco

Worldwide, tobacco use causes nearly 6 million deaths per year.⁵⁰ In the US, cigarette smoking is responsible for 1 in 5 deaths annually.⁵¹ Doll and Peto⁵² state “no single measure is known that would have as great an impact on the number of deaths attributable to cancer as a reduction in the use of tobacco.” Cigarette packs have proven to be an effective communication device for tobacco companies,^{8,9} and research has shown they can be effective tools to communicate about the health risks of smoking too.¹⁰

The WHO Framework Convention on Tobacco Control recommends large pictorial images be placed on cigarette packages because of evidence that compared to text only warnings,

pictorial warnings communicate health risks more effectively.⁵³ Compared to text warnings, pictorial warnings elicit more concern about the harms of smoking and more negative attitudes towards smoking.^{10,11} Furthermore, pictorial warnings lead to greater quit intentions,¹¹ which is one of the strongest predictors of smoking cessation.^{12,13} However, there is little understanding of the mechanisms that cause pictorial warnings to influence quit intentions or attempts. Understanding the role these warnings play in cessation and the processes by which they exert their influence can guide policy makers to create the most effective cigarette pack warnings as they implement the warnings mandated by the Family Smoking Prevention and Tobacco Control Act.¹⁴

Because smoking is a social behavior, heavily influenced by peer and social networks, social interactions may be particularly important in the context of anti-smoking communication campaigns and pictorial warnings on cigarette packs.^{15,16} Smokers are more likely to socialize with other smokers, and smoking influences the behavior of others within a social network.⁵⁴ Furthermore, smoking behavior frequently happens in social settings,^{55,56} offering openings for conversations to take place. Anti-smoking campaign studies have found associations between both smoking behavior and its predictors, and social interactions about the campaign.¹⁷⁻²² Additionally, unlike conventional mass-media anti-smoking campaigns, pictorial warnings are found directly on smokers' cigarette packs in over 70 countries, both increasing regular exposure to the warnings and offering a unique opportunity to trigger social interactions during the act of smoking. Few studies have looked at whether these pictorial warnings trigger conversations, and if so how those interactions might encourage quitting smoking.

The few studies that have examined the role of social interactions about pictorial warnings have examined only the frequency, rather than the content of these interactions.^{23,24}

One study found that talk about warnings in Canada increased immediately following the release of new pack warnings, but gradually decreased over time. In Mexico, where new warnings are released on a rotating schedule every 6 months, talk remained stable over time.²⁴ White and colleagues found that adolescent's talk about warnings increased from baseline, and that established smokers talked about them more than never smokers.²³

Hall and colleagues conducted two pilot studies ($n=30, 48$) and looked at the frequency, content, and nature of the conversations smokers had about warnings.⁵⁷ They found that nearly all smokers talked about the warnings on their packs (97%, and 96%), conversations were initiated by both the smoker in the study (66% in both studies), and prompted by someone not in the study asking the smoker about the warning (50%, and 34%).⁵⁷ They found that there was a statistically significant increase in number of conversations about the health effects of smoking compared to baseline in week 1, but weeks 2-4 were not significantly different from baseline.⁵⁷

Further characterization of social interactions about pictorial cigarette pack warnings with a large longitudinal sample can provide tobacco control policy makers and health communication theorists with a better understanding of how social interactions triggered by warnings may affect smoking behavior.

Social interactions as a mediator

Social interactions may mediate the relationship between exposure to the health communication campaigns and their intended outcomes.^{4,5} Understanding the role of social interactions as a mediator is particularly important for communication campaigns because researchers often classify those not directly exposed to the campaign as non-exposed even though they may have talked about it with others, this could underestimate the effect of the campaign.

Hypothesis 1. Exposure to pictorial cigarette pack warnings increases social interactions.

Hypothesis 2. Social interactions increase quit attempts.

Hypothesis 3. Exposure to pictorial cigarette pack warnings increases social interactions which increases quit attempts.

Valence of the conversation. In addition to knowing *whether* people are talking about the campaign or not, it is also critical to learn and understand *what* is said about the campaigns.^{5,58,59} However, studies often treat conversation as either happening or not, rather than considering how the content of the social interactions may mediate the relationship between exposure and outcome. Conversational content may determine the influence social interactions have on quit attempts.^{4,5} Positive talk about behavior or campaigns has been found to lead to positive effects, and negative talk has been linked to more negative effects.^{44,60,61} Examining the effects of conversations stimulated by a new human papillomavirus vaccine campaign message found participants who reported more favorable conversations, and those who participated in conversations where there was more positive opinion sharing about the advertisement and vaccine, predicted intentions to vaccinate.⁶¹ Figure 2.1 illustrates two hypotheses that follow from this line of thinking.

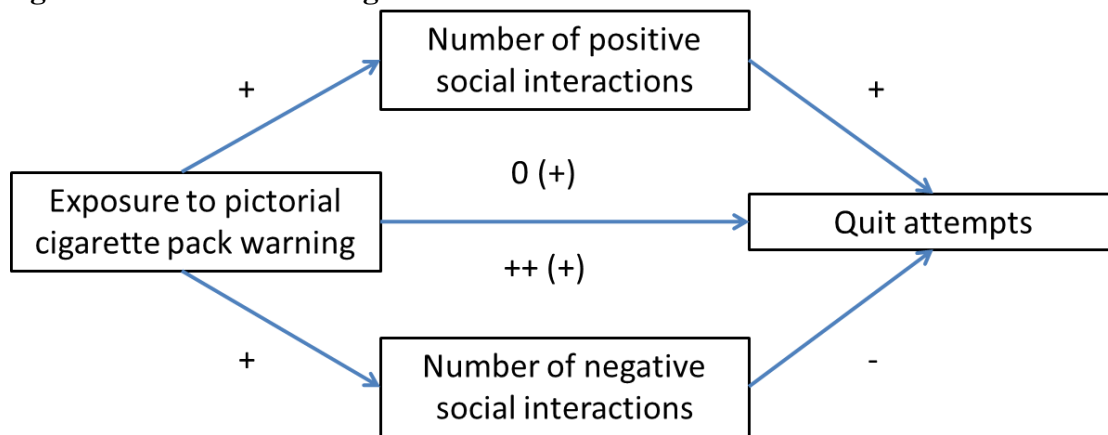
Hypothesis 4. Number of positive social interactions mediates the association between pictorial cigarette pack warnings and quit attempts.

Hypothesis 5. Number of negative social interactions suppresses the association between pictorial cigarette pack warnings and quit attempts.

Because positive talk is more common than negative⁵⁷ when talking about pictorial warnings, it is possible for both hypothesis 3 and 5 to be true. I believe that when both positive and negative social interactions are grouped together, the more common positive social

interactions will cause the overall mediation pathway to be positive as stated in hypothesis 3. If we are unable to satisfactorily create a variable for positive and negative social interactions from the conversational topics and warning descriptor variables, we will explore other ways of categorizing conversation content as a mediator.

Figure 2.1. Positive and negative social interactions as mediators.



Theoretical mechanisms explaining how social interactions effect change. In addition to understanding whether social interactions increase quit attempts, understanding *why* they may be working is critical. As discussed above, three proposed mechanisms may explain how social interactions exert their effects. Social interactions may increase cognitive elaboration about the harms of smoking listed in the pictorial warnings.⁴⁰ Alternately, they may lead to the discovery of subjective norms around quitting in their social group or community.^{1,46} Lastly, talking about the warning may be increase the recall or recognition of the pictorial warning.⁴⁹ These three mechanisms are not mutually exclusive.

Hypothesis 6. Social interactions triggered by cigarette pack warnings increase cognitive elaboration, which in turn increases quit attempts.

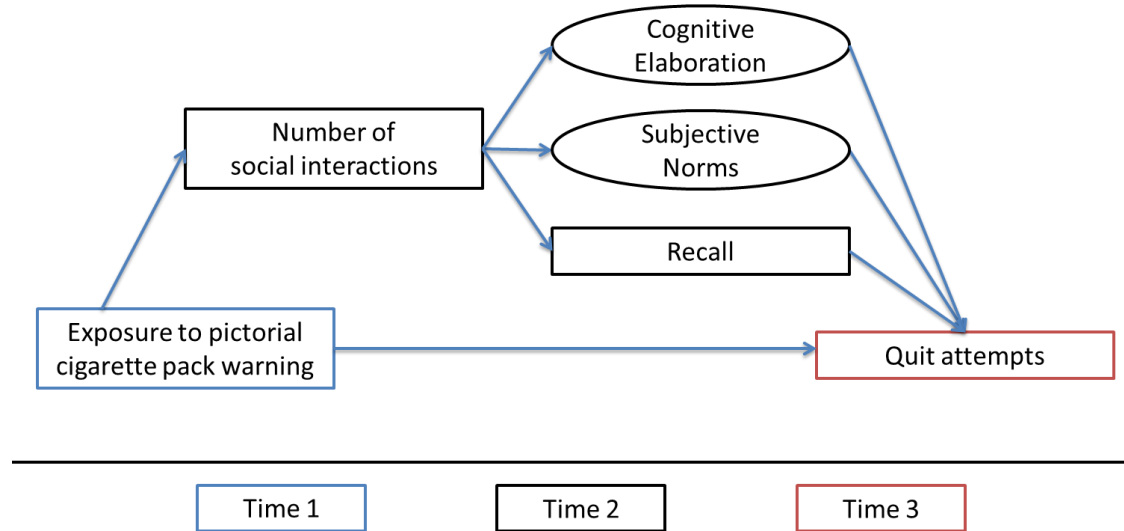
Hypothesis 7 Social interactions triggered by cigarette pack warnings increase subjective norms about quitting, which in turn increases quit attempts.

Hypothesis 8. Social interactions triggered by cigarette pack warnings increase recall of the warning, which in turn increases quit attempts.

I will test these hypotheses with three different models. The empirical literature does not provide very much guidance for how these processes might play out over time, these three models posit three different ways these processes may be occurring. Hall and colleagues found that the most social interactions occurred in the first week of their study.⁵⁷ Therefore, each model uses the exposure to pictorial cigarette pack warnings at time 1, and the measure of the number of social interactions at time 2. These models differ based on the time point at which the mediators are measured, and the time point at which quit attempts were assessed.

The primary model (Figure 2.2) uses the measure for social interactions, cognitive elaboration, subjective norms and recall collected at time 2 as mediators increasing quit attempts at time 3. This model presumes that social interactions will increase cognitive elaboration, subjective norms, and recall within the span of one week (the time between the longitudinal measures), but that it may take another week to see the impact of the mediators on quit attempts. For the figures below, constructs in boxes indicate measured, or manifest variables, and constructs in ovals represent latent variables that will be indicated by multiple survey items (further discussion in Chapter 3).

Figure 2.2. Primary model for testing hypotheses 6-8.



Alternate model 1 (Figure 2.3) uses time 2 measures for each of the mediators and quit attempts. This model presumes that the mediation process occurs within a 1-week time span.

Alternate model 2 (Figure 2.4) uses the time 2 measure for number of social interactions, and time 3 measures for cognitive elaboration, subjective norms, recall and quit attempts. This model presumes a lag between the effect of the number of social interactions on cognitive elaboration, subjective norms, and recall, but that the impact of those measures on quit attempts will occur in a 1-week time span.

Figure 2.3. Alternate model 1 for testing hypotheses 6-8.

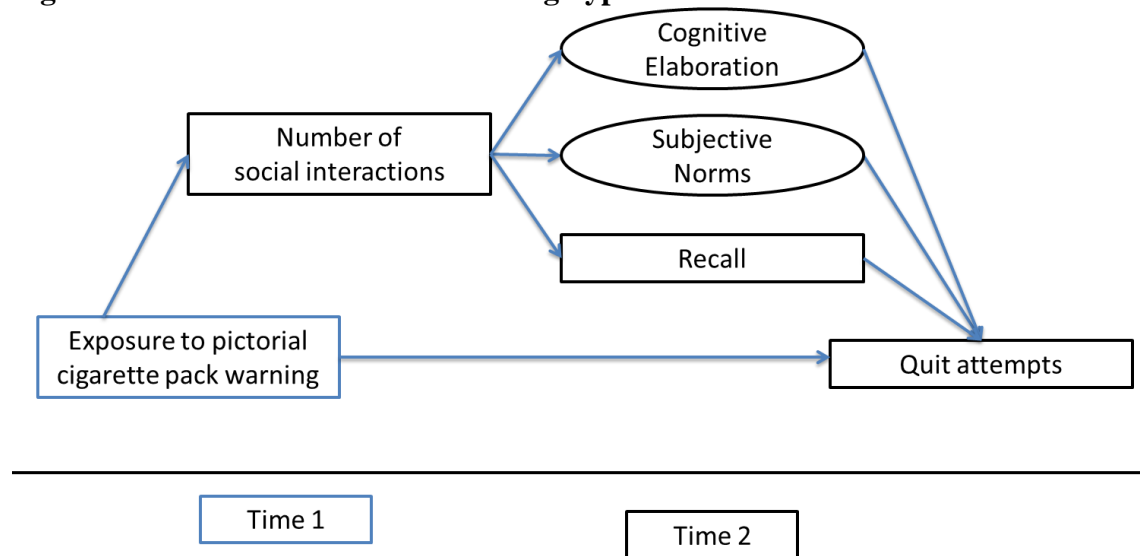
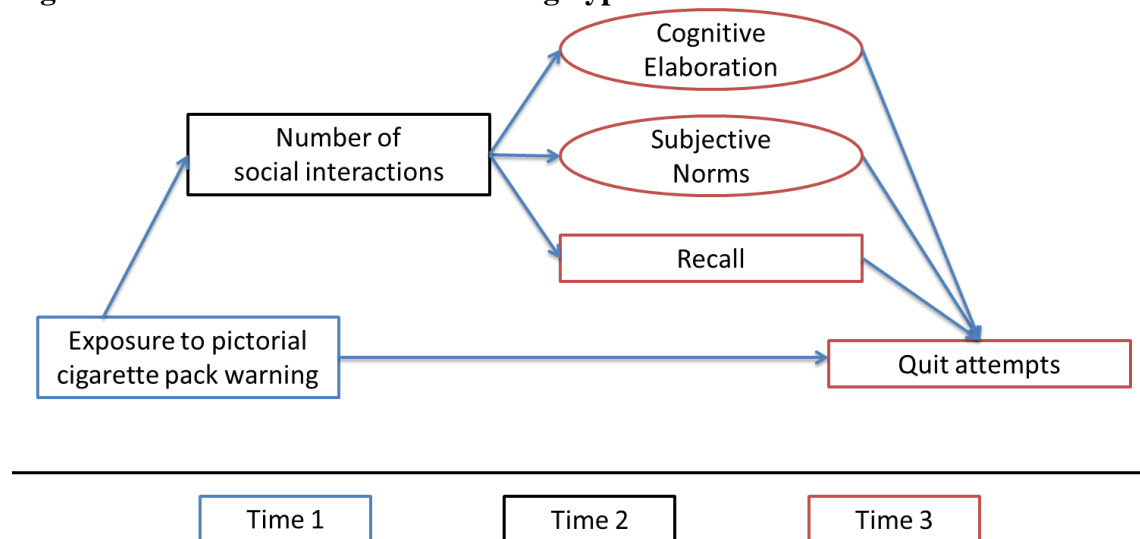


Figure 2.4. Alternate model 2 for testing hypothesis 6-8.



Social interaction trajectories

Previous studies indicate that cigarette pack warnings are most effective when they are new and that responses to the warnings exhibit a partial “wear-out” effect over the course of months or years.⁶²⁻⁶⁴ Thrasher et al. reported a relatively high percentage (50%) of smokers talking about cigarette pack warnings immediately following the implementation of new pictorial

cigarette pack warnings in Canada, but the percentage declined at the next survey time point, four months later.²⁴ Research has shown that one way to decrease wear-out effects is to implement a rotation of cigarette warnings.^{63,65} Some countries, including Australia, Belgium, New Zealand, Mexico, and Trinidad and Tobago, require the content of cigarette warnings to change on a regular basis.⁶⁶ Indeed, the frequency of talking about cigarette pack warnings remained relatively stable over time in Mexico, where pictorial warnings rotate every six months.²⁴ This research suggests that different countries have different trajectories in social interactions about warnings, based on when warnings are introduced, and policies on rotation. However, it doesn't explore if trajectories about social interactions demonstrate distinct patterns among subgroups.

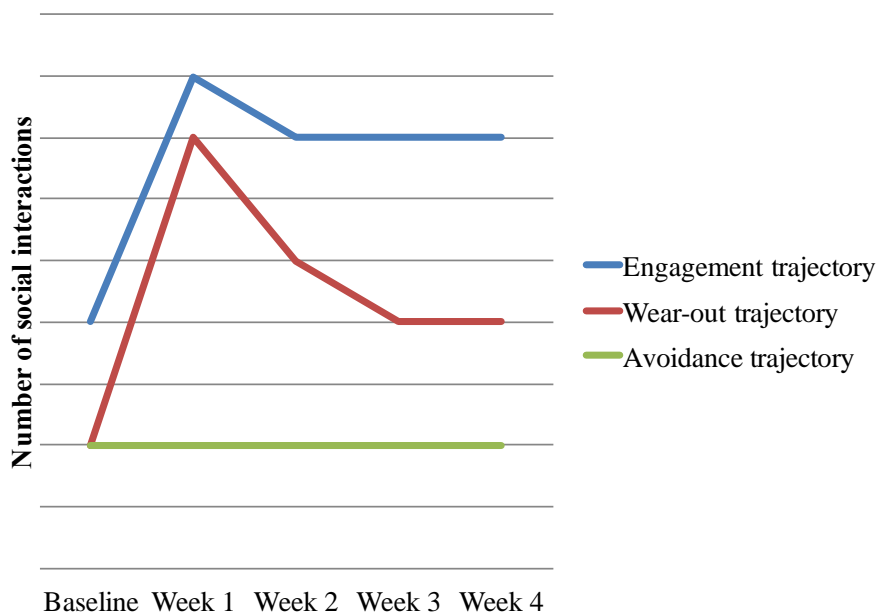
It appears that in the absence of policies that refresh warning content, the primary trajectory for social interactions about warnings over time is a wear-out effect.^{24,57} However, as Southwell and Yzer state, “any conception of related mass media effects as uniform phenomena should be tempered by the potential moderating influence of widely varying conversational networks.”⁴ Because the number of social interactions are likely to vary across different groups,⁶⁷ it is possible that individual trajectories differ from this primary “wear-out” trajectory. In one study examining conversational trajectories about HIV prevention in injection drug users, researchers found different conversational trajectories based on the topic of conversation, some topics remained higher than baseline, even after an 18-month period, and others exhibited wear-out effects.⁶⁸

I believe that one average trajectory will exist for which the number of social interactions about the warning on their pack increases from baseline to week 1, and then shows a wear-out effect but with the number of social interactions remaining higher than baseline for weeks 3 and

4. I also believe there will be individual variance in both slope and intercept from this mean resulting in alternate trajectories, a low social interaction trajectory that doesn't differ from baseline (the avoidance trajectory), and a high social interaction trajectory that doesn't exhibit the wear-out effect (the engagement trajectory) (Figure 2.5). The measure asks about the number of conversations they've had in the last week about the currently on their pack, at baseline this refers to the Surgeon General's Warning and the remaining weeks it refers to the pictorial warning.

Hypothesis 9. Social interactions about pictorial warnings will have distinct individual trajectories that, in aggregate for the sample overall, peak early and then wane over time.

Figure 2.5. Three potential social interaction trajectories



There is little empirical research about characteristics that influence conversational or social interaction trajectories.⁶⁸ However, given that conversational frequency is likely to vary among demographic groups,⁶⁷ individual conversational trajectories may also vary based on those characteristics. I will explore demographic and population characteristics that are associated with the variance from the mean trajectory that is identified.

Previous research has found that high positive affect is strongly associated with social activity.⁶⁹⁻⁷¹ I believe those who report negative emotional reactions to the warnings, and those who experience a greater number of negative social interactions may make efforts to hide the warning or discourage conversations about the warning, and experience fewer social interactions they have about the warning over time. Similarly, those who quit or reduce their smoking may experience a sharp decrease in the number of social interactions over time. Alternately, because smoking behavior frequently happens in social settings,^{55,56} those with high nicotine dependence and those who smoke at least a pack of cigarettes per day, may be more likely to have their number of social interactions remain consistent overtime.

Significance and implications

Previous studies have shown that conversations prompted by campaign content can increase the effectiveness of the anti-smoking campaigns.^{15,16 17-22} These results support the important influence of interpersonal communication, but they do little to help explain *why* these effects occur. Further examination of the nature of social interactions around pictorial cigarette pack warnings, and the processes through which they are working, may elucidate how smokers communicate about these warnings with others in their social network, and help us understand why they work.

Understanding social interactions in the context of pictorial warnings on cigarette packs can help policy makers develop more effective warnings and lower smoking rates. A better comprehension of the processes by which social interactions work on health campaigns can help researchers design more effective health campaigns. Lastly, improving our conception of these processes can help refine existing health communication theories.

CHAPTER 3. RESEARCH DESIGN AND METHODS

Overview of Parent Study

Data for this proposed research come from a randomized controlled trial (RCT) funded by the NCI and FDA (P30CA016086-38S2). The main aim of the parent trial is to assess the impact of pictorial warnings on quit attempts. The study recruited a convenience sample of 2,150 adult smokers ages 18 and older both in North Carolina and California. Data collection was completed in September, 2015. Pregnant women, non-English speakers, and people who exclusively smoke roll-your-own tobacco were excluded from participating in the trial.

Recruitment. Pacific Institute for Research and Evaluation (PIRE) recruited smokers and collected the data. PIRE used a variety of recruitment methods, including Facebook and Craigslist posts, bus advertisements, flyers/postcards, in-person recruitment, and email listservs with the help of the parent study team. The trial was successful at recruiting a diverse sample of smokers (61% low-income, 18% gay or bisexual, and 54% Black or multiracial).

Methods. Smokers were randomized in roughly equal numbers to the control condition or the pictorial condition ($n \approx 1,075$ per condition). Participants in the pictorial condition received one of four pictorial cigarette pack warnings selected from the original FDA warnings on the top half of the front and back of their cigarette packs (Figure 3.1). Smokers in the control condition received one of four existing Surgeon General's text-only warnings on the side of their cigarette packs.

Figure 3.1. Pictorial cigarette pack warnings used in parent study



Participants came to a baseline appointment and then four follow-up appointments weekly, for a total of five appointments. Participants filled out a 30-45 minute survey on a computer at each attended appointment. For the first four visits, participants brought eight days' worth of cigarette packs with them to be labeled. At these appointments, smokers in the pictorial condition received a warning on the top 50% of the front and back of the packs, in accordance with federal law and proposed FDA requirements.¹⁴ Smokers in the control condition received their assigned text-only warning over the existing warning on the side of their cigarette packs to control for the effects of labeling. Study participants received a cash incentive up to \$185 in North Carolina and \$200 in California, depending on their level of participation. Incentives were distributed incrementally at the end of each of the five study appointments. Participants received information about local cessation resources at their last appointment.

Measures and Data Preparation

Measures for all three aims appear in Appendix I. Please see Table 3.1 for the naming convention for the six waves of data.

Table 3.1. Data collection time points

Name	Week 0	Week 0	Week 1	Week 2	Week 3	Week 4
Description	Pre-test	Post test	1 week post-test	2 weeks post-test	3 weeks post-test	4 weeks post-test

I will use SAS version 9.3 for data cleaning and recoding, descriptive statistics, and bivariate analysis. For mediation analysis, I will use structural equation modeling (SEM), and for

the trajectory analysis I will use latent curve modeling. I will conduct both SEM and latent curve modeling with the lavaan package in R v 3.2.

For Aim 1, missing data will be handled using listwise deletion. For Aims 2 and 3, standard techniques for dealing with missing data (e.g., listwise and pairwise deletion) can result in inaccurate standard errors and parameter estimates, and can reduce the statistical power.⁷² Given this, to handle missing data for everything other than the dependent variable, I plan to use full information maximum likelihood estimation.⁷³ This missing data technique is available in statistical packages, including R. Rather than imputing the missing values, this approach uses the entire, incomplete dataset to derive parameter estimates by dividing the data into smaller subsets based on patterns of missing data. In simulation studies, researchers found this method often performs better than standard methods for handling missing data.^{73,74} Full information maximum likelihood estimation is recommended by several leading SEM and latent curve model methodologists to handling missing data with these methods.⁷⁵⁻⁷⁷

While the parent trial will use intent to treat analysis to examine the main trial outcome, for this research, I will only include those in the sample who have data on quit attempts and number of social interactions at weeks 1-4, (a preliminary analysis suggests this is ~850 in each arm). Because the mediation analysis relies on mediators at one time predicting quit attempts at a later time, using values that are carried forward from previous time points (also called the last observation carried forward method) is not a suitable method. Similarly, since the third aim is using changes in social trajectories over time, estimated data, or data carried forward for the dependent variable may not be appropriate, especially given the ample sample size with complete data.

For the recall items used in aim 2, participants were randomly assigned to receive the items at week 1, 2, 3, or 4, only receiving the item once throughout the study to avoid a testing effect. I will use the sample of participants (~200) who received the recall measure and lag the other predictors for that sample as discussed in chapter 2 and depicted in figures 2.2-2.4. In the event that a smaller sample size leads to a poorly fit model, or fails to converge, I will use the attention noticing items, which are asked at each week post baseline, as a proxy for recall.

I will examine the randomization checks already performed for the parent trial: *t*-tests or χ^2 tests to assess whether group assignment was associated with demographic characteristics or baseline levels of the mediator variables to evaluate whether randomization worked as intended. I will repeat these analyses for the analytical sample I use. Subsequent analyses will control for any variables that differed between groups at baseline.

Analysis Plan for Aim 1

The literature on social interactions focuses primarily on frequency of the social interactions and there is no comprehensive descriptive literature about social interactions around pictorial cigarette pack warnings. Thus aim 1 of my dissertation is to characterize these social interactions about pictorial cigarette pack warnings. The proposed methodological approach is to use the PROC FREQ command in SAS to examine the items listed in Table 3.2.

Table 3.2. Social interactions survey items.

Construct	Item	Response Scale, Coding and Recoding
Frequency of conversations	In the last week, how many times did you talk to other people about the health warning on your cigarette packs?	1=Never (recoded 0) 2=1-2 times (recoded 1.5) 3=3-4 times (recoded 3.5) 4=5-9 times (recoded 7) 5=10 or more times (recoded 10)

Who the conversations were with	<p>[If answered something other than “never” to frequency of conversations]</p> <p>In the last week, who did you talk to about the warnings? (Check all that apply.)</p> <p>My spouse or significant other, Other family member, My Child, Friend, Co-worker, Medical professional, Someone you did not previously know, Other</p>	<p>1=Yes 0=No</p>
Who the conversations were with	<p>[If answered something other than “never” to frequency of conversations]</p> <p>In the last week, did you talk about the warning with nonsmokers?</p>	<p>1=Yes 0=No</p>
Who the conversations were with	<p>[If answered something other than “never” to frequency of conversations]</p> <p>In the last week, did you talk about the warning with smokers?</p>	<p>1=Yes 0=No</p>
Who started the conversation	<p>[If answered something other than “never” to frequency of conversations]</p> <p>Think about the last conversation you had about the warning. Who started the conversation?</p>	<p>1=Me 2=Someone else (recoded as 0) 3=Don’t remember (recoded as 0)</p>
Content of the conversation	<p>[If answered something other than “never” to frequency of conversations]</p> <p>Think about the conversations you had about the warning in the last week. What came up during these conversations? (Check all that apply.)</p> <p>The health effects of smoking, Whether the warning would make me want to quit, Whether the warning would make other smokers want to quit, Whether the warning would stop people from starting to smoke, Whether the warning should be on cigarette packs in the US, Cigarette pack warnings in other countries, Made fun of warning, This research study, Other</p>	<p>1=Yes 0=No (Recoded to create separate dichotomous variables for each)</p>
Content of the conversation	<p>[If answered something other than “never” to frequency of conversations]</p>	<p>1=Yes 0=No</p>

	<p>Think about the conversations you had about the warning in the last week. Did you or the other person say that the warnings were...? (Check all that apply.)</p> <p>Scary; Depressing, gloomy; Stupid, pointless; Judgmental, controlling; Interesting, engaging; Informative, useful; Gross; Silly; Other</p>	(Recoded to create separate dichotomous variables for each)
Showing the warning	In the last week, how many times did you intentionally show someone the warning?	<p>1=Never (recoded 0)</p> <p>2=1-2 times (recoded 1.5)</p> <p>3=3-4 times (recoded 3.5)</p> <p>4=5-9 times (recoded 7)</p> <p>5=10 or more times (recoded 10)</p>
Sharing on social media	<p>In the last 4 weeks, have you posted about the warning on your cigarette packs on any of the following social media platforms? (Check all that apply.)</p> <p>Facebook, Instagram, Twitter, MySpace, Reddit Vine, None of these, Other</p>	<p>1=Yes</p> <p>0=No</p> <p>(Recoded to create separate dichotomous variables for each)</p>
Sharing on social media	<p>[if answered something other than “none of these” to social media question above]</p> <p>What did you post? (Check all that apply.)</p> <p>Comment about the warning, Picture of the warning, Comment about the study</p>	<p>1=Yes</p> <p>0=No</p> <p>(Recoded to create separate dichotomous variables for each)</p>

I will conduct *t*-tests and chi square tests to examine differences in each variable by exposure to pictorial cigarette pack warnings. Similarly, in the pictorial warning condition, I will use *t*-test and chi square tests to explore differences in each variable by the following demographic characteristics: age, sex, race, ethnicity, GLB, education, and income.

Hypothesis 1. Exposure to pictorial cigarette pack warnings increases social interactions.

- Prediction 1. Exposure to pictorial cigarette pack warnings will elicit a greater number of social interactions. Based on previous social interactions research, I also

predict that smokers under 30 will have more social interactions than those 30 and older.⁷⁸

Analysis Plan for Aim 2

To examine my Aim 2 mediation hypotheses, I will use SEM, following the analytical steps outlined in Bollen (1998) and Kline (2011).^{75,76} This statistical approach allows for testing multiple mediation and serial mediation, while explicitly specifying measurement error associated with the latent variables cognitive elaboration and subjective norms.^{75,76} Additionally, an SEM approach allows for concurrent testing of all mediators of interest, thus estimating correlations among the variables.

To detect the occurrence of harmful multicollinearity, I will use standard metrics (i.e., correlation > .80 and variance inflation factor ≥ 10).⁷⁹ I will then either remove the highly correlated predictors from the model or retain a smaller number of variables using principal components analysis. I will adjust the standard errors and account for the non-independence of repeated observations across individuals over time. Due to the longitudinal nature of the study, I will lag the variables as described in Chapter 2, and seen in Figures 2.2-2.4. For hypothesis testing, I will use two-tailed tests and a critical alpha of 0.05.

First, using R, I will run a separate measurement model for the latent variables cognitive elaboration and subjective norms. These models will specify the associations between the latent variables and the indicator variables. Next, I will examine several statistics to evaluate measurement model fit, including the model χ^2 statistic ($p > .05$), the root mean square error of approximation (RMSEA < .08),⁸⁰ and the Bentler Comparative Fit Index (CFI > .90).⁸¹ If any of these statistics indicate that the model has poor fit, I will respecify the model in an effort to improve model fit. When respecifying the model I will use both theory and empirical tests (e.g.,

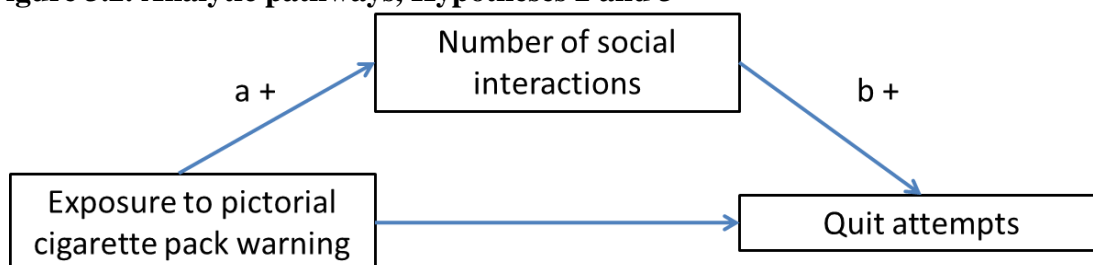
modification indices) to determine how to proceed.^{75,76} For example, to respecify the model, I may drop non-significant indicators, trim non-significant paths, or specify indicators as categorical rather than continuous. I may also correlate error terms for indicators because of similarities in wording or sentence structure.

After the measurement models are determined to have adequate fit, I will estimate a structural model with the pathways for each hypothesis. To help pinpoint problems with convergence of the model and model fit, I will use an iterative model building process. The process entails building smaller pieces of the model individually; eventually forming the full and final model after each individual piece is completed.

To test my hypotheses, after following the steps outlined above for the measurement model, I will estimate a simple structural equation models depicting the relationship between pictorial warning exposure and quit attempts. Figures 3.2-3.4 are simplified structural equation models, with squares representing measured or manifest variables, and ovals representing latent variables. To reduce visual clutter, indicators for latent variables, error terms, and correlations are not depicted.

I will estimate a structural equation model with standardized path coefficients and *p*-values for each mediation path depicted in Figures 3.2-3.4. These pathways map onto standard procedures for mediation analysis.⁸² The product of each “a” pathway and “b” pathway ($a*b$) denotes the mediated effect.^{82,83} I describe my predictions for each hypothesis below.

Figure 3.2. Analytic pathways, Hypotheses 2 and 3



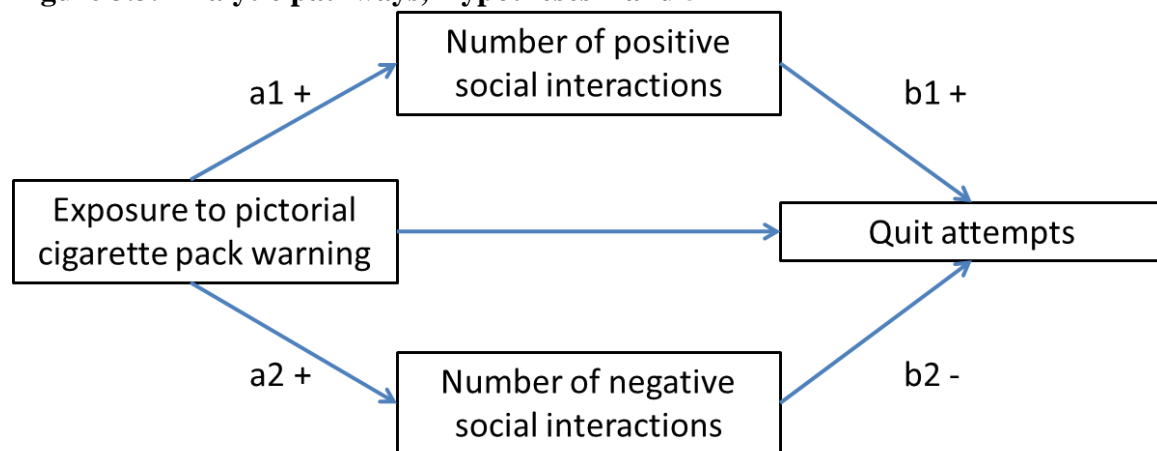
Hypothesis 2. Social interactions increase quit attempts.

- Prediction 2: More social interactions will be associated with more quit attempts.

Hypothesis 3. Exposure to pictorial cigarette pack warnings increases social interactions which increases quit attempts.

- Prediction 1: Exposure to pictorial cigarette pack warnings will elicit a greater number of social interactions; the “a” pathway will be positive and statistically significant. This was already tested in Aim 1.
- Prediction 2: More social interactions will be associated with more quit attempts; b pathway will be positive and statistically significant.
- Prediction 3: Social interactions will mediate the effect of pictorial cigarette pack warnings on quit attempts; the mediated pathway ($a*b$) will be positive and statistically significant.

Figure 3.3. Analytic pathways, Hypotheses 4 and 5



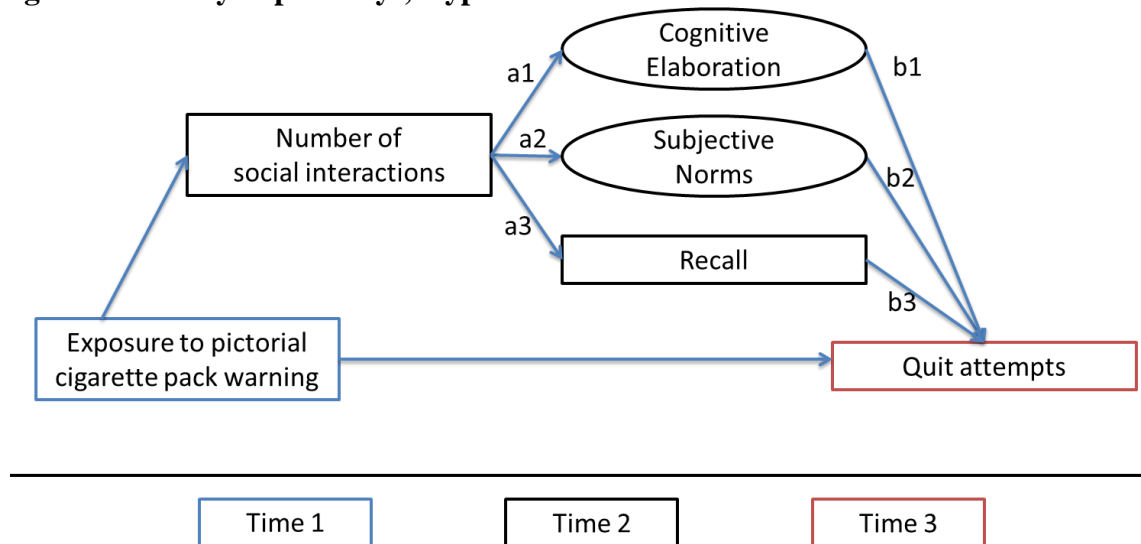
Hypothesis 4. Number of positive social interactions mediates the association between pictorial cigarette pack warnings and quit attempts.

- Prediction 4: Exposure to pictorial cigarette pack warnings will elicit a greater number of positive social interactions; the a_1 pathway will be positive and statistically significant.
- Prediction 5: Positive social interactions will be associated with more quit attempts; b_1 pathway will be positive and statistically significant.
- Prediction 6: Positive social interactions will mediate the effect of pictorial cigarette pack warnings on quit attempts; the mediated pathway (a_1*b_1) will be positive and statistically significant.

Hypothesis 5. Number of negative social interactions suppresses the association between pictorial cigarette pack warnings and quit attempts.

- Prediction 7: Exposure to pictorial cigarette pack warnings will elicit a greater number of negative social interactions; the a_2 pathway will be positive and statistically significant.
- Prediction 8: Negative social interactions will elicit fewer quit attempts; the b_2 pathway will be negative and statistically significant.
- Prediction 9: Negative social interactions will suppress the effect of pictorial cigarette pack warnings on quit attempts; the mediated pathway ($a*b$) will be negative and statistically significant indicating inconsistent mediation which is also sometimes called suppression.^{83,84}

Figure 3.4. Analytic pathways, Hypotheses 6-8



Hypothesis 6. Social interactions triggered by cigarette pack warnings increase cognitive elaboration, which in turn increases quit attempts.

- Prediction 10: Social interactions will be associated with higher levels of cognitive elaboration; a1 pathway will be positive and statistically significant.
- Prediction 11: Cognitive elaboration will be associated with more quit attempts; b1 pathway will be positive and statistically significant.
- Prediction 12: Social interactions and cognitive elaboration will mediate the effect of pictorial cigarette pack warnings on quit attempts; the mediated pathway ($a1*b1$) will be positive and statistically significant.

Hypothesis 7. Social interactions triggered by cigarette pack warnings increase subjective norms about quitting, which in turn increases quit attempts.

- Prediction 13: Social interactions will be associated with stronger subjective norms about quitting; a2 pathway will be positive and statistically significant
- Prediction 14: Subjective norms about quitting will be associated with more quit attempts; b2 pathway will be positive and statistically significant.

- Prediction 15: Social interactions and subjective norms about quitting will mediate the effect of pictorial cigarette pack warnings on quit attempts; the mediated pathway (a_2*b_2) will be positive and statistically significant.

Hypothesis 8. Social interactions triggered by cigarette pack warnings increase recall of the warning, which in turn increases quit attempts.

- Prediction 16: Recall will be associated with stronger subjective norms; a_3 pathway will be positive and statistically significant
- Prediction 17: Recall will be associated with more quit attempts; b_3 pathway will be positive and statistically significant.
- Prediction 18: Social interactions and recall will mediate the effect of pictorial cigarette pack warnings on quit attempts; the mediated pathway (a_3*b_3) will be positive and statistically significant.

Finally, in Aim 2, I may conduct additional exploratory analyses to examine alternate model structures for Hypotheses 6-8, as depicted in Figures 2.3 and 2.4.

In the event that the final model fails to converge or exhibits poor fit after taking the steps described above, I will fit path models using ordinary least squares regression. Using the PROCESS macro in SAS to estimate parallel multiple mediation and serial models ⁸².

Analysis Plan for Aim 3

I will use a latent curve model to examine the trajectory of the number social interactions about pictorial warnings on cigarette packs in Aim 3, following the analytical steps outlined in Bollen and Curran (2006).⁸⁵ Latent curve models have random intercepts and random slopes that allow each participant to have a different trajectory over time. Coefficients are incorporated into the models by considering them latent variables. This capitalizes on all of the strengths of SEMs

and applies them to latent curve models. This includes using maximum likelihood techniques for missing data, estimating nonlinear forms of trajectories, the inclusion of latent covariates and latent repeated variables, and the inclusion of time-invariant as well as time-varying covariates. A key advantage of this approach is that it enables analyses of associations between change over time in the independent and dependent variables of interest. I will use the same indices as Aim 2 to assess model fit. I will use this technique to answer three different questions:⁸⁶

1. What is the trajectory of social interactions for the entire sample?
2. Are there distinct trajectories of social interactions?
3. If there are distinct trajectories, what variables predict them?

For questions one and two, I will use an unconditional latent curve model (without covariates) to estimate the shape of the trajectory for number of social interactions about pictorial warnings over time for the entire sample. In fitting the unconditional latent curve model, I will examine the variance of the intercept. A significant variance in intercept would reveal substantial individual differences in the number of social interactions at baseline. I will also look for significant variation in slope to indicate individual differences in number of social interactions over time. Statistically significant variance in intercept or slope will indicate that there are distinct individual trajectories of social interactions.

Hypothesis 9. Social interactions about pictorial warnings will have distinct individual trajectories that, in aggregate for the sample overall, peak early and then wane over time.

- Prediction 19. Social interactions will increase between baseline and week 1 and then decrease in subsequent weeks (wear-out trajectory).
- Prediction 20. Social interactions will remain low a stable over time (avoidance trajectory).

- Prediction 21. Social interactions will start higher intercept than the wear-out trajectory, increase at week 1 and not exhibit a wear-out effect (engagement trajectory).

Once the baseline model has been established, and if the unconditional model indicates distinct trajectories, I will add covariates as predictors of the trajectory over time to explore the answer to question three.⁸⁶ I will add both time invariant covariates (TIC) (age, gender, sexual orientation, race, ethnicity, poverty, education) and time variant covariates (emotional reactions, experience of negative social interactions, experience of positive social interactions, intentionally showing someone the warning, having a quit attempt in the last week, smoking attitudes, average number of cigarettes smoked in the last week, and nicotine dependence). TICs typically predict the random components of change directly with the goal of determining what variables are associated with individuals who report higher versus lower intercepts or steeper versus flatter slopes. TVCs estimate the time-specific influence of the covariates on the change in the DV. By including both types of covariates in the model, the model can simultaneously evaluate within-person influences (via TVCs) and between-person influences (via TICs) on stability and change of social interactions over time.^{85,86}

- Prediction 22. Negative emotional reaction and negative attitudes will be associated with the avoidance trajectory.
- Prediction 23. Intentionally showing the warning to others, high nicotine dependence and smoking more than 20 cigarettes a day will be associated with the engagement trajectory.

Power Calculations

The trial has enrolled 2,150 smokers. I will use an analytical sample that includes only participants with self-reported quit attempt and number of social interactions data available at each time point ~850 in each arm. Given this sample size, I will have more than ample statistical power to conduct analyses in all three aims. For Aim 1, I have >99% power to detect a difference in the mean number of social interactions between the control and pictorial warning group. Using data from the parent trial, given a standard deviation of 3, I will have power to detect the difference between a mean of 1.8 and 3.2, assuming an alpha of .05.

For the mediation analyses in Aim 2 and the trajectory analysis in Aim 3, I followed the MacCallum et al. approach to calculate power for structural models.^{87,88} For Aims 2 and 3, I will have > 99% power for a well-specified model with a sample size of both 1,700 for Aim 2 and 850 for Aim 3 and > 70 degrees of freedom, assuming an alpha of .05.

CHAPTER 4: FREQUENCY AND CONTENT OF CONVERSATIONS ABOUT PICTORIAL WARNINGS ON CIGARETTE PACKS

INTRODUCTION

Worldwide, tobacco use causes nearly 6 million deaths per year.¹ In the US, cigarette smoking is responsible for 1 in 5 deaths.² Cigarette packs have proven to be an effective communication device for tobacco companies,^{3,4} and research has shown they can be effective tools to communicate about the health risks of smoking.⁵

The WHO Framework Convention on Tobacco Control recommends large pictorial images appear on cigarette packages because of evidence that, compared to text only warnings, pictorial warnings communicate health risks more effectively.⁶ Compared to text warnings, pictorial warnings elicit more concern about the harms of smoking,^{5,7} more negative attitudes towards smoking,^{5,7} greater quit intentions,^{7,8} and more quit attempts.⁸ Although tobacco industry lawsuits have delayed implementation of pictorial warnings in the US, the Food and Drug Administration (FDA) intends to propose a revised set of warnings that will address the concerns raised in the lawsuit.⁹ Understanding how smokers interact with pictorial warnings in real world settings may provide important information as the US designs new warnings for maximal impact.

Because smoking is a social behavior, heavily influenced by peer and social networks,¹⁰⁻¹² social interactions may be particularly important in the context of anti-smoking communication campaigns and pictorial warnings on cigarette packs.⁷ Smokers are more likely to socialize with other smokers, and smoking influences the behavior of others within a social network.¹² Furthermore, smoking behavior frequently happens in social settings,^{13,14} offering

openings for conversations to take place. Several studies have found face-to-face or online social interactions were positively associated with motivation to stop smoking, such as intentions to quit smoking.¹⁵⁻²²

Pictorial warnings have certain advantages over traditional anti-smoking campaigns. They are found directly on smokers' cigarette packs, which increases regular exposure to the warnings and offers a unique opportunity to trigger social interactions during the act of smoking. Evidence suggests that pictorial warnings have particular utility in the generation of interpersonal interaction, given the potential of visual content to elicit emotional responses.^{23,24} Southwell (2013) reviewed decades of literature on conversations about health and science. He noted two mechanisms that account for this generative tendency of emotionally evocative pictorial content: they get people thinking and more actively engaged. Pictorial content can provide useful currency in making connections with other people. For these reasons, the potential of pictorial warnings to spark conversations seems substantial, and yet relatively few studies have examined the role of social interactions about pictorial warnings. Those that have primarily examined the frequency, rather than the content of these interactions.²³⁻²⁷

In our trial, we sought to describe the frequency, content, and nature of adult smokers' social interactions about pictorial cigarette pack warnings in the context of a randomized controlled trial that allowed for a robust comparison with text-only warnings. Characterization of social interactions about pictorial cigarette pack warnings with a large sample studied longitudinally can provide tobacco control policymakers and health communication theorists with a better understanding of how social interactions triggered by warnings may affect smoking.

METHODS

Participants

We recruited a convenience sample of adult smokers (ages 18 or older) in North Carolina and California, US from September 2014 to August 2015. The three most effective methods for identifying participants were Craigslist, word of mouth, and Facebook.²⁸

Procedures

We conducted a randomized controlled trial comparing the impact of pictorial warning labels versus text-only warnings (clinicaltrials.gov identifier: [NCT02247908](https://clinicaltrials.gov/ct2/show/study?term=NCT02247908)). The trial was effective at increasing quit attempts across the four weeks; details regarding methods and main results appear in Brewer et al. (2016).⁸ Briefly, participants brought in an eight-day supply of cigarettes to the baseline visit and were randomly assigned to have one of eight warnings placed on their packs. Participants received the same warning for the duration of the study. Four pictorial warnings contained text required by the Tobacco Control Act and a picture to illustrate a health harm of smoking selected from the US's originally proposed set of images.²⁹ Four text-only control warnings used the US Surgeon General's warning statements that have been required on the side of cigarette packs since 1985. Participants attended four follow-up visits spaced one week apart, bringing an eight-day supply of cigarettes to all but the final visit.

Participants completed a computer survey at the baseline visit and at each subsequent weekly visit. While participants completed the surveys at these appointments, research staff placed the assigned warnings on participants' cigarette packs following a standardized protocol.³⁰ All participants provided their written informed consent, and The University of North Carolina institutional review board approved the study procedures.

Measures

The survey used items previously validated and newly developed survey items that we cognitively tested with 15 adult smokers.³¹ The baseline survey assessed the frequency of conversation about the current surgeon general's warning on their pack and demographic characteristics. The subsequent weekly surveys asked about the frequency of conversation about the label we placed on their pack, conversation partners, conversation content, and social media posts about the warnings. Results reported in this chapter are preliminary. Please refer to the peer reviewed published paper for final results.

Conversation frequency

The weekly surveys assessed frequency of conversations about the warnings with one item, "In the last week, how many times did you talk to other people about the health warning on your cigarette packs?" The response options were "never" (coded as 1), "1-2 times" (coded as 1.5), "3-4 times" (coded as 3.5), "5-9 times" (coded as 7), and "10 or more times" (coded as 10).³⁰

Conversation partners

The weekly surveys provided a list of conversation partners and asked participants to select the people with whom they discussed the warning during the last week. Conversations partners were my "spouse or significant other," "other family member," "my child," "friend," "co-worker," "medical professional," "someone you did not previously know," and "other."³⁰

Conversation content

The weekly surveys provided the participants with a list of topics and asked them to select which topics had come up in conversations during the last week. Topics were "the health effects of smoking," "the warning would make them want to quit," "the warning would make

other smokers want to quit,” “the warning would stop people from starting to smoke,” “the warning should be on cigarette packs in the US,” “cigarette pack warnings in other countries,” “someone made fun of the warning,” “the research study,” and “other.” A separate survey item provided a list of warning descriptors and asked participants to select descriptors that they or their conversation partner had used in the last week. The descriptors were “scary;” “depressing, gloomy;” “stupid, pointless;” “judgmental, controlling;” “interesting, engaging;” “informative, useful;” “gross;” “silly;” and “other.”³⁰

Social media

The final survey asked participants if they had posted about the warning on any social media platforms in the last four weeks. The platforms listed were “Facebook,” “Instagram,” “Twitter,” “MySpace,” “Reddit,” “Vine,” “other,” and “none of these.”³⁰

RESULTS

The trial enrolled 2,149 adult current smokers (1,039 men, 1,060 women, and 34 transgender people). Their mean age was 40. Trial participants were diverse with respect to race, sexual orientation, education and income; and participant characteristics did not differ by trial arm (Table 4.1).

Table 4.1. Participant characteristics

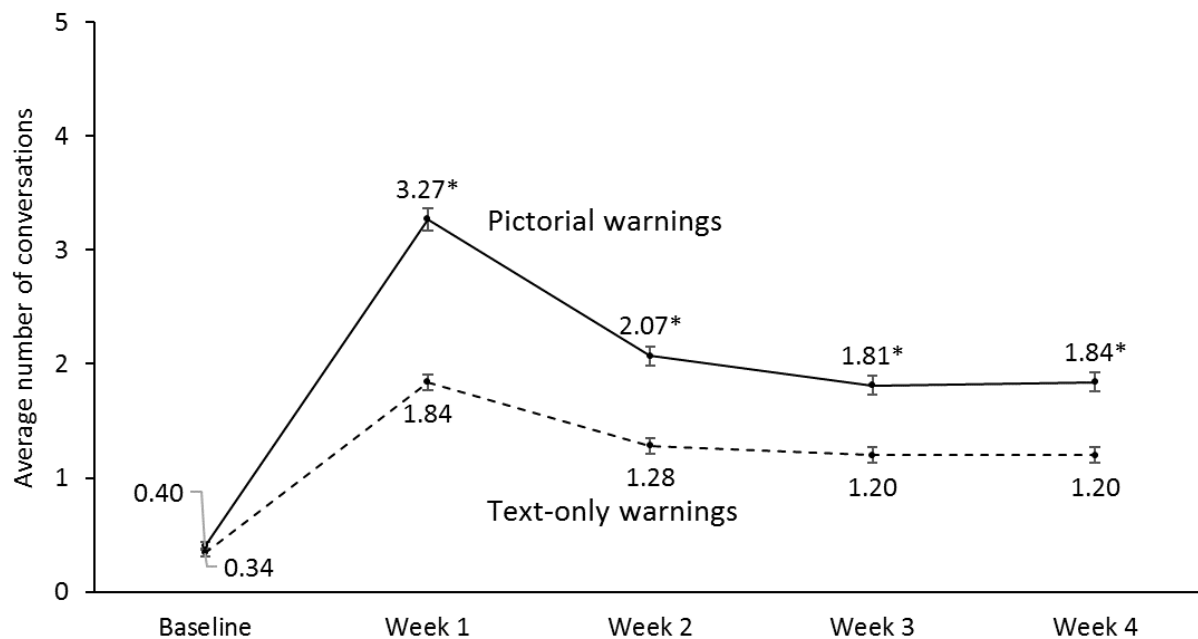
Characteristic	Pictorial Warnings (<i>n</i> =1,071)	Text-Only Warnings (<i>n</i> =1,078)
Age in years, mean (SD)	39.8 (13.7)	39.7 (13.4)
Gender		
Female	512 (48.2)	548 (51.2)
Male	532 (50.0)	507 (47.4)
Transgender	19 (1.8)	15 (1.4)
Gay, lesbian or bisexual	195 (18.8)	173 (16.3)
Hispanic	89 (8.5)	92 (8.6)
Race		
Asian	42 (4.0)	28 (2.7)
Black	510 (48.9)	484 (45.8)
White	358 (34.3)	393 (37.2)
Other/multi-racial	134 (12.5)	152 (14.1)
Education		
High school or less	344 (32.5)	333 (31.1)
Some college	502 (47.4)	519 (48.5)
College graduate	156 (14.7)	156 (14.6)
Graduate or professional degree	58 (5.5)	63 (5.9)
Low income (<150% of federal poverty level)	589 (55.2)	570 (53.0)
Cigarettes smoked per day, Mean (SD)	8.7 (7.3)	8.8 (6.6)

Note. Data are reported as number (percentage) of participants unless otherwise noted. Characteristics did not differ by trial arm. Missing demographic data range from 0% to 2%.

Frequency of social interactions

Conversations about the warnings were a common experience with 90% of smokers with pictorial warnings (*n*=995) and 78% of smokers with text-only warnings (*n*=1,003) having at least one conversation during the study ($p<.01$). While trial arms did not differ in the number of conversations they had about the warnings on their pack at baseline (Figure 4.1), smokers with pictorial warnings had more conversations throughout the trial compared to those with text-only warnings (mean = 8.18 conversations [SD=7.97] vs. 5.02 [SD=6.25], $p<.01$). The highest number of conversations for each group occurred during the first week with an average of 3.27 (SD=2.93) for the pictorial warnings and 1.84 (SD=2.14) for the text-only warnings ($p<.01$).

Figure 4.1. Frequency of conversations about warnings on cigarette packs. Error bars show standard errors. * $p < .05$.



Eighty-six percent of smokers with pictorial warnings reported that they intentionally showed the warning to someone compared to 73% in the text-only group ($p < .001$). During the first week, smokers with pictorial warnings intentionally showed others their warnings an average of 2.88 times ($SD = 2.86$) compared to 1.66 times ($SD = 2.08$) for those with text-only warnings ($p < .001$).

Conversation partners

During the course of the trial, participants who talked about the warnings ($n = 896$ for pictorial vs. 785 for text-only) conversed with a wide range of people. Most participants reported talking about the warning with a friend (82% pictorial warnings vs. 74% text-only warnings, $p < .01$). Some talked with significant others or spouses (41% vs. 41%, ns), other family members (44% vs. 35%, $p < .05$), co-workers (33% v 27%, $p < .05$) and someone they did not previously know (31% vs. 17%, $p < .05$). Fewer participants talked with their children (18% v 17%, ns) or a

medical professional about the warning (10% vs. 9%, ns). Participants ($n= 893$ for pictorial vs. 780 for text-only) had conversations about the warning labels with both smokers (91% pictorial vs 85% text-only, $p<.05$), non-smokers (63% vs. 61%, ns), and with those whose smoking status they did not know (18% vs. 15%, $p<.05$).

Content of the conversations

Throughout the trial, participants who talked about the warnings discussed a variety of topics. Most participants discussed the trial (75% pictorial vs. 71% text-only, ns), whether the warnings would make them want to quit (75% vs. 59%, $p<.05$), and the health effects of smoking (74% vs. 68%, $p<.05$; Table 4.2). Some participants discussed whether the warnings would make other smokers want to quit (64% vs. 45%, $p<.05$), whether the warnings should be on cigarette packs (60% vs. 38%, $p<.05$) and whether the warning would prevent initiation of smoking (60% vs. 38%, $p<.05$).

Table 4.2. Topics of the conversations throughout the trial

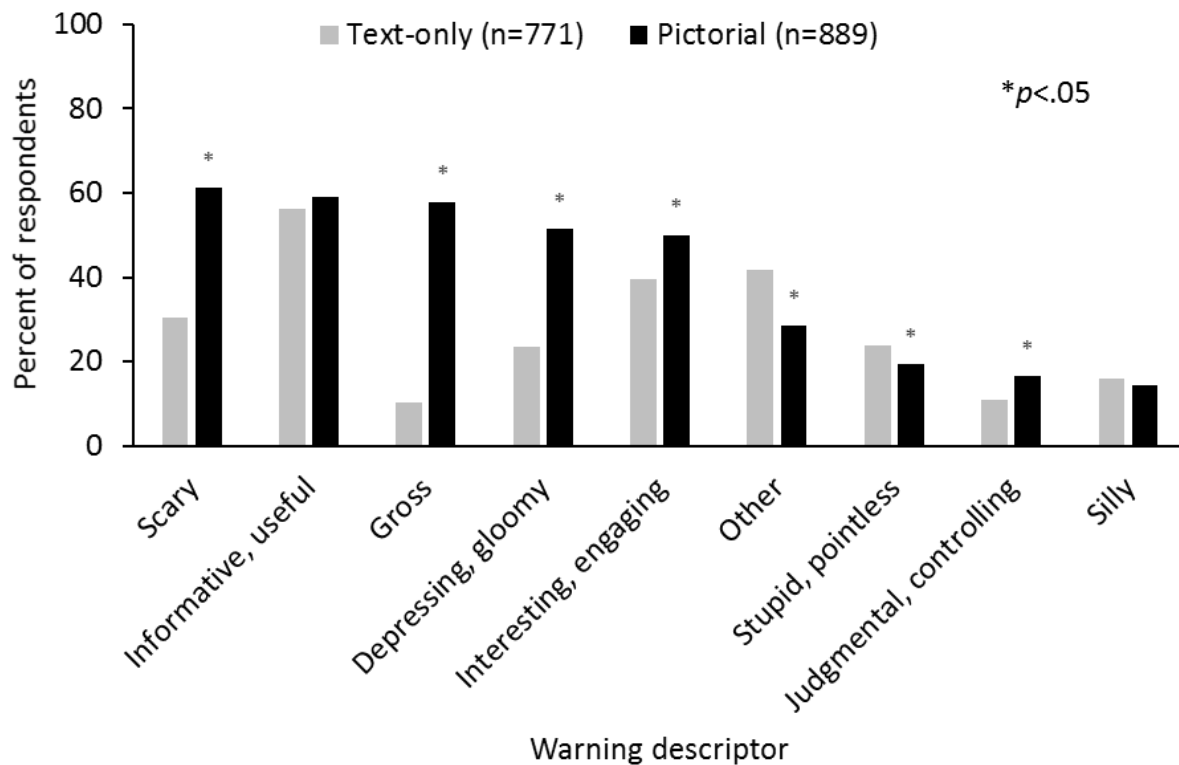
Topic of conversations	Pictorial Warnings ($n=896$) %	Text-only Warnings ($n=785$) %
This research study	75	71
Whether the warnings would make me want to quit	75*	59
The health effects of smoking	74*	68
Whether the warning would make other smokers want to quit	64*	45
Whether the warnings should be on cigarette packs in the US	60*	38
Whether the warnings would stop people from starting to smoke	57*	40
Cigarette pack warnings in other countries	42*	35
Made fun of warning	22*	16
Other	15	18

* $p<.05$

Participants reported having conversations describing the warnings using several adjectives ($n=889$ for pictorial vs. 771 for text-only; Figure 4.2). Pictorial warnings were more

frequently described as “gross” (58% pictorial vs. 10% text-only, $p<.05$), “scary” (61% vs. 30%, $p<.05$), and “depressing and gloomy” (51% vs. 23%, $p<.05$) compared to text-only warnings. Both warnings were described as “informative and useful” with similar frequency (59% vs. 56%, ns). Text-only warnings were more frequently described as “stupid and pointless” (19% pictorial vs. 24% text-only, $p<.05$), or with other adjectives (28% vs. 42%, $p<.05$) compared to pictorial warnings.

Figure 4.2. How participants described the warnings throughout the trial.



Social media

Fourteen percent of participants shared the warnings on social media (Facebook, Instagram, Twitter, Myspace, Reddit, Vine, or other), which did not differ between trial arms. Of those sharing ($n=142$ for pictorial vs. $n=130$ for text-only), most participants reported posting on a platform the survey did not list (other) (46% pictorial vs. 55% text-only, ns). The top two listed

social media platforms participants shared on were Facebook (45% pictorial vs. 36% text-only, ns) and Instagram (18% vs. 8%, $p<.05$). Participants reported posting comments about the warnings (40% pictorial vs. 41% text-only, ns), comments about the trial (46% vs. 45%, ns), and pictures of the labels (62% vs. 42%, $p<.05$).

DISCUSSION

Social interactions about pictorial cigarette pack warnings occurred more frequently than for text-only warnings during the trial. Moreover, the topics of conversations about pictorial warnings extended past the warnings themselves and included conversations about the health effects of smoking and cessation, generating conversations that may amplify the direct impact of the warning in discouraging smoking. In addition, smokers had conversations with many different partners, which may extend the reach of these warnings beyond the targeted smoker and may be one of the processes by which pictorial warnings have impact. Indeed, the nature of these conversations suggests that smokers are more deeply processing these warning messages in ways that might not occur without such social interactions.

These findings build on previous research from Hall and colleagues who found in a pilot study that nearly all smokers talked about the warning labels on their packs.³⁰ In our trial, conversations increased during the first week, followed by a drop in the second week. This pattern is consistent with work from previous studies that indicate that cigarette pack warnings are most effective when they are new and that responses to the warnings exhibit a partial wear-out effect over the course of months or years.³²⁻³⁴ An important finding is the increase in conversations that pictorial warnings elicited over the *entire trial* compared to text warnings. Even in the final week of the trial, participants discussed pictorial warnings more often than text-

only warnings. Research has shown that one way to maintain these effects is to rotate cigarette warnings labels to keep them fresh.^{33,35}

Social media may amplify the reach and impact of pictorial warnings.³⁶ Almost a sixth of smokers shared an image or comment about the label unprompted, but mass and social media campaigns launched together with pictorial warnings may magnify the effects of pictorial warnings.³⁷ In Mexico, exposure to a mass media campaign launched in conjunction with the introduction of pictorial warning labels was associated with greater attention to pictorial warnings and cognitive elaboration.³⁸ Similarly, an Australian study found that television advertisements heightened the effect of pictorial warning exposure on knowledge of the health effects of smoking.³⁹ Future studies should explore the possible synergistic effects of mass media and social media campaigns on pictorial warnings.

Participants reported some critical or negative commentary regarding the content of the warnings. Not all of the reported conversation was positive or supportive of the warning message. Such critique is not uncommon; David and colleagues also found participant denigration of anti-tobacco messages in their study of social interactions.⁴⁰ Simple generation of any conversation, then, is not likely to be universally helpful in extending the reach of intended reaction to the original warning labels. Nonetheless, we also found a substantial amount of relevant conversation that both extended exposure to the warning messages and likely reinforced memory for the warnings among those initially exposed. This is somewhat analogous to the finding that while pictorial warnings may elicit negative reactions among some individual smokers (i.e., message reactance),⁴¹ this is greatly outweighed by the positive effects of warnings at the population level.^{7,42}

Strengths of our study include our use of a randomized trial, longitudinal data, the use of cognitively-tested measures about social interactions, and a naturalistic pack-labeling protocol that exposed smokers to warnings on their actual cigarette packs.³⁰ However, the trial took place in the US, where pictorial warnings are not currently on cigarette packs, potentially heightening the immediate novelty of the warnings and providing an impetus for some of the conversations about the warnings. However, the larger number of conversations due to the pictorial warnings, across many topics, suggests that pictorial warnings offer special added value relative to existing text-only warnings. The generalizability of these findings to smokers in other settings and over a longer period merits further study.

Pictorial cigarette pack warnings prompt conversations. It is important for policymakers to consider the social context for pictorial warnings once they are introduced. Future research should explore whether and how naturally occurring and experimentally prompted social interactions about pictorial warning labels impact smoking behavior.

CHAPTER 5: HOW DO CONVERSATIONS ABOUT PICTORIAL CIGARETTE PACK WARNINGS IMPACT QUIT ATTEMPTS? A MULTIPLE MEDIATIONAL ANALYSIS OF A RANDOMIZED CONTROLLED TRIAL

INTRODUCTION

Social interactions are a key mechanism through which health communication campaigns influence behavior.¹⁻⁵ Campaigns reach the public through direct exposure to messages, but the process of viewers sharing this information with others may also be critical to extending the reach of a campaign.⁶ Conversations about health communication campaigns may mediate the relationship between exposure to the campaigns and their intended outcomes,^{4,5} although much more research is needed to understand this phenomenon.

Southwell and Yzer outline three theoretical mechanisms that could be responsible for the effect of conversations about a media campaign on behavioral outcomes.⁴ First, conversations may increase cognitive elaboration (i.e., thinking about the campaign) because individuals invest more heavily in processing the initial information in order to prepare themselves for the conversation or the conversation itself increases cognitive elaboration.⁴ Second, people's health behavior like smoking may be influenced by a person's perception of the injunctive norm surrounding that behavior (i.e., whether others approve or disapprove of the behavior).⁷⁻⁹ The content of campaigns may instigate conversations that affect normative beliefs.^{1,10-13} Third, in addition to hearing and storing information directly from the media to be retrieved later, conversations about the campaign's message may prompt related thoughts and therefore may increase message recall.¹⁴⁻¹⁶

In addition to knowing *whether* people are talking about a campaign or not, it is also critical to learn and understand *what* people are saying about the campaign, and yet to date this has rarely been studied.^{5,17-19} Although previous research has examined the frequency of conversations about communication campaigns, we do not know how the content of the social interactions may or may not mediate the relationship between exposure and outcomes. Research suggests that conversational content may determine the influence social interactions have on behavior.^{4,5,20} For example, researchers examining the effects of conversations stimulated by a new human papillomavirus vaccine campaign message found participants who reported more favorable conversations about vaccinating, and those who participated in conversations where there was more positive opinion sharing about the advertisement and vaccine, predicted intentions to vaccinate.²¹

One context in which social interactions may be important, yet understudied, is pictorial cigarette pack warnings. Cigarette packs are an effective communication medium, both for marketing purposes,^{22,23} and communicating the health risks of smoking.²⁴ Compared to text warnings, pictorial warnings elicit more quit attempts and more conversations about warnings.^{25,26} The Message Impact Framework proposes that social interactions prompted by messages can influence reactions to a message and facilitate change in smoking attitudes and beliefs.²⁷ Understanding the role that conversations about warnings play in cessation, and the processes by which they exert their influence, can help policy makers identify the most effective warnings as they implement the warnings required by the US Family Smoking Prevention and Tobacco Control Act.²⁸

We sought to establish whether conversations mediate the relationship between exposure to pictorial warnings and quit attempts, and, importantly, to understand whether and how the

theoretical mechanisms of cognitive elaboration, injunctive norms, and recall may be influencing quit attempts. Furthermore, we aimed to examine the role conversational content played in the relationship between pictorial warnings and quit attempts.

METHODS

Participants

We recruited a convenience sample of 2,149 adult smokers (ages 18 or older) in North Carolina and California, US from September 2014 to August 2015. The three most effective methods for identifying participants were Craigslist, word of mouth, and Facebook.²⁹ Trial participants were diverse in race, sexual orientation, education and income; participant characteristics did not differ by trial arm (Table 5.1).

Table 5.1. Participant characteristics

Characteristic	Text-Only Warnings (n=1,078)	Pictorial Warnings (n=1,071)
Age in years, mean (SD)	39.7 (13.4)	39.8 (13.7)
Gender		
Female	548 (51.2)	512 (48.2)
Male	507 (47.4)	532 (50.0)
Transgender	15 (1.4)	19 (1.8)
Gay, lesbian or bisexual	173 (16.3)	195 (18.8)
Hispanic	92 (8.6)	89 (8.5)
Race		
Asian	28 (2.7)	42 (4.0)
Black	484 (45.8)	510 (48.9)
White	393 (37.2)	358 (34.3)
Other/multi-racial	152 (14.1)	134 (12.5)
Education		
High school or less	333 (31.1)	344 (32.5)
Some college	519 (48.5)	502 (47.4)
College graduate	156 (14.6)	156 (14.7)
Graduate or professional degree	63 (5.9)	58 (5.5)
Low income (<150% of federal poverty level)	570 (53.0)	589 (55.2)
Cigarettes smoked per day, mean (SD)	8.8 (6.6)	8.7 (7.3)

Note: Data are reported as number (percentage) of participant unless otherwise noted. Characteristics did not differ by trial arm. Missing demographic data range from 0% to 2%.

Procedures

We conducted a randomized controlled trial comparing the impact of pictorial warning labels versus text-only warnings (clinicaltrials.gov identifier: [NCT02247908](https://clinicaltrials.gov/ct2/show/study/NCT02247908)). The trial was effective at increasing quit attempts across the four weeks; details regarding methods and main results appear in Brewer et al. (2016).²⁵ Participants brought in an eight-day supply of cigarettes to the baseline visit and were randomly assigned to receive one of eight warnings on their cigarette packs. Participants received the same warning for the duration of the trial. Four pictorial warnings contained text required by the Tobacco Control Act and a picture to illustrate a health harm of smoking selected from the FDA's originally proposed set of images³⁰ (Figure 5.1). Four text-only control warnings used the US Surgeon General's warning statements that have been required on the side of cigarette packs since 1985.

Figure 5.1. Pictorial cigarette pack warnings used in study



Participants completed computer surveys at the baseline visit and at each subsequent weekly visit. While participants completed the surveys at these appointments, research staff placed the assigned warnings on participants' cigarette packs following a standardized protocol.³¹ Participants randomized to the pictorial condition had their warnings placed on the top 50% of the front and back of their cigarette packs, in accordance with the proposed FDA requirements.³² Participants in the text-only condition had their warnings placed on the side of the packs covering the existing US Surgeon General's warnings. We applied the new warning labels on top of the existing warnings to control for the effect of putting a label on smokers'

packs. All participants provided their written informed consent, and The University of North Carolina institutional review board approved the study procedures.

Measures

The survey used previously validated items and newly developed survey items that we cognitively tested with 15 adult smokers.³³ The baseline survey assessed demographic characteristics and the four weekly surveys asked about frequency of conversations, quit attempts, cognitive elaboration about the warning, injunctive norms about quitting, recall of the warning, and content of the conversations. The survey randomly assigned participants to receive an unaided recall question during one of the four weekly surveys.

Conversation frequency

The weekly surveys assessed frequency of conversations about the warnings with one item, “In the last week, how many times did you talk to other people about the health warning on your cigarette packs?” The response options were “never” (coded as 1), “1-2 times” (coded as 1.5), “3-4 times” (coded as 3.5), “5-9 times” (coded as 7), and “10 or more times” (coded as 10).

Quit attempts

Weekly quit attempts were defined as answering “yes” to the item “During the last week, did you stop smoking for 1 day or longer because you were trying to quit smoking?” An overall quit attempt was defined as answering “yes” to one of the weekly quit attempt questions, or, at the final visit, answering yes to the item “Since you started the study, did you stop smoking for 1 day or longer because you were trying to quit smoking?”⁸⁹

Theoretical mechanisms

The weekly surveys assessed cognitive elaboration with three items: “How much did the warning cause you to think about the harmful effects of smoking?”, “When you notice your

cigarette pack, how often do you think about the message that the warning conveys?”, and “When your cigarette pack is not in sight, how often do you think about the message that the warning conveys?” The five point response scales ranged from “not at all” to “all the time” for the first item and “never” to “all the time” for the other two items.³⁴ The weekly surveys used three items to assess injunctive norms: “People who are important to me would approve of my quitting smoking in the next 2 months,” “People who are important to me think I should quit smoking in the next 2 months,” and “People who are important to me want me to quit smoking in the next 2 months.” The five point response scale for all three items ranged from “strongly disagree” to “strongly agree.”³⁵ To measure unaided recall, the survey asked participants in the pictorial warning arm to describe the image on their pack, and participants in both arms to describe the text of the message. Two coders read the entries and coded recall as correct or not ($\kappa=.96$); any discrepancies were settled by consensus. If participants in the pictorial arm recalled either the text or the image correctly, recall was coded as correct.

Conversational content

The survey provided the participants with a list of topics and asked them to select which topics had come up in conversations during the last week. The topics included: “the warning would make other smokers want to quit,” “the warning would stop people from starting to smoke,” “the warning should be on cigarette packs in the US,” and “someone made fun of the warning.” We gave participants a score for each topic by assigning them 1 point for each week they conversed about a topic. Scores ranged from 0 (i.e., a topic never came up) to 4 (i.e., the topic came up every week).

In a separate item, the survey provided a list of warning descriptors and asked participants to select which descriptors had been used by themselves or their conversation

partner in the last week. The descriptors included: “scary”; “depressing, gloomy”; “stupid, pointless”; “interesting, engaging”; “informative, useful”; “gross”; and “silly.” We gave participants a score for each descriptor using the same procedure we used for conversation topics.

We used the scores for conversational topics and warning descriptors to create three conversational content variables. We calculated a “negative affect conversations” score for each participant by averaging the scores of “scary”; “depressing, gloomy”; and “gross.” The score for “discounting conversations” was calculated by averaging the scores of “stupid, pointless”; “silly”; and “made fun of warning.” We calculated the score of “engaging conversations” by averaging the scores of “interesting, engaging”; “informative, useful”; “whether the warning would make other smokers want to quit”; “whether the warning would stop people from starting to smoke”; and “whether the warning should be on cigarette packs in the US.”

Analysis

We examined the number of conversations about pictorial warnings, theoretical mechanisms, and conversational content as mediators of the relationship between pictorial warning and quit attempts using MPLUS version 9.3.³⁶ Because the quit attempt outcome is binary, we used the WLSMV estimator and report results as standardized path coefficients (β s).³⁷ We used bootstrapped 95% confidence intervals with 1,000 repetitions for mediational analysis, as this approach does not assume that indirect effects are normally distributed.³⁸ For the theoretical mechanisms model, we assessed measurement models for cognitive elaboration and injunctive norms for adequate fit before estimating the structural model examining theoretical mechanisms as a mediator of the relationship between number of conversations and quit attempts. We evaluated several indicators of acceptable model fit, including the root mean square

error of approximation (RMSEA<.08),³⁹ the Tucker-Lewis Index (TLI>.95),⁴⁰ and the Bentler Comparative Fit Index (CFI>.95).⁴¹

For the theoretical mechanisms model, we used an iterative model building process, looking at each theoretical mechanism individually and examining model fit as additional mediators were added; when mediators were not significant or worsened model fit, they were eliminated from future models. Due to the longitudinal nature of the data, we lagged variables in different patterns to test the mediation of the theoretical mechanisms. First, we tested a non-lagged model where the number of conversations, the theoretical mechanisms, and quit attempts all occurred within the same week. We then examined two alternate lag patterns. Lag A placed the number of conversations and theoretical mechanisms at weeks 1, 2 and 3 to predict quit attempts at weeks 2, 3 and 4. Lag B placed the number of conversations at weeks 1 and 2 to predict the theoretical mechanisms at weeks 2 and 3, which in turn would predict quit attempts at weeks 3 and 4. Due to the non-independence of the repeated observations across individuals over time, residuals for the same items at different time points were allowed to covary. Modification indices were used to improve model fit where theoretically plausible.^{42,43} Because the conversational content measures include all 4 weeks of data, no lags were used for those models.

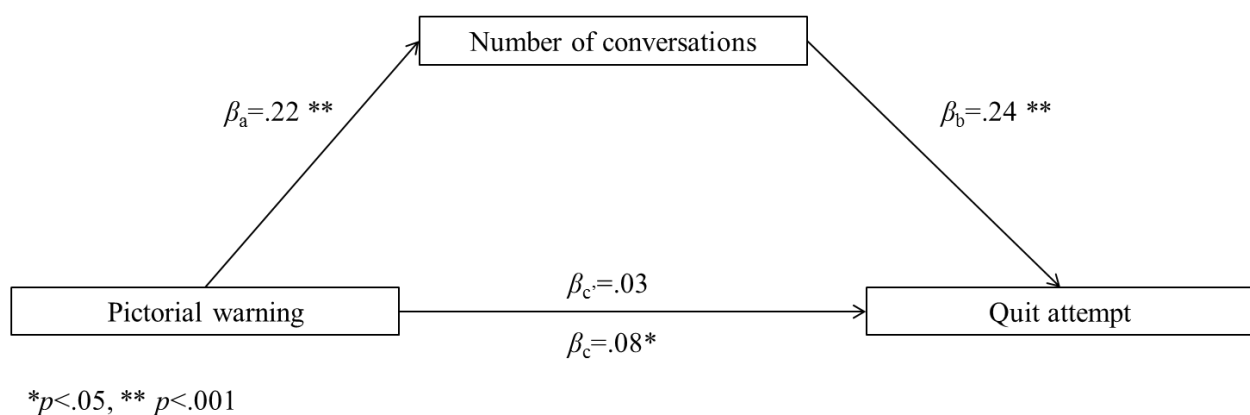
RESULTS

Conversations as a mediator

As we have previously reported,⁴⁴ smokers with pictorial warnings on their packs had more conversations throughout the trial compared to those with text-only warnings (8.2 conversations vs. 5.0; $\beta_a=.22$, $p<.001$; Figure 5.2). The number of conversations was subsequently associated with more quit attempts ($\beta_b=.24$, $p<.001$), mediating the relationship between exposure to pictorial warnings and quit attempts ($\beta_a*\beta_b=.05$ [95% CI .04 to .07], $p<.001$;

Figure 2). Without number of conversations as a mediator, the total effect of pictorial warnings on quit attempts (the “c-path”) was .08 ($p<.05$). When accounting for the mediating effect of number of conversations, the effect of the pictorial warning on quit attempts was reduced and non-significant, indicating full mediation ($\beta_c=.03$, n.s.).

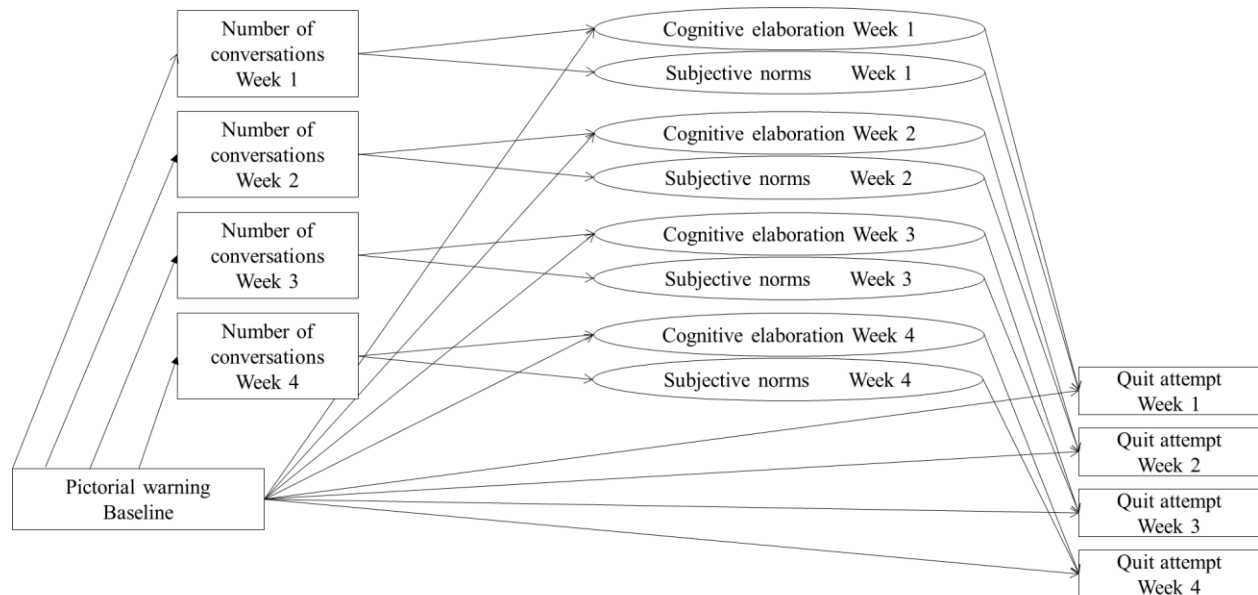
Figure 5.2. Frequency of conversations as a mediator of the association between pictorial warning exposure and quit attempts ($n=2,149$).



Theoretical mechanisms for mediation

In analyses that examined theoretical mechanisms as mediators of the relationship between number of conversations and quit attempts, the non-lagged mediation models were good fits for cognitive elaboration and injunctive norms. However recall mediation models all demonstrated poor fit, and worsened model fit when included in multiple mediation models; therefore we dropped recall from the final model. The final model including both cognitive elaboration and injunctive norms had good fit (RMSEA=.03 [90% CI=.030 to .034], CFI/TLI=.95/.93; Figure 5.3). Models examining different lags (Lag A and B) both had good fit for cognitive elaboration and injunctive norms, with similar or smaller mediational effects (Supplementary Tables 5.1 and 5.2). The non-lagged model was chosen for parsimony and because it used all available data.

Figure 5.3. Structural equation model for theoretical mechanisms as mediators ($n=1,998$). Squares represent measured variables. Ovals represent latent factors. Indicators for cognitive elaboration and injunctive norms not shown. Residuals for the same variables measured at different times were allowed to covary. Residuals for cognitive elaboration and social interactions at the same time point were allowed to covary.



Pictorial warnings increased the number of conversations ($\beta_a=.13$ to $.24$, $p<.001$; Table 2), which was associated with greater cognitive elaboration ($\beta_d=.60$ to $.84$, $p<.001$), which in turn was associated with more quit attempts ($\beta_b=.47$ to $.50$, $p<.001$). The mediated effect of cognitive elaboration was strongest at week 1 ($\beta_a*\beta_d*\beta_b=.1$ [95%CI $.07$ to $.13$]), but remained statistically significant in weeks 2 through 4. The size of the effect reduced after the first week for both the ‘a’ path from pictorial warning exposure to number of conversations and the ‘d’ path from number of conversations to cognitive elaboration. However, the ‘b’ path from cognitive elaboration to quit attempts was consistent across the 4 weeks of the study. Injunctive norms was not a significant mediator at weeks 1, 3 and 4, but had a very small negative mediated effect at week 2 ($\beta_a*\beta_d*\beta_b= -.004$ [95% CI $-.01$ to $-.001$]).

Table 5.2. Cognitive elaboration and subjective norms as mediators of the association between pictorial warning exposure and quit attempts ($n=1,998$).

Mediation pathways	a path β_a	d path β_d	b path β_b	Mediated effect $\beta_a*\beta_d*\beta_b$ (95% CI)
Pictorial warning → Number of conversations w1 → Cognitive elaboration w1 → Quit attempt w1	.24**	.84**	.50**	.10*(.07-.13)
Pictorial warning → Number of conversations w1 → Subjective norms w1 → Quit attempt w1	.24**	.21**	-.08	0.00(-.01-0.00)
Pictorial warning → Number of conversations w2 → Cognitive elaboration w2 → Quit attempt w2	.15**	.60**	.50**	.05*(.03-.06)
Pictorial warning → Number of conversations w2 → Subjective norms w2 → Quit attempt w2	.15**	.23**	-.11*	-.004*(-.01- -.001)
Pictorial warning → Number of conversations w3 → Cognitive elaboration w3 → Quit attempt w3	.13**	.62**	.49**	.04*(.02-.06)
Pictorial warning → Number of conversations w3 → Subjective norms w3 → Quit attempt w3	.13**	.24**	-.08*	0.00(-.01-0.00)
Pictorial warning → Number of conversations w4 → Cognitive elaboration w4 → Quit attempt w4	.13**	.65**	.47**	.04*(.02-.06)
Pictorial warning → Number of conversations w4 → Subjective norms w4 → Quit attempt w4	.13**	.17**	-.04	0.00(-.00-.00)

Note. Table reports standardized path coefficients (β 's) for multiple serial mediator model. Residuals for the same variables measured at different times (week 1 to week 4) were allowed to covary. The 'a-path' represents the path from pictorial warning to number of conversations. The 'd-path' represents the path from the number of conversations to the theoretical mechanisms. The 'b-path' represents the path from the theoretical mechanisms to quit attempts. Residuals for number of conversations were allowed to vary with cognitive elaboration at the same time point. RMSEA= .03 (90%CI .030-.034) CFI/TLI=.95/.93. * $p<.05$, ** $p<.001$

Conversational content as a mediator

Negative affect conversation and engaging conversation were both mediators of the impact of pictorial warnings on quit attempts in single mediator models (negative affect conversation: $\beta_a\beta_b=.09$ [95% CI .06 to .12]; engaging conversation: $\beta_a\beta_b=.03$ [95% CI .02 to .04]). Discounting conversation was not a mediator of the pathway ($\beta_a\beta_b=.00$ [95% CI -.01 to .00], n.s.). In a multiple mediator model that included negative affect, engaging, and discounting conversation, only negative affect conversation was a mediator of the impact of pictorial warnings on quit attempts ($\beta_a\beta_b=.08$ [95% CI .04 to .11]; Table 5.3).

Table 5.3. Conversational content as a mediator of the association between pictorial warning exposure and quit attempts ($n=2,149$)

			a path	b path	Mediated effect
Mediation pathways			β_a	β_b	$\beta_a\beta_b$ (95% CI)
Pictorial warning	→ Negative affect	→ Quit attempt	.43**	.18**	.08* (.04-.11)
Pictorial warning	→ Reactance	→ Quit attempt	.04	-.07*	0.00 (-.01-.00)
Pictorial warning	→ Value	→ Quit attempt	.20**	.07*	.01 (.00-.03)

Note. Table reports standardized path coefficients (β 's) for multiple mediator model. The 'a-path' represents the path from pictorial warnings to the conversational content. The 'b-path' represents the path between the conversational content and quit attempts. * $p<.05$, ** $p<.001$

DISCUSSION

Pictorial warnings increased the number of conversations about warnings which was associated with quit attempts. While previous research has found that people talk about smoking cessation campaigns to others in their social network,^{20,45-52} and others have shown that people are more likely to quit if they have had conversations about an anti-smoking campaign,^{52,53} few have examined the role of conversations as a mediator of smoking cessation.^{20,54} This study is one of the first to show the role of conversation

frequency and content as mediators in the context of pictorial warnings. Our findings indicate that conversations sparked by pictorial warnings are an important mechanism through which the warnings influenced quit attempts.

Our study found that cognitive elaboration was one theoretical mechanism that explains how conversations influence quit attempts, and we found that cognitive elaboration had a larger effect than injunctive norms. We found that the number of conversations about the warning increased quit attempts through the process of cognitive elaboration. This effect has been studied in the field of political communication, where conversations about political campaigns increased cognitive elaboration, which in turn increased political knowledge.⁵⁵ These findings indicate that conversations lead to quitting because the conversations prompt people to think more about the health effects of smoking and the messages on the warning. By understanding how conversations exert influence on behavior, we can help understand why conversations matter, which can lead to designing more effective warnings.

Previous work has found that talk about media campaigns has the ability to impact normative beliefs,^{10,12,13} and health behavior theory suggests that normative beliefs influence behavior.^{1,7-9,11} Our results show that talking about the warnings was associated with increased injunctive norms about quitting smoking; however, we did not find support for injunctive norms eliciting quit attempts, and in the second week it had as a very small negative mediational effect. Previous research suggests that injunctive norms matter most when noncompliance leads to social stigmatization.⁵⁶ It could be that while conversations increase injunctive norms about quitting, the risk of social stigma from not quitting is not high enough to elicit behavior change. It is also possible that injunctive

norms may be a theoretical mechanism that takes longer to influence behavior, and that 4 weeks (which was the time frame of our study) was not long enough to capture those behavioral effects. There could also be other more critical theoretical mechanisms by which conversations could influence behavior that were not examined here. For example, conversations could work by increasing the perceived personal relevance of the message, increasing self-efficacy about quitting or changing beliefs about the harms of smoking.

Our study indicates that the content of the conversations matters. Specifically, conversations about negative affective reactions mediated the impact of pictorial warnings on quit attempts, whereas other types of conversations did not. Previous research has shown that pictorial warnings cause fear and negative affect,⁵⁷⁻⁵⁹ and meta-analyses have indicated that negative affect is an important motivator of change across many health behaviors, including smoking.⁶⁰⁻⁶² Our research builds on these findings by demonstrating that *conversations* about negative affect are also an important motivator of behavior change. By understanding what types of conversations are likely to change behavior, we can gain a better understanding of how conversations are exerting their influence.

Our study benefited from longitudinal data from a randomized controlled trial, cognitively-tested measures about social interactions, and a naturalistic pack labeling protocol that exposed smokers to warnings on their actual cigarette pack.³¹ However, the study took place in the US, where pictorial warnings are not currently on cigarette packs, potentially heightening the immediate novelty of the warnings which perhaps sparked more conversations about the warnings. The external validity of these findings for smokers in other settings and over a longer period of time merits further study.

Additionally, if participants inferred the objective of our study, self-report measures could bias the study results. Finally, we did not manipulate the frequency of conversations, only smokers' exposure to pictorial warnings; therefore, most of the mediated pathways were observational rather than experimental. This limited our ability to draw conclusions about causation.

CONCLUSIONS

Understanding how and why pictorial warnings influence quitting behavior can provide researchers and policy makers with valuable information as they work to design the most effective warnings. We found that conversations about the warnings were a key mechanism through which pictorial warnings influenced quit attempts. US law passed in 2009 requires these warnings.²⁸ However, implementation of pictorial warnings in the US has been stalled due to a 2012 lawsuit by the tobacco industry, and the warnings will likely be redesigned based on the outcome of the litigation.⁶³ The results of this study, in conjunction with previous research, support designing pictorial warnings intended to increase conversations and spark thinking about the health effects of smoking and the messages the warnings convey. Policymakers and health communication campaign creators might benefit from including a measure of the likelihood of a message to trigger a conversation in their message testing phases, similar to the way they include measures of perceived message effectiveness. Future research on pictorial warning design should focus on ways to optimally stimulate conversations – particularly negative affect conversations – as a way of achieving smoking cessation. More broadly, future research could explore whether the role of negative affect conversations and cognitive elaboration

is unique to tobacco warnings, or if it extends to other health warnings or campaign topics.

Supplementary Table 5.1. Cognitive elaboration and subjective norms as mediators of the association between pictorial warning exposure and quit attempts, Lag A ($n=1,998$).

Mediation pathways	a path β_a	d path β_d	b path β_b	Mediated effect $\beta_a*\beta_d*\beta_b$ (95% CI)
Pictorial warning → Number of conversations w1 → Cognitive elaboration w1 → Quit attempt w2	.24**	.80**	.51**	.10*(.07-.13)
Pictorial warning → Number of conversations w1 → Subjective norms w1 → Quit attempt w2	.24**	.20**	-.09*	.00(-.01-0.00)
Pictorial warning → Number of conversations w2 → Cognitive elaboration w2 → Quit attempt w3	.15**	.55**	.49**	.04*(.03-.06)
Pictorial warning → Number of conversations w2 → Subjective norms w2 → Quit attempt w3	.15**	.23**	-.08*	.00(-.01- 0.00)
Pictorial warning → Number of conversations w3 → Cognitive elaboration w3 → Quit attempt w4	.13**	.59**	.46**	.04*(.03-.06)
Pictorial warning → Number of conversations w3 → Subjective norms w3 → Quit attempt w4	.13**	.24**	-.04	0.00(0.00-0.00)

Note. Table reports standardized path coefficients (β 's) for multiple serial mediator model. Residuals for the same variables measured at different times (week 1 to week 4) were allowed to covary. The 'a-path' represents the path from pictorial warning to number of conversations. The 'd-path' represents the path from the number of conversations to the theoretical mechanisms. The 'b-path' represents the path from the theoretical mechanisms to quit attempts. Residuals for number of conversations were allowed to vary with cognitive elaboration at the same time point. RMSEA= .03 (90%CI .030-.034) CFI/TLI=.95/.93. * $p<.05$, ** $p<.001$

Supplementary Table 5.2. Cognitive elaboration and subjective norms as mediators of the association between pictorial warning exposure and quit attempts, Lag B ($n=1,998$).

Mediation pathways	a path β_a	d path β_d	b path β_b	Mediated effect $\beta_a*\beta_d*\beta_b$ (95% CI)
Pictorial warning → Number of conversations w1 → Cognitive elaboration w2 → Quit attempt w3	.24**	.28**	.47**	.07*(.05-.10)
Pictorial warning → Number of conversations w1 → Subjective norms w2 → Quit attempt w3	.24**	.22**	-.06	-.01(-.02- 0.00)
Pictorial warning → Number of conversations w2 → Cognitive elaboration w3 → Quit attempt w4	.17**	.44**	.44**	.07*(.05-.10)
Pictorial warning → Number of conversations w2 → Subjective norms w3 → Quit attempt w4	.17**	.21**	-.04	0.00(-.01-0.00)

Note. Table reports standardized path coefficients (β 's) for multiple serial mediator model. Residuals for the same variables measured at different times (week 1 to week 4) were allowed to covary. The 'a-path' represents the path from pictorial warning to number of conversations. The 'd-path' represents the path from the number of conversations to the theoretical mechanisms. The 'b-path' represents the path from the theoretical mechanisms to quit attempts. Residuals for number of conversations were allowed to vary with cognitive elaboration at the same time point. RMSEA= .03 (90%CI .030-.034) CFI/TLI=.95/.93. * $p<.05$, ** $p<.001$

CHAPTER 6: CONVERSATIONAL TRAJECTORIES ABOUT PICTORIAL CIGARETTE PACK WARNINGS: MESSAGE REACTIONS AND DEMOGRAPHIC PREDICTORS

INTRODUCTION

Social interactions are a key mechanism through which health communication campaigns influence behavior.¹⁻⁵ Of course, these campaigns may directly reach the members of the public, but it is the social sharing of this information that may be critical to a campaign's success. In the US, cigarette smoking is responsible for 1 in 5 deaths annually,⁵¹ and because smoking is a social behavior, social interactions may be particularly important in the context of anti-smoking communication campaigns and pictorial warnings on cigarette packs.^{15,16} Cigarette packs have proven to be an effective communication device for tobacco companies,^{8,9} and research has shown they can be effective tools to communicate about the health risks of smoking.¹⁰

The WHO Framework Convention on Tobacco Control, an international treaty with 168 signatories, recommends large pictorial images be placed on cigarette packages because of evidence that compared to text only warnings, pictorial warnings communicate health risks more effectively.⁵³ Compared to text warnings, pictorial warnings elicit more concern about the harms of smoking and more negative attitudes towards smoking^{10,11} lead to greater quit intentions,^{11,89} and more quit attempts.¹⁴

Smokers are more likely to socialize with other smokers, and smoking influences the behavior of others within a social network.⁵⁴ Furthermore, smoking behavior frequently happens in social settings,^{55,56} offering openings for conversations to take

place. Anti-smoking campaign studies have found associations between both smoking behavior and its predictors, and social interactions about the campaign.¹⁷⁻²² Additionally, unlike conventional mass-media anti-smoking campaigns, pictorial warnings are found directly on smokers' cigarette packs in over 100 countries, both increasing regular exposure to the warnings and offering a unique opportunity to trigger social interactions during the act of smoking. The Message Impact Framework⁷ proposes that social interactions prompted by messages can facilitate change in smoking attitudes and beliefs. Our previous work indicates that having conversations about the warnings mediates the relationship between exposure to pictorial warnings and quit attempts.¹¹⁸

Previous studies indicate that cigarette pack warnings are most effective when they are new, and that responses to the warnings exhibit a partial “wear-out” effect over the course of months or years.⁶²⁻⁶⁴ Thrasher et al. reported a relatively high percentage (50%) of smokers talking about cigarette pack warnings immediately following the implementation of new pictorial cigarette pack warnings in Canada, but the percentage declined at the next survey time point, four months later.²⁴ Research suggests that different countries have different trajectories in social interactions about warnings, based on when warnings are introduced, and policies on rotation.^{24,63,65,66} However, it does not explore if trajectories of social interactions differ among subgroups, or by characteristics of the warning. Because the number of social interactions are likely to vary across different groups,⁶⁷ it is possible individual characteristics influence their trajectory.

This study sought to explore how demographic and message reactions predict the trajectory of conversation frequency. While a tobacco industry lawsuit has delayed the implementation of pictorial warnings in the US, the FDA intends to propose a revised

set of warnings that will address the concerns raised in the lawsuit.⁹⁰ The findings from this study can provide important information as the FDA designs new warnings for maximal impact.

METHODS

Participants

We recruited adult smokers in North Carolina and California, US (clinicaltrials.gov Identifier: [NCT02247908](#)) to participate in a randomized controlled trial comparing the impact of pictorial warnings versus text-only warnings from September 2014 to August 2015. This study uses only those in the pictorial warning arm for the analytical sample ($n=1,071$). Intervention arm participants were diverse in race, sexual orientation, education and income. Trial arm was not associated with baseline social interactions (Table 6.1).

Table 6.1. Participant characteristics

Characteristic	Participants ($n=1,071$)
Age in years, mean (SD)	39.8 (13.7)
Gender	
Female	512 (49.0)
Male	532 (51.0)
Gay, lesbian or bisexual	195 (18.8)
Hispanic	89 (8.5)
Race	
White	358 (34.3)
Black, Asian, or Other/multi-racial	686 (65.7)
Education	
Some college or less	846 (79.81)
College graduate	214 (20.19)
Low-income (<150% of federal poverty level)	589 (55.3)

Note: Data are reported as number (percentage) of participant unless otherwise noted. Missing demographic data range from 0% to 2%.

Procedures

The trial was effective at increasing quit attempts across the four weeks; details regarding recruitment, design methods, and main results appear in Brewer et al. (2016).⁸⁹ Participants brought in an eight-day supply of cigarettes to the baseline visit, and we applied one of four warnings to participant's cigarette packs. The four pictorial warnings contained text required by the Tobacco Control Act and a picture to illustrate a health harm of smoking selected from the FDA's originally proposed set of images (Figure 6.1).⁹⁵

Figure 6.1. Pictorial cigarette pack warnings used in study



Participants completed two computer surveys at the baseline visit and one survey at each weekly visit afterwards. While participants completed the surveys at these appointments, research staff placed the assigned warnings on participants' cigarette packs. All participants provided their written informed consent, and The University of North Carolina institutional review board approved the study procedures.

Measures

We used validated items and cognitively tested newly developed survey items with 15 adult smokers prior to finalizing the survey instrument.⁹⁷ The baseline pre-labeling survey assessed nicotine dependence,¹¹⁹ and negative reinforcement attitude.¹²⁰ The baseline post-labeling survey assessed demographic characteristics, reactance to the warnings,¹⁰² perceived effectiveness of the warning,^{64,121} and negative emotional

reactions to the warning.⁹⁵ We defined college education as those who had graduated from college and low-income as reporting a household income below 150% of the federal poverty line.

Conversation frequency. The four weekly surveys asked about frequency of conversations about the warning on the smokers' pack which was measured with the item "In the last week, how many times did you talk to other people about the health warning on your cigarette packs?" The response options were never (coded as 1), 1-2 times (coded as 2), 3-4 times (coded as 3), 5-9 times (coded as 4), 10 or more times (coded as 5). We used the midpoint of these categories to calculate the average number of conversations per week when plotting the trajectories.

Perceived message effectiveness. The survey assessed perceived message effectiveness with two items. The items were "how much will having this warning on your cigarette packs make you concerned about the health effects of smoking?" and, "how much will having this warning on your cigarette packs make you want to quit smoking?." The four point response scales ranged from "not at all" to "a lot." We created a composite score of perceived message effectiveness by averaging these two items together.

Negative emotional reactions. The survey used 15 items to assess negative emotional reactions to the warning. The items were "how much did the warning on your cigarette packs make you feel...blue, afraid, anxious, repelled, on edge, ashamed, uneasy, sad, scared, grossed out, regretful, frightened, guilty, disgusted, and depressed." The five point response scales ranged from "not at all" to "extremely." We created a composite variable of negative emotional reaction by averaging these 15 items together.

Analysis

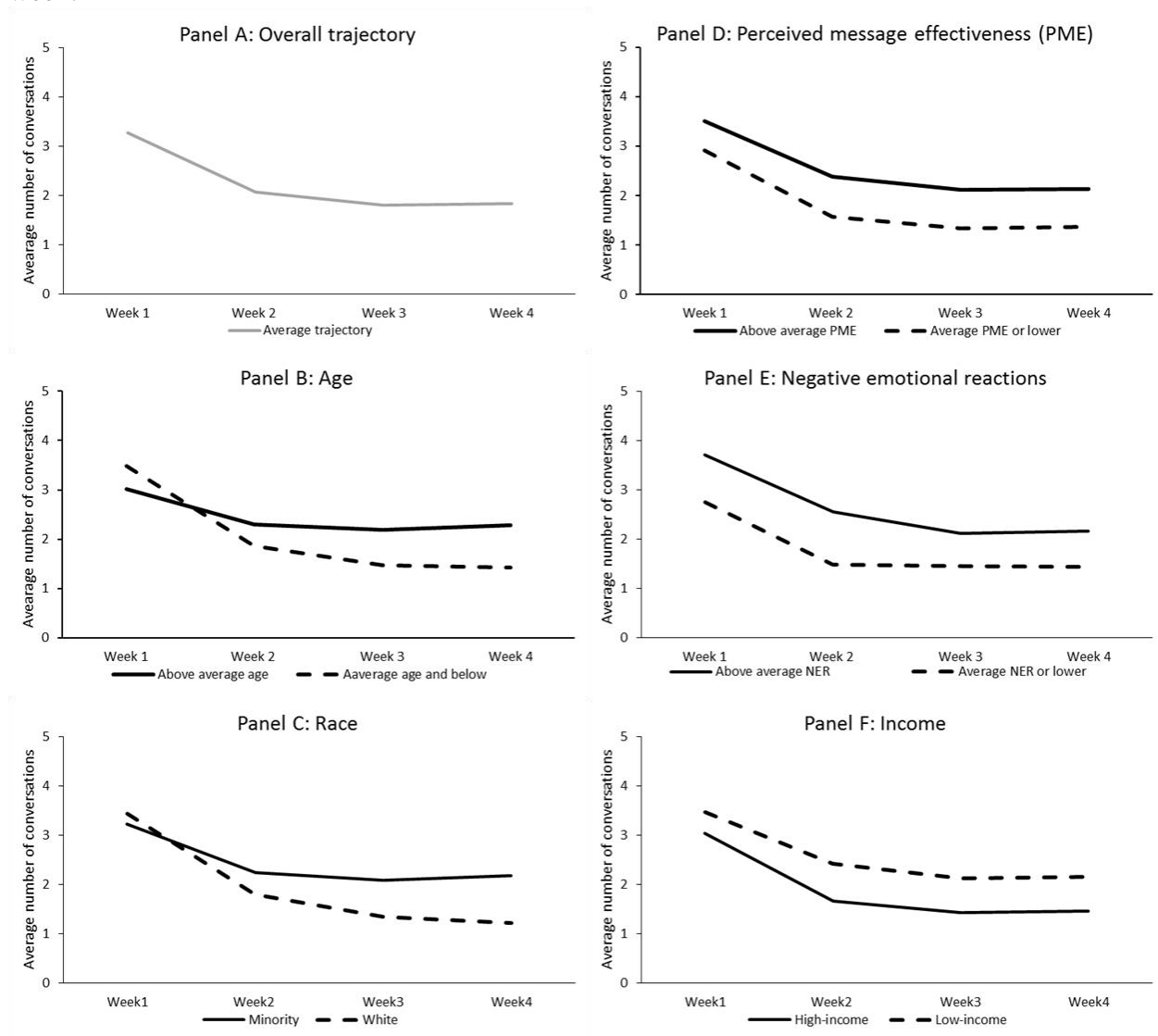
To confirm the shape of the trajectory of conversation frequency throughout the study, an unconditional latent growth curve model¹²² was estimated using MPLUS 7.3.¹⁰⁸ Then a conditional growth curve model was fit with the intercept (conversations during the first week), slope (wear-out during the second week), and shape (rate of change over time beyond what is predicted by wear-out during the second week) factors regressed on age, gender, race, ethnicity, sexual orientation, education, income, cigarettes smoked per week, nicotine dependence, negative reinforcement attitude, reactance to the warning, perceived effectiveness of the warning and negative affect emotional reactions to the warning (all at baseline). Model fit was assessed using a chi-square goodness-of-fit test, the comparative fit index (CFI), the Tucker-Lewis index, and the root mean square error of approximation (RMSEA).^{80,81} Given the large sample size, we relied on the CFI, TLI, and RMSEA in assessing fit, as large sample sizes inflate the chi-square statistic. Because the dependent variable is categorical, initial models were fit using the WLSMV estimator with theta parameterization to obtain fit statistics and confirm model fit. After we confirmed homoscedastic residuals, analysis used the MLR estimator with a probit link and Gausshermite integration with seven quadrature points to obtain the more precise point estimates. We report results as standardized path coefficients (β s) after controlling for all predictors in the conditional model. Results reported in this chapter are preliminary. Please refer to the peer reviewed published paper for final results.

RESULTS

Model fit

Conversations about the warnings decreased throughout the study (Figure 6.2A). The shape of the trajectory was quadratic (unconditional model fit: CFI/TLI=.99/.99; RMSEA=.02). Model fit remained excellent after adding predictors to the model (conditional model fit: CFI/TLI=1.00/1.00; RMSEA=.004).

Figure 6.2. Trajectories of conversations about pictorial cigarette pack warnings by week.



Correlates of week 1 conversations

Altogether, the covariates explain 14% of the variance in conversations about the warnings during the first week of the study ($p < .001$). Older participants had fewer conversations at week 1 ($\beta = -.17$, $p < .001$; Figure 6.3). For example, smokers under 40 had an average of 3.5 conversations the first week, compared to an average of 3.0 for those 40 and older (Figure 6.2B). Minority smokers had fewer week 1 conversations compared to white smokers ($\beta = -.10$, $p < .05$; Figure 6.2C), while low-income smokers had more conversations during the first week compared to high-income smokers ($\beta = .09$, $p < .05$; Figure 6.2F). Greater perceived message effectiveness and stronger negative emotional reactions to the warnings were associated with more week 1 conversations ($\beta = .16$ and $\beta = .14$, respectively, $p < .05$; Figure 6.2D/E).

Correlates of wear-out during the second week

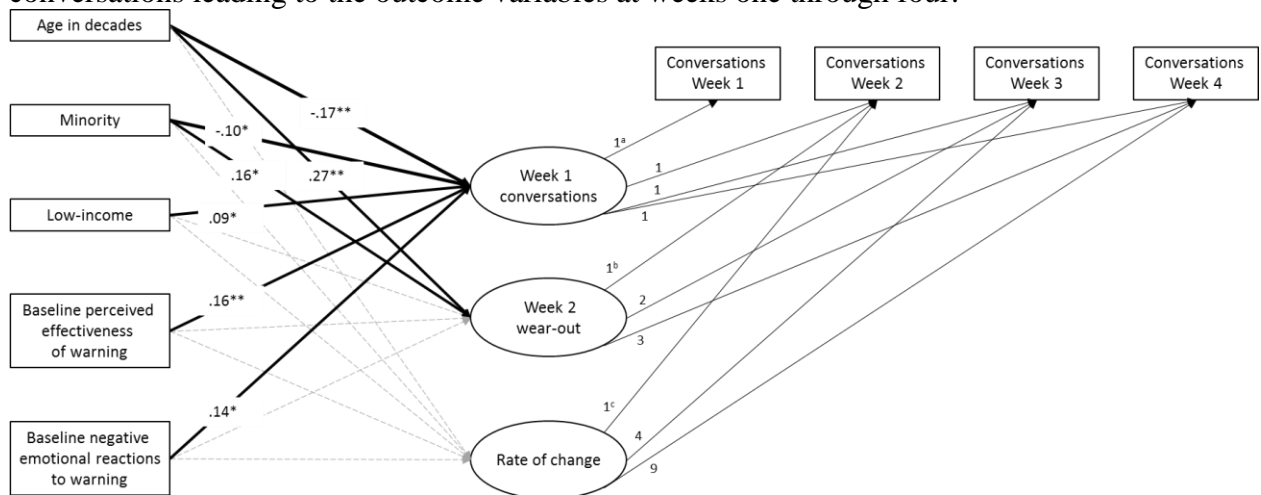
Altogether, the covariates explain 21% of the variance in the wear-out in conversations during the second week ($p < .01$). Older participants had a more gradual wear-out effect ($\beta = .27$, $p < .001$; Figure 6.2B, Figure 6.3). Minority smokers also had a more gradual wear-out effect compared to white smokers ($\beta = .16$, $p < .05$; Figure 6.2C). Due to the gradual wear-out, older smokers and minority smokers had more conversations about the warnings throughout the study, despite having fewer at week 1. For example, smokers under the age of 40 had an average of 7.5 conversations throughout the study, compared to 8.9 conversations for smokers 40 and older ($p < .01$). Minority smokers had an average of 8.8 conversations throughout the study, compared to 7.2 conversations for white smokers ($p < .01$).

Correlates of rate of change

None of the covariates were associated with the rate of change throughout the study

beyond what was predicted by the wear-out during the second week (Figure 6.3).

Figure 6.3. Conditional latent growth curve model ($n = 888$). Shows standardized path coefficients leading from predictors to the intercept, slope and shape factors of number of conversations leading to the outcome variables at weeks one through four.



Note: Model controls for ethnicity, gender, sexual orientation, college education, baseline nicotine dependence, baseline negative reinforcement attitude, baseline reactance to warning, and cigarettes smoked per week. Squares show measured variables. Ovals show latent factors. Dashed lines show non-significant paths. Bold lines show significant paths. ^aFixed loading. ^bTime interval from week 1. ^cTime interval quadratic. * $p < .05$, ** $p < .01$.

DISCUSSION

Conversations about cigarette pack warnings decreased over time. This is consistent with work from previous studies that indicate that cigarette pack warnings are most effective when they are new and that responses to the warnings exhibit a partial wear-out effect over the course of months or years.⁶²⁻⁶⁴ Research has shown that one way to decrease wear-out effects is to rotate cigarette warnings.^{63,65} For example, in Mexico, where pictorial warnings rotate every six months, the frequency of talking about cigarette pack warnings remained relatively stable over time.²⁴

In our study, minorities and older adults had fewer conversations during the first week, but a less severe wear-out effect during the second week. This more gradual decline results in having more conversations throughout the study, despite having fewer conversations during week 1. Low-income smokers have more conversations both at week one and throughout the study. This adds to previous research that indicates pictorial warnings may be one of the tobacco control policies that could reduce communication disparities across different racial and socioeconomic groups.¹²³

Two initial reactions to the warning predicted more conversations: perceived effectiveness and negative affect. These findings add to the literature supporting the use of strong negative emotional appeals in communication campaigns aiming to change health attitudes and behaviors. Communication campaigns regarding seatbelt use,¹²⁴ condom use,¹²⁵ and alcohol abuse,¹²⁶ have used these appeals successfully and this work suggests that conversations about the campaigns are a possible mechanism through which they exert their influence on behavior. These findings also add to a growing body of literature linking measures of perceived effectiveness to measures that are associated with behavior change.¹²⁷⁻¹²⁹

It is promising that conversations during the study were associated with initial reactions to the warning. This suggests that researchers and communication campaign designers can use cross-sectional data and focus group data to test reactions to different warnings in order to find warnings that elicit stronger negative emotions and greater perceived effectiveness.

Strengths of our study include longitudinal data on a diverse sample, the use of cognitively-tested measures about social interactions, and a naturalistic pack labeling

protocol that exposed smokers to warnings on their actual cigarette pack.⁹⁶ However, our study took place in the US, where pictorial warnings are not currently on cigarette packs, potentially heightening the immediate novelty of the warnings and thus sparking conversations about the warnings that would not have occurred otherwise. The generalizability of these findings to smokers in other settings and over a longer period remains to be established. Additionally, if participants inferred the objective of our study, self-report measures could bias the study results. Finally, we did not manipulate the number of conversations experimentally, which limits our ability to draw conclusions about causation. Nor did we include a measure capturing the total number of conversations participants engaged in during the week, beyond conversations about the warnings. Future research should consider experimental manipulation of conversations, or include measures to control for spuriousness.

Demographic characteristics and initial reactions to the warnings predict different numbers of conversations at week 1. Given the importance of negative emotional reactions and perceived effectiveness in predicting conversations, future warnings should be designed to have high levels of perceived effectiveness, and elicit strong negative emotions in order to spark conversations. More broadly, communication campaign designers, should examine whether negative emotions, and perceived effectiveness are predictors of social interactions in other communication campaigns designed to reduce other tobacco product use, alcohol abuse, obesity, or risky sex.

CHAPTER 7: GENERAL DISCUSSION

The people around us influence our behaviors in many ways. Social cognitive theory posits that our social environment influences health behaviors: we see people performing a behavior and the consequences and then use that information to guide our future behavior. The theory of reasoned action suggests that our behavior is shaped by the approval of the behavior by people important to us (i.e., injunctive norms) and our motivation to comply with these norms. These theories provide insight into how a health behavior like quitting smoking responds to the social environment, including social interactions about mass media campaigns and pictorial warnings. We do not view mass media campaigns or pictorial warnings in a social vacuum. Even if we view something alone, the conversations we have about the message can ultimately influence whether or not we change our behavior as a result.

Pictorial warnings are particularly effective at generating conversations. Southwell (2013) noted two mechanisms that account for this phenomenon. First, the evocative nature of pictorial content can get us thinking and actively engaged more so than text alone. Second, we tend to share sensational content with others as a way of building interpersonal bonds, in this way the warnings can act as a social currency and provide entry point into engaging in conversations. This may be especially salient with regards to smoking, as smokers feel increasingly judged for their behavior.¹³⁰

We know that social interactions play an important role in how health communication campaigns exert their effects. Even though policies require pictorial cigarette pack warnings in over 100 countries, covering 58% of the world's population,⁶⁶ we know little about how social interactions about these warnings influence people's behavior. My dissertation offers three key insights about social interactions sparked by pictorial cigarette pack warnings: social interactions matter, conversation content matters, and the frequency of conversations diminishes over time.

Social interactions matter

My dissertation found that social interactions are an important catalyst for pictorial warnings increasing quit attempts. Pictorial warnings elicited more conversations about the warnings than text-only warnings, and engaging in more conversations was associated with more quit attempts. Smokers talked about the warnings with non-smokers, friends, significant others, and strangers, which means that the reach of pictorial warnings is extended beyond the primary target. Because of this finding and the two-step model of communication offered by Katz and Lazarsfeld,² I suggest that conversations are important in the dissemination of the warning message beyond the smoker themselves. This potentially increases the impact of pictorial warnings beyond smokers with the warnings on their packs.

While pictorial warnings are on cigarette packs in many countries, social norms about conversations vary by culture. Thus, it is important to study social interactions about the warnings in these different cultural contexts, which may modify the effect of warnings. The socio-ecological framework¹³¹⁻¹³³ theorizes that our behavior is responsive not only to intrapersonal factors, but also to our immediate environment, and other

broader environments and conditions. In other words, while we are all individuals who have conversations within our specific social networks, those social networks are operating within at least one overarching cultural context.

Because of this, I speculate that conversations are a context dependent mediator, acting as a mediator in some cultures or sub-populations, but not in others. Conversations tend to be valued in and of themselves as a way to foster connection in Hispanic culture, whereas in Scandinavian culture, conversations are expected to serve a purpose in pursuit of a larger goal.¹³⁴ Another cultural difference is the tendency to expect differences of opinion. It is important to indicate agreement and consensus in Scandinavian talk, whereas Hispanic conversations allow for the possibility of disagreements to arise.¹³⁴ Using this example, we might expect conversations that enforce social norms to arise more frequently in Hispanic cultures given the value places on conversation as a social activity, and the allowance for differences of opinion. In other cultural contexts, certain topics like health may be taboo to discuss, which could limit the role that conversations could play. If cultural norms differ with respect to discussing emotionally charged topics, this could influence how much social interactions matter and confirming these findings in other contexts will be important.

Conversation content matters

When I began delving into social interactions research, I found a dearth of research on the content of conversations about health communication campaigns, especially pictorial warnings. I was curious about whether conversations mattered, but I also wanted to know what people said about the warnings, and if what they said influenced their smoking behavior. I was encouraged to find that the topics of

conversation about the pictorial warnings included the health effects of smoking, cessation, and prevention of initiation. The topics discussed during conversation suggest that social interactions may spur smokers to process these messages more deeply. Indeed, we found that cognitive elaboration (i.e., thinking about the warnings or their message) explained how conversations influenced quit attempts.

After exploring what people said about the warnings, I wanted to know what role conversation content played in eliciting quit attempts. We found that smokers with pictorial warnings engaged in conversations describing the warnings as scary, depressing, and gross more frequently, and that the number of weeks a smoker had a conversation using those descriptors was associated with quit attempts. The relationship between negative emotional conversations and deciding to quit smoking may be due to one of three functions of emotion in the decision making process. First, the negative emotions in the conversations could act as information, for example at a decision point someone asks themselves, “How do I feel about smoking?” and use their feelings as information to make their choice. Second, they could act as a spotlight; the negative feelings during the conversations could cause smokers to focus on the warning message. Third, the emotional conversations could act as a motivator, for example thinking, “I don’t want to have these negative conversations, so I am going to quit.”¹³⁵ Our findings, similar to previous research about negative emotions,^{19,20,39,61} suggest that the warnings’ ability to evoke emotional conversations may help smokers add meaning to the facts in the warnings and in this way make pictorial warnings effective.

Conversation frequency diminishes over time

As expected, we found that conversations about cigarette pack warnings exhibit a partial wear-out effect; they decreased over time, but they remained higher than they were at baseline. This is consistent with previous research has found that the effects of mass media campaigns, including pictorial warnings, tend to partially or completely wear-out over time.^{24,57,136,137} Empirical data from advertising research offers two insights that may explain the sharp drop-off in conversations during the second week, and the gradual partial wear-out of conversations.

First, marketing research suggests that consumers who were highly motivated to process an advertisement (cared about the decision they were making, or knowledgeable about the product), and able to do so (sufficient time to process the advertisement), had faster wear-out times than those who were not motivated or able to process.¹³⁸ One could argue that smokers care about smoking since they are actively engaging in the behavior, and that because smokers carried the warning-labeled packs during the week, they had sufficient time to process the warnings. These mechanisms (motivation and ability to processes) may help us understand the sudden drop-off we see between the first and second week.

Second, the same review of marketing research suggests that emotional advertisements wear-out more slowly compared to advertisements relying on discursive processing.¹³⁸ This could explain why we see a partial wear-out during the four weeks the warnings were on the packs, rather than conversations returning to baseline levels. Another explanation could be desensitization to the warnings. Emotions characterized by high arousal such as anxiety or amusement, boost sharing more than emotions

characterized by low arousal, such as sadness or contentment.⁹³ However, as people are repeatedly exposed to the warnings on their cigarette packs, the warnings may not evoke high arousal emotions as strongly. We may be able to combat this desensitization to the warnings by refreshing the content of the warnings to stimulate conversations.

Future directions

My dissertation findings identify additional research that would help build the science of social interactions and warnings. First, making strong causal inferences about how conversations about pictorial warnings impact quit attempts requires more direct experimental manipulation of the conversations. To do this I would recruit friendship dyads where at least one person is a smoker to participate in an experiment manipulating whether or not they engage in conversation after viewing the warning. In the conversation condition, I would instruct the friends to “try to have a normal discussion, as though you saw one of the warnings on your friend’s pack, and one of you commented on it.” The pairs would be told the facilitator would be back in five minutes to administer the questionnaire, but that if they ran out of things to say, they could talk about something else. In the no conversation condition, participants would be shown the warnings, and they would then be instructed to complete the questionnaire without discussing their responses. This experimental design would allow me to look at the effect of conversation on quit intentions. Based on the findings of this dissertation, and previous research,^{22,24,57,110} I would expect that the increase in conversations would raise quit intentions.

Second, I would like to use experiments to explore whether media campaigns or social media can effectively spark conversations about the warnings, or whether

conversations have more impact if they occur organically. I could test two ways of encouraging social interactions by including either a call to action (e.g. “join the conversation”) or a social media hashtag (e.g.#warningsayswhat), using a control with neither for comparison. While conversations are associated with more quit attempts, it is possible that encouraging conversations about the warnings, rather than letting them happen organically, could have unintended consequences.⁴⁴ Thus, I expect that organic conversations would be more effective per the Theory of Psychological Reactance,¹³⁹ which hypothesizes that people may react in opposition to being told what to do.

Third, I am interested in delving deeper into the content of the conversations. Given the scarcity of research on conversational content in a tobacco control context, and the findings I have reported, I would like to know more about the content of these conversations. The current measurement approach treated a 1-minute conversation and a 30-minute conversation as being the same. A conversation that is deeply personal about the health effects of smoking counted the same as a conversation dismissing the health effects of smoking. I would like to explore how “quality” and quantity of conversations impacts quit attempts. Social Impact Theory identifies three factors that explain how our social environment affects us: strength, temporality, and number of people.¹⁴⁰ These dimensions of social impact are theorized to interact such that their effects are multiplicative. Adapting these dimensions specifically to conversations, I hypothesize that conversations about pictorial warnings will be most effective to the extent that they: 1) are strong or high in quality (i.e., meaningful conversations, or with conversations with important others); 2) occur frequently; and 3) involve as many different people as possible.

Conclusion

Social interactions help explain a part of the how and why pictorial warnings on cigarette packs influence quitting behavior. We should explore the processes through which social interactions exert their influence in other health campaigns to determine if the findings from this dissertation are generalizable into other content areas. Policy makers and health campaign designers should embrace the role that social interactions play, and seek ways to maximize the influence of social interactions.

Footnote

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APPENDIX: MEASURES

Note. t1=time 1 (baseline pretest), t2=time 2 (baseline post-test), t3=time 3 (week 1), t4=time 4 (week 2), t5=time 5 (week 3), t6=time 6 (week 4)

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Independent Variable	Exposure to pictorial cigarette pack warnings	N/A (manipulated variable)								
Dependent Variable (Aim 1, Aim 3) Mediator (Aim 2)	Social Interactions	In the last week, how many times did you talk to other people about the health warning on your cigarette packs?	1=Never 2=1-2 times 3=3-4 times 4=5-9 times 5=10 or more times		X		X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Dependent Variable (Aim 1)	Social Interactions	<p>[If answered something other than “never” to “In the last week, how many times did you talk to other people about the warning on your cigarette packs?”]</p> <p>In the last week, who did you talk to about the warnings? (Check all that apply.) My spouse or significant other Other family member My Child Friend Co-worker Medical professional Someone you did not previously know Other</p>	1=Yes 0=No				X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Dependent Variable (Aim 1)	Social Interactions	<p>[If answered something other than “never” to “In the last week, how many times did you talk to others about the warning on your cigarette packs?”]</p> <p>In the last week, did you talk about the warning with...? (Check all that apply.) Smokers Non-smokers Not sure</p>	<p>1=Yes 0=No</p>				X	X	X	X
Dependent Variable (Aim 1)	Social Interactions	<p>[If answered something other than “never” to “In the last week, how many times did you talk to others about the warning on your cigarette packs?”]</p> <p>Think about the last conversation you had about the warning. Who started the conversation?</p>	<p>1=Me 2=Someone else 3=Don’t remember</p>				X	X	X	X

Dependent Variable (Aim 1)	Social Interactions	<p>[If answered something other than “never” to “In the last week, how many times did you talk to others about the warning on your cigarette packs?”]</p> <p>Think about the conversations you had about the warning in the last week. What came up during these conversations?</p> <p>(Check all that apply.)</p> <p>The health effects of smoking</p> <p>Whether the warning would make me want to quit</p> <p>Whether the warning would make other smokers want to quit</p> <p>Whether the warning would stop people from starting to smoke</p> <p>Whether the warning should be on cigarette packs in the US</p> <p>Cigarette pack warnings in other countries</p> <p>Made fun of warning</p>	<p>1=Yes</p> <p>0=No</p>					X	X	X	X
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Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
		This research study Other								
Dependent Variable (Aim 1) Mediator (Aim 2) Covariate (Aim 3)	Social Interactions	<p>[If answered something other than “never” to “In the last week, how many times did you talk to others about the warning on your cigarette packs?”]</p> <p>Think about the conversations you had about the warning in the last week. Did you or the other person say that the warnings were...?</p> <p>(Check all that apply.)</p> <p>Scary Depressing, gloomy Stupid, pointless Judgmental, controlling Interesting, engaging Informative, useful Gross Silly Other</p>	1=Yes 0=No				X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Dependent Variable (Aim 1) Covariate (Aim 3)	Social Interactions	In the last week, how many times did you intentionally show someone the warning?	1=Never 2=1-2 times 3=3-4 times 4=5-9 times 5=10 or more times				X	X	X	X
Dependent Variable (Aim 1)	Social Interactions	In the last 4 weeks, have you posted about the warning on your cigarette packs on any of the following social media platforms? (Check all that apply.) Facebook Instagram Twitter MySpace Reddit Vine None of these Other	1=Yes 0=No							X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Dependent Variable (Aim 1)	Social Interactions	[if answered something other than “none of these” to social media question above] What did you post? (Check all that apply.) Comment about the warning Picture of the warning Comment about the study	1=Yes 0=No							X
Dependent variable (Aim 2) Covariate (Aim 3)	Quit attempts	During the last week, did you stop smoking for 1 day or longer because you were trying to quit smoking?	1=Yes 0=No	Adapted Centers for Disease Control and Prevention ¹⁴¹	X		X	X	X	X
Dependent variable (Aim 2) Covariate (Aim 3)	Quit attempts	Since you started the study, did you stop smoking for 1 day or longer because you were trying to quit smoking?	1=Yes 0=No	Adapted Centers for Disease Control and Prevention ¹⁴¹						X
Dependent Variable, (Aim 2, alternate)	Quit intentions	[SKIP if answered 0 to “On how many of the last 7 days did you smoke cigarettes?”] How interested are you in quitting smoking in the next month?	1=Not at all interested 2=A little interested 3=Somewhat interested 4=Very interested	Adapted from Klein, Zajac, Monin ¹⁴²	X	X	X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Dependent Variable, (Aim 2, alternate)	Quit intentions	[SKIP if answered 0 to “On how many of the last 7 days did you smoke cigarettes?”] How much do you plan to quit smoking in the next month?	1=Not at all 2=A little 3=Somewhat 4=Very much	Adapted from Klein, Zajac, Monin ¹⁴²	X	X	X	X	X	X
Dependent Variable, (Aim 2, alternate)	Quit intentions	[SKIP if answered 0 to “On how many of the last 7 days did you smoke cigarettes?”] How likely are you to quit smoking in the next month?	1=Not at all likely 2=A little likely 3=Somewhat likely 4=Very likely	Adapted from Klein, Zajac, Monin ¹⁴²	X	X	X	X	X	X
Mediator (Aim 2)	Recall	[Pictorial warning group] Think about the Surgeon General’s Warning that was on the side of the cigarette packs you used since your last visit. Tell us what the warning said.	(open ended)				X	X	X	X
Mediator (Aim 2)	Recall	[Pictorial warning group] Think about the <u>picture</u> in the warning that we put on the front and back of your cigarette packs. Please describe the picture.	(open ended)				X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2)	Recall	[Pictorial warning group] Think about the text on the warning that we put on the front and back of your cigarette packs. Tell us what the text said.	(open ended)				X	X	X	X
Mediator (Aim 2)	Recall	[Control group] Think about the Surgeon General's Warning that we put on the side of your cigarette packs. Tell us what the warning said.	(open ended)				X	X	X	X

Mediator (Aim 2, alternate)	Recognition	<p>[Pictorial warning group] Please select the text of any Surgeon General's Warnings that were on the side of the cigarette packs that you used since your last visit. (Check all that apply.)</p> <p>SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, and May Complicate Pregnancy.</p> <p>SURGEON GENERAL'S WARNING: Quitting Smoking Now Greatly Reduces Serious Risks to Your Health.</p> <p>SURGEON GENERAL'S WARNING: Smoking by Pregnant Women May Result in Fetal Injury, Premature Birth, and Low Birth Weight.</p> <p>Cigarette Smoke Contains Carbon Monoxide.</p>	<p>1=Yes 0=No</p>					X	X	X	X
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Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
		Don't know								
Mediator (Aim 2, alternate)	Recognition	[Pictorial warning group] Please select the picture in the warning that we put on the front and back of your cigarette packs.	1=teeth/diseased gums 2=tracheotomy 3=lungs 4=cancerous woman				X	X	X	X
Mediator (Aim 2, alternate)	Recognition	[Pictorial warning group] Please select the text on the warning label that we put on the front and back of your cigarette packs.	1=WARNING: Cigarettes cause cancer 2= WARNING: Cigarettes are addictive 3= WARNING: Cigarettes cause fatal lung disease 4= WARNING: Smoking can kill you				X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2, alternate)	Recognition	[Control group] Please select the text of the warning that we put on the side of your cigarette packs.	1= SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, and May Complicate Pregnancy. 2= SURGEON GENERAL'S WARNING: Quitting Smoking Now Greatly Reduces Serious Risks to Your Health. 3= SURGEON GENERAL'S WARNING: Smoking by Pregnant Women May Result in Fetal Injury, Premature Birth, and Low Birth Weight. 4= SURGEON GENERAL'S WARNING: Cigarette Smoke Contains Carbon Monoxide				X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2, alternate)	Attention/ noticing	How much did the warning grab your attention?	1=Not at all 2=A little 3=Somewhat 4=Quite a bit 5=Very much	Adapted from Nonnemaker et al. ⁹⁵			X	X	X	X
Mediator (Aim 2, alternate)	Attention/ noticing	In the last week, how often did you notice the warning?	1=Never 2=Rarely 3=Sometimes 4=Often 5=All the time				X	X	X	X
Mediator (Aim 2, alternate)	Attention/ noticing	In the last week, how often did you read or look closely at the warning?	1=Never 2=Rarely 3=Sometimes 4=Often 5=All the time	Fathelrahman et al. ¹⁰⁶			X	X	X	X
Mediator (Aim 2)	Cognitive elaboration	How much did the warning cause you to think about the harmful effects of smoking?	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Fathelrahman et al. ¹⁰⁶			X	X	X	X
Mediator (Aim 2)	Cognitive elaboration	When you notice your cigarette pack, how often do you think about the message that the warning conveys?	1=Never 2=Rarely 3=Sometimes 4=Often 5=All the time	Fathelrahman et al. ¹⁰⁶			X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2)	Cognitive elaboration	When your cigarette pack is not in sight, how often do you think about the message that the warning conveys?	1=Never 2=Rarely 3=Sometimes 4=Often 5=All the time	Fathelrahman et al. ¹⁰⁶			X	X	X	X
Mediator (Aim 2)	Subjective Norms-quitting	People who are important to me think I should quit smoking in the next 2 months.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Armitage. ¹⁰⁷	X		X	X	X	X
Mediator (Aim 2)	Subjective Norms-quitting	People who are important to me would approve of my quitting smoking in the next 2 months.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Armitage. ¹⁰⁷	X		X	X	X	X
Mediator (Aim 2)	Subjective Norms-quitting	People who are important to me want me to quit smoking in the next 2 months.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Armitage. ¹⁰⁷	X		X	X	X	X
Mediator (Aim 2)	Subjective Norms-quitting	When it comes to quitting smoking in the next 2 months, I want to do what people who are important to me think I should do.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Armitage. ¹⁰⁷	X		X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Covariate (Aim 3)	Positive smoking attitudes	Say how much you agree or disagree with each statement below. Cigarettes taste good.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Positive smoking attitudes	I enjoy the taste sensations while smoking.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Positive smoking attitudes	When I smoke, the taste is pleasant.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Positive smoking attitudes	I enjoy the flavor of a cigarette.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Positive smoking attitudes	If I'm tense, a cigarette helps me relax.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Covariate (Aim 3)	Positive smoking attitudes	When I'm angry, a cigarette can calm me down.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Positive smoking attitudes	Cigarettes help me deal with anxiety or worry.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Positive smoking attitudes	Smoking calms me down when I feel nervous.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Negative smoking attitudes	If I'm tense, a cigarette helps me relax.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Negative smoking attitudes	When I'm angry, a cigarette can calm me down.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Covariate (Aim 3)	Negative smoking attitudes	Cigarettes help me deal with anxiety or worry.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Negative smoking attitudes	Smoking calms me down when I feel nervous.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Brandon & Baker. ¹²⁰	X	X	X	X	X	X
Covariate (Aim 3)	Nicotine dependence	[SKIP if answered 0 to “On how many of the last 7 days did you smoke cigarettes?”] How soon after you wake up do you smoke your first cigarette?	1=Within 5 minutes 2=6-30 minutes 3=31-60 minutes 4=After 60 minutes	Fagerström Test for Nicotine Dependence ¹¹⁹	X					X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Blue?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely			X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Afraid?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵		X	X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Anxious?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Repelled?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	--		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...On edge?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Ashamed?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵ and Keller and Block. ¹⁴³		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Uneasy?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵		X	X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Sad?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Watson et al. ¹⁴⁴		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Scared?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵ and Watson et al. ¹⁴⁴		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Grossed out?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Regretful?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵ and Keller and Block. ¹⁴³		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Frightened?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵ and Watson et al. ¹⁴⁴		X	X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Guilty?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵ and Watson et al. ¹⁴⁴		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Disgusted?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker, et al. ⁹⁵		X	X	X	X	X
Covariate (Aim 3)	Emotional reactions	How much did the warning on your cigarette packs make you feel...Depressed?	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely			X	X	X	X	X
Covariate (Aim 3)	Smoking Frequency	On how many of the last 7 days did you smoke cigarettes?	0=0 days 1=1 day 2=2 days ... 7=7 days	PATH, 2014 ¹⁴⁵	X		X	X	X	X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Covariate (Aim 3)	Smoking quantity	[SKIP if answered 0 to “On how many of the last 7 days did you smoke cigarettes?”] On average, on those [fill in # of days from question above], how many cigarettes did you usually smoke each day? A pack usually has 20 cigarettes in it.	1-120 cigarettes per day	PATH, 2014 ¹⁴⁵	X		X	X	X	X
Demographic variable (Aim 1) Covariate (Aim 3)	Sex	What is your sex?	1=Male 2=Female 3=Transgender	Adapted from Path, 2014. ¹⁴⁵		X				
Demographic variable (Aim 1) Covariate (Aim 3)	Age	How old are you?	[number] years old	PATH, 2014 ¹⁴⁵		X				
Demographic variable (Aim 1) Covariate (Aim 3)	Hispanic ethnicity	Are you of Hispanic, Latino or Spanish origin?	0=No 1=Yes	2010 Census		X				

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Demographic variable (Aim 1) Covariate (Aim 3)	Race	What is your race? (Check all that apply.)	1=White 2=Black or African American 3=American Indian or Alaska Native 4=Asian 5=Native Hawaiian or Other Pacific Islander 6=Some other race (please specify)	2010 Census		X				
Demographic variable (Aim 1) Covariate (Aim 3)	Education	What is the highest degree or level of school you have completed?	1=Less than high school degree 2=High school graduate (or GED) 3=Some college or technical school 4=Associate's degree 5=Bachelor's degree 6=Graduate or professional degree	2010 Census		X				
Demographic variable (Aim 1) Covariate (Aim 3)	Sexual orientation	The next question is about your sexual orientation. Do you consider yourself to be...	1=Straight or heterosexual 2=Gay or lesbian 3=Bisexual	Williams Institute ¹⁴⁶		X				

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Demographic variable (Aim 1) Covariate (Aim 3)	Household income	Which of the following categories best describes your total household income in the last 12 months? [skip if household size >15]	[skip if did not answer household size] Response options were based on reported household size			X				

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