

UNDERSTANDING THE ROLE OF REACTANCE TO PICTORIAL WARNINGS ON  
CIGARETTE PACKS

Marissa G. Hall

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in  
partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department  
of Health Behavior in the Gillings School of Global Public Health.

Chapel Hill  
2017

Approved by:

Noel T. Brewer

Marcella H. Boynton

Seth M. Noar

Kurt M. Ribisl

Paschal Sheeran

© 2017  
Marissa G. Hall  
ALL RIGHTS RESERVED

## ABSTRACT

Marissa G. Hall: Understanding the Role of Reactance to Pictorial Warnings on Cigarette Packs  
(Under the direction of Noel T. Brewer)

**Background.** Pictorial cigarette pack warnings may be less effective if they elicit *reactance*, a motivation to resist a perceived threat to freedom. This dissertation developed and validated a brief version of the Reactance to Health Warnings Scale (RHWS). The dissertation also sought to determine the mechanisms by which pictorial warnings elicit stronger quit intentions and subsequent quit attempts, and whether reactance weakened the effect of the warnings.

**Methods.** To develop the Brief RHWS and to test mediation, I used data from a trial that randomly assigned 2,149 adult US smokers in 2014 and 2015 to receive pictorial warnings or text-only warnings on their cigarette packs for four weeks. To further evaluate the brief RHWS, I randomly assigned US adults ( $n=1,413$ ) to view pictorial or text warnings on digital images of cigarette packs.

**Results.** The three-item Brief RHWS had good internal consistency and test-retest reliability. The scale correlated with higher trait reactance ( $\beta=.32, p<.001$ ) and exposure to pictorial warnings ( $\beta=.21, p<.001$ ), supporting its convergent validity. With respect to predictive validity, the Brief RHWS was associated with lower perceived message effectiveness, lower quit intentions, greater avoidance of the warnings, and more cigarettes smoked per day (all  $p<.05$ ).

Pictorial warnings produced stronger quit intentions ( $p<.05$ ) which were associated with a greater likelihood of making a quit attempt ( $p<.001$ ). Negative affect toward the warnings

mediated the effect of pictorial warnings on quit intentions (mediated effect=.25,  $p<.001$ ), whereas message reactance suppressed the effect (mediated effect=-.06,  $p<.001$ ). Negative affect was associated with greater perceived likelihood of harm from smoking and anticipated regret of continuing to smoke, which were in turn associated with stronger quit intentions (all  $p<.05$ ).

**Conclusion.** The Brief RHWS can aid in the development of persuasive messages. Pictorial warnings elicited greater quit intentions, an effect that was stronger after accounting for message reactance. Negative affect appears to be a key mechanism by which pictorial cigarette pack warnings exert their effect on smoking-related cognitions and behaviors. Moreover, pictorial warnings changed risk appraisals and quit intentions indirectly through negative affect.

## **ACKNOWLEDGEMENTS**

Thank you to my dissertation committee for generously providing your time, feedback, and guidance throughout the dissertation-writing process. In particular, I thank my chair and mentor, Noel Brewer, for helping me become a better thinker, scientist, writer, and colleague. Thanks also to my amazing cohort and lab-mates who have taught me so much, as well as the dedicated faculty and staff in the Health Behavior department for supporting me. Finally, I thank my husband Patrick, my parents, brother, grandparents, and in-laws for cheering me on, as well as my new son Theo for being a fun distraction during the home-stretch.

I am incredibly grateful for the generosity of the funding sources that supported my time as a doctoral student, including the Gillings Merit Award, the Harry A. Guess Scholarship, the Department of Health Behavior, the Health Cognition and Behavior Lab, the Center for Regulatory Research on Tobacco Communication, the Marci Kramish Campbell Dissertation Award, and the Pre-doctoral Ruth L. Kirschstein National Research Service Award through the National Cancer Institute (Award #F31 CA196037-01A1).

## TABLE OF CONTENTS

LIST OF TABLES .....	ix
LIST OF FIGURES .....	xi
CHAPTER 1: OVERVIEW AND SPECIFIC AIMS .....	1
CHAPTER 2: LITERATURE REVIEW .....	5
Introduction.....	5
Overview of Conceptual Model.....	6
Impact of Pictorial Warnings on Quit Intentions .....	6
Mediation .....	7
Moderation.....	14
Significance and Implications of the Model .....	17
CHAPTER 3: REACTANCE TO HEALTH WARNINGS SCALE: DEVELOPMENT AND VALIDATION .....	20
Introduction.....	20
Methods.....	24
Participants.....	24
Procedures .....	25
Measures .....	26
Data Analysis .....	27
Results.....	30
Exploratory Factor Analysis .....	30
Scale Validity.....	30

Mediation of Impact of Warnings.....	31
Moderation by Smoking Status.....	33
Discussion.....	33
Conclusions.....	37
CHAPTER 4. PARENT STUDY AND POWER CALCULATIONS .....	56
Overview of Parent Study .....	56
Participants.....	56
Recruitment.....	56
Methods.....	56
Power Calculations .....	58
CHAPTER 5: A BRIEF MEASURE OF REACTANCE TO HEALTH WARNINGS .....	60
Introduction.....	60
Methods.....	61
Study 1 .....	61
Study 2 .....	65
Results.....	66
Scale Psychometrics.....	67
Convergent Validity.....	67
Predictive Validity .....	67
Discussion.....	68
Conclusions.....	71
CHAPTER 6: MEDIATORS OF THE EFFECT OF PICTORIAL CIGARETTE PACK WARNINGS ON QUIT INTENTIONS .....	81
Introduction.....	81

Methods.....	83
Participants.....	83
Procedures.....	83
Measures .....	84
Data Analysis .....	85
Results.....	86
Discussion .....	88
Conclusions.....	90
CHAPTER 7: DISCUSSION.....	97
Reactance Overview .....	98
Mediators Overview.....	98
Practical Implications of the Dissertation Research .....	99
Theoretical Implications of the Dissertation Research .....	100
Conclusions.....	102
APPENDIX I: MEASURES .....	103
APPENDIX II: AIM 3 FINDINGS.....	117
REFERENCES .....	119



## LIST OF TABLES

Table 3.1. Participant characteristics .....	38
Table 3.2. Correlates of reactance to health warnings .....	39
Table 3.3. Reactance scale conceptualization.....	40
Table 3.4. Correlations among reactance scale factors.....	41
Table 3.5. Psychometric properties of the Reactance to Health Warnings Scale .....	42
Table 3.6. Reactance scale test-retest reliability among smokers.....	45
Table 3.7. Mean factor scores, by experimental condition and smoking status .....	46
Table 3.8. Mediators of association between pictorial warning exposure and perceived effectiveness .....	47
Table 3.9. Mean reactance scores by warning, among smokers and non- smokers .....	48
Table 3.10. Multiple mediation of association between pictorial warning exposure and perceived effectiveness .....	49
Table 3.11. Mediators of association between pictorial warning exposure and motivational ability, among smokers .....	50
Table 3.12. Multiple mediation of association between pictorial warning exposure and motivational ability, among smokers.....	51
Table 3.13. Mediators of association between pictorial warning exposure and avoidance of warning, among smokers.....	52
Table 3.14. Multiple mediation of association between pictorial warning exposure and avoidance, among smokers .....	53
Table 5.1. Reactance items selected for item response theory testing, Study 1 .....	72
Table 5.2. Participant characteristics at baseline .....	74
Table 5.3. Brief Reactance to Health Warnings Scale.....	76
Table 5.4. Correlates of reactance to health warnings (brief form) .....	77

Table 5.5. Correlates of reactance to health warnings (long form) .....	78
Table 6.1. Participant characteristics ( $n=2,149$ ) .....	91
Table 6.2. Means and bivariate correlations among variables assessed in multiple mediation .....	93
Table 6.3. Mediation of association between pictorial warning exposure and quit intentions ( $n=2,149$ ).....	94

## LIST OF FIGURES

Figure 2.1. Original nine FDA pictorial warnings .....	18
Figure 2.2. Conceptual model .....	19
Figure 3.1. Pictorial warnings used in experiment .....	54
Figure 3.2. Mediation pathways.....	55
Figure 4.1. Warnings used in parent study .....	59
Figure 5.1. Pictorial warnings used in Studies 1 and 2 .....	79
Figure 5.2. Confirmatory factor analysis for Brief Reactance to Health Warnings Scale, Study 1 .....	80
Figure 6.1. Warnings used in trial.....	95
Figure 6.2. Structural equation model assessing impact of pictorial warnings on quit intentions and quit attempts ( $n=2,149$ ) .....	96
Figure A.1. Moderation of the relationship between pictorial warning exposure and message reactance ( $n=2,149$ ).....	118

## CHAPTER 1: OVERVIEW AND SPECIFIC AIMS

Tobacco use is the leading cause of preventable morbidity and mortality worldwide, causing nearly six million deaths each year (World Health Organization, 2013b). Health warnings on cigarette packages may help to discourage smoking initiation and increase cessation (Brewer, Hall, et al., 2016; Hammond, 2011; Noar, Hall, et al., 2016). The World Health Organization Framework Convention on Tobacco Control calls for large images on cigarette packs based on evidence that pictorial warnings may be more effective at communicating health risks than text-only warnings (World Health Organization, 2013a). Compared to text warnings, pictorial warnings also lead to greater quit intentions (Brewer, Hall, et al., 2016; Noar, Hall, et al., 2016), one of the most important predictors of smoking cessation (Hellman, Cummings, Haughey, Zielesny, & O'Shea, 1991; Hyland et al., 2006; Yong et al., 2014). However, the mechanisms by which pictorial warnings influence quit intentions are poorly understood. Characterizing these processes can help policymakers design warnings that elicit responses that increase quit intentions and, ultimately, smoking cessation.

Two frameworks have distinct predictions about how pictorial warnings may change smokers' quit intentions. The first framework posits that pictorial warnings are more effective than text-only warnings because they heighten affective and cognitive risk appraisals. Following the Sheeran et al. (2014) risk appraisals framework, I will focus on four risk appraisals: perceived likelihood of experiencing the harms of smoking, perceived severity of the harms of smoking, fear elicited by the warnings, and anticipated regret of continuing to smoke. Health

behavior and communication theory predicts that pictorial warnings will amplify these risk appraisals which, in turn, may increase quit intentions (Ajzen, 1991; Loewenstein, Weber, Hsee, & Welch, 2001; E. Peters, Lipkus, & Diefenbach, 2006; Rosenstock, 1974; Witte, 1992; Zeelenberg & Pieters, 2007).

However, pictorial warnings may have unintended consequences. A second framework suggests that although some people may react to a pictorial warning by adapting in a self-protective way like quitting smoking, others may exhibit message reactance (i.e., a motivation to resist a health message in response to a perceived threat to one's freedom) (Brehm, 1966). Brehm's (1966; 1993) Theory of Psychological Reactance posits that individuals experiencing reactance may seek to reassert control in response to a perceived threat to freedom. Thus, reactance may cause a "boomerang response," in which people act in opposition to what the message advocates. Several studies have explored reactance to pictorial warnings, but these studies typically look only at whether pictorial warnings cause reactance, rather than whether reactance leads to unintended consequences like lower quit intentions or increased smoking (Erceg-Hurn & Steed, 2011; Nonnemaker, Choiniere, Farrelly, Kamyab, & Davis, 2015). Moreover, these studies have not explored whether reactance undermines the effects of perceived likelihood, perceived severity, fear, and anticipated regret on quit intentions.

In my dissertation, I explore the intervening mechanisms through which pictorial warnings strengthen quit intentions, with attention to whether reactance offsets these effects. The dissertation used data from an FDA/NCI-funded trial (i.e., the parent study) that randomly assigned 2,149 adult smokers to receive a pictorial warning or a text warning on their cigarette packs for four weeks. My dissertation aims are to:

**Aim 1. Develop a reliable and valid brief measure of reactance to health warnings.**

Activities to address this aim:

- a. Create a brief version of the Reactance to Health Warnings scale, focusing on items that performed well in preliminary research;
- b. Conduct confirmatory factor analysis with the brief scale to determine the dimensionality of the scale; and
- c. Evaluate the reliability and construct validity of the brief scale.

**Aim 2. Empirically test a conceptual model of how pictorial warnings influence quit**

**intentions, examining whether reactance suppresses this relationship.** Activities to address this aim:

- a. Specify a structural equation model with good model fit;
- b. Determine whether risk appraisals (perceived likelihood, perceived severity, fear, and anticipated regret) mediate the relationship between pictorial warning exposure and quit intentions; and
- c. Determine whether reactance suppresses the overall positive effect of pictorial warnings on quit intentions (i.e., inconsistent mediation).

**Aim 3. Examine whether positive attitudes toward smoking, positive smoker prototypes, nicotine dependence, self-efficacy to quit smoking, response efficacy of quitting smoking, or trait reactance moderate the relationship between pictorial warning exposure and reactance.** Activities to address this aim:

- a. Determine whether interaction terms are statistically significant in the moderated mediation model from Aim 2; and

- b. Probe the statistically significant interactions to determine the magnitude and direction of moderated relationships.

## **CHAPTER 2: LITERATURE REVIEW**

### **Introduction**

Tobacco remains the leading cause of preventable death globally, causing nearly six million deaths each year (World Health Organization, 2013b). Pictorial cigarette pack warnings are a promising strategy for communicating the health risks of smoking and increasing quit intentions (Brewer, Hall, et al., 2016; Hammond, 2011; Noar, Francis, Bridges, Sontag, Brewer, et al., 2016; Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016; Noar, Hall, et al., 2016). Based on strong preliminary evidence of their superiority over text warnings, the World Health Organization Framework Convention on Tobacco Control calls for large pictorial warnings to be placed on cigarette packs (World Health Organization, 2013a). As of 2016, 105 countries – representing 58% of the world’s population – had implemented policies requiring pictorial warnings (Canadian Cancer Society, 2016). The US, however, has used the same set of four text-only warnings for more than 30 years. Smokers are habituated to these warnings and seldom notice them; the Institute of Medicine declared that the current text warnings have become “unnoticed and stale” and “fail to convey relevant information in an effective way” (Institute of Medicine, 2007).

The 2009 Family Smoking Prevention and Tobacco Control Act requires that pictorial warnings depicting the health risks of smoking appear on the top half of the front and back of all cigarette packs (United States Public Laws, 2009). After courts struck down nine pictorial warnings that were initially proposed (Figure 2.1), the US Food and Drug Administration (FDA)



responded with plans to develop a set of pictorial warnings that will withstand legal challenges (Kraemer & Baig, 2013). Additional research on the impact of pictorial warnings could guide FDA's efforts and could also inform the selection of new candidate warnings in the 105 countries that require pictorial cigarette pack warnings.

The mechanisms by which pictorial warnings influence quit intentions are not well understood. A 2016 meta-analysis of 37 pictorial warning experiments found that pictorial warnings increased quit intentions, but the eight studies that measured quit intentions did not examine mediators of the effect (Noar, Hall, et al., 2016). Moreover, the studies in the meta-analysis assessed more than 25 different outcome variables, indicating little consensus about the mechanisms by which pictorial warnings exert their effects. To address these gaps, this dissertation presents a conceptual model of how pictorial warning exposure influences quit intentions among smokers.

### **Overview of Conceptual Model**

My conceptual model depicts the emotional and cognitive responses that I predict will mediate and moderate the association between pictorial warning exposure and quit intentions (Figure 2.2). This model uses quit intentions as the dependent variable because quit intentions have been shown to prospectively predict cessation behavior in several studies (Hellman et al., 1991; Hyland et al., 2006; Yong et al., 2014).

### **Impact of Pictorial Warnings on Quit Intentions**

Models from social psychology, health behavior, and persuasion literatures suggest that pictorial warnings will increase quit intentions more than text-only warnings via the mechanisms described below (Ajzen, 1991; Brehm, 1966; Loewenstein et al., 2001; Nonnemaker, Farrelly, Kamyab, Busey, & Mann, 2010; Rosenstock, 1974; Sheeran, Harris, & Epton, 2014; Witte,

1992). The observational literature has been inconclusive about the relationship between countries implementing pictorial warnings and quit intentions (Monarrez-Espino, Liu, Greiner, Bremberg, & Galanti, 2014; Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016). However, the literature on experiments conducted largely in controlled settings paints a clearer picture; the 2016 meta-analysis found that pictorial warnings were associated with higher quit intentions than text warnings (effect size  $d=.54$ ,  $k=8$ ) (Noar, Hall, et al., 2016). Thus, I predict that pictorial warnings will elicit higher quit intentions than text-only warnings.

### **Mediation**

Theory suggests that pictorial warnings may be more effective than text-only warnings by eliciting affective and cognitive risk appraisals, as defined by Sheeran et al. (2014). This conceptual model includes four distinct risk appraisals: perceived likelihood of experiencing the harms of smoking, perceived severity of the harms of smoking, fear elicited by the warnings, and anticipated regret of continuing to smoke.

First, perceived likelihood of harm (i.e., beliefs about one's vulnerability of experiencing harms) may play a central role in how pictorial warnings exert their effects. Pictorial warnings convey information about the health risks of smoking through vivid imagery and accompanying text, and thus may increase smokers' perceived likelihood of experiencing the harms of smoking, such as cancer or heart disease. Perceived likelihood may predict intentions and protective health behavior, as suggested in several theories based on expectancy-value approaches including the Health Belief Model (Rosenstock, 1974), the Extended Parallel Process Model (Witte, 1992), Protection Motivation Theory (Rogers, 1975), and the Prototype/Willingness Model (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). According to these theories, individuals assess the

likelihood of potential health outcomes and then use this information to choose a best course of action, which may motivate changes in intentions and behavior.

Meta-analyses of observational studies have consistently found associations of perceived likelihood with intentions and with health behaviors (Brewer et al., 2007; Floyd, Prentice-Dunn, & Rogers, 2000; Gerrard, Gibbons, & Bushman, 1996; Harrison, Mullen, & Green, 1992; Katapodi, Lee, Facione, & Dodd, 2004; Milne, Sheeran, & Orbell, 2000; Witte, 1992). More recently, Sheeran et al. (2014) meta-analyzed experimental studies that successfully changed perceived likelihood, finding that perceived likelihood was associated with greater intentions ( $d=.36$ ,  $k=131$ ) and behavior ( $d=.25$ ,  $k=56$ ).

Evidence from pictorial warning studies stands in contrast to the above-described meta-analyses. Noar, Hall, et al. (2016) found that pictorial warnings did not increase perceived likelihood of harm in the five studies that measured this construct ( $d=.02$ ,  $p=.65$ ,  $k=8$ ). Likewise, an experiment published after the Noar, Hall, et al. (2016) search of the literature found that pictorial warnings did not increase perceived likelihood more than text-only warnings among 63 smokers in Germany (Sussenbach, Niemeier, & Glock, 2013). Two studies from a systematic review of the observational literature on pictorial warnings examined perceived likelihood as an outcome (Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016). Wardle et al. (2010) found that perceived likelihood of experiencing health problems from smoking did not increase after the United Kingdom implemented pictorial warnings (Wardle et al., 2010). Likewise, a study of 587 smokers in Australia found that the perceived likelihood of getting several smoking-related health conditions did not change after pictorial warnings were introduced in 2005 (Miller, Hill, Quester, & Hiller, 2011). Although pictorial warning studies have not found effects for perceived

likelihood, this construct warrants greater attention given its importance in health behavior theories and supporting evidence across a range of health behaviors.

Another cognitive risk appraisal that may explain how pictorial warnings influence quit intentions is perceived severity, or beliefs about how detrimental the consequences of a health problem are. Several theories, also based on expectancy-value approaches, propose that health interventions change intentions and behavior via perceived severity, including the Health Belief Model (Rosenstock, 1974), Protection Motivation Theory (Rogers, 1975), and the Extended Parallel Process Model (Witte, 1992). In line with these theories, pictorial warnings could generate higher levels of perceived severity by depicting the health consequences of smoking with vivid and often gruesome imagery.

Similar to perceived likelihood, observational reviews have demonstrated a link between perceived severity and protective health behaviors (Brewer et al., 2007; DiMatteo, Haskard, & Williams, 2007; Floyd et al., 2000; Harrison et al., 1992; Milne et al., 2000; Witte & Allen, 2000). For example, a meta-analysis of 34 studies found that perceived severity was associated with greater vaccination rates (pooled  $r=.16$ ,  $k=32$ ) (Brewer et al., 2007). The Sheeran et al. (2014) experimental meta-analysis found that, in intervention studies targeting a wide range of behaviors that changed perceived severity, perceived severity was associated with higher intentions ( $d=.32$ ,  $k=44$ ) and behavior ( $d=.34$ ,  $k=23$ ).

Few studies have examined whether pictorial warnings increase perceived severity. Noar, Hall, et al. (2016) could not synthesize data on perceived severity because only one study measured the construct. This study found that pictorial warnings increased perceived severity more than text-warnings ( $d=.80$ ,  $p<.05$ ) in a sample of 88 adult smokers in Germany (Schneider, Gadinger, & Fischer, 2012). A systematic review of the observational literature again found only

one study that measured perceived severity (Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016). This study concluded that perceived severity of getting gangrene, emphysema, and clogged arteries increased significantly after pictorial warning implementation in Australia (Miller et al., 2011). Although the literature on pictorial warnings and perceived severity is sparse, theory and initial evidence indicates the relevance of the construct as a potential mechanism of changes in intentions and behavior.

Research and theory also indicate that emotional risk appraisals can inform health decision-making (E. Peters et al., 2006). In particular, the gruesome and emotionally-evocative content of pictorial warnings may elicit fear, or a negative anticipatory emotion in response to a danger or threat (S. Levy & Guttman, 1976; Loewenstein et al., 2001; Witte, 1992). According to the Parallel Process Model (Leventhal, 1971), Protection Motivation Theory (Rogers, 1975), and the Extended Parallel Process Model (Witte, 1992), fear appeals (such as pictorial warnings) may encourage individuals to respond in an adaptive, self-protective way, changing their intentions or behavior in order to reduce the threat to their health. Peters et al. (2006) describe four ways that affect (including fear) can guide the construction of health-related preferences and values, ultimately motivating changes in intentions and behavior. First, affect can serve as *information*, cueing or guiding health-related judgments. Affect can also act as a *spotlight*, altering attention to health information. Emotions may also serve as a *motivator*, directly influencing behavioral intentions and actions. Finally, affect can act as a *common currency*, allowing individuals to weigh positive and negative feelings in order to compare different options (E. Peters et al., 2006). These four functions of affect may help to explain how fear-evoking pictorial warnings influence smoking-related intentions and behavior.

Empirically, fear has been shown to be an important motivator of change across multiple health behaviors, including smoking (Witte & Allen, 2000). Sheeran et al. (2015) meta-analyzed intervention studies that changed anticipatory emotion (defined as fear, worry or anxiety), finding that greater anticipatory emotion was associated with greater intentions ( $d=.31$ ,  $k=97$ ) and protective behavior ( $d=.21$ ,  $k=46$ ). The 2016 meta-analysis of pictorial warning experiments found that pictorial warnings increased negative affective reactions, including fear, more than text-only warnings ( $d=.54$ ,  $k=11$ ) (Noar, Hall, et al., 2016). However, none of the studies in the systematic reviews of observational studies measured fear (Noar, Francis, Bridges, Sontag, Brewer, et al., 2016).

Finally, anticipated regret of continuing to smoke may play a role in how pictorial warnings exert their effects. Anticipated regret can be defined as a negative feeling smokers expect to experience in the future upon realizing that they have made the wrong decision in continuing to smoke (Brewer, DeFrank, & Gilkey, 2016; Lazuras, Chatzipolychroni, Rodafinos, & Eiser, 2012; Loewenstein et al., 2001; Sheeran et al., 2014; Zeelenberg & Pieters, 2007). Regret has both affective and cognitive elements and thus can be described as a cognitive emotion. The vivid imagery and informational content of pictorial warnings may stimulate anticipated regret among smokers. Regret Regulation Theory suggests that anticipated regret, in turn, may motivate individuals to change their intentions and behavior in order to avoid experiencing regret in the future (Zeelenberg & Pieters, 2007).

Three meta-analyses provide empirical support for these theorized predictions. Sandberg and Conner (2008) meta-analyzed observational studies of the theory of planned behavior and found that anticipated regret was associated with greater intentions (pooled  $r=.47$ ,  $k=25$ ). Anticipated regret was also associated with behavior change (pooled  $r=.28$ ,  $k=8$ ) (Sandberg & Conner, 2008).

Another recent meta-analysis of observational studies found that greater anticipated regret was associated with stronger intentions (pooled  $r=.50$ ,  $k=80$ ) and higher likelihood of engaging in health behaviors (pooled  $r=.29$ ,  $k=48$ ) (Brewer, DeFrank, et al., 2016). Sheeran et al. (2014) meta-analyzed intervention studies that successfully changed anticipated emotions, which includes regret, guilt, and shame. They found that these interventions led to greater intentions ( $d=.27$ ,  $k=10$ ) and behavior ( $d=.30$ ,  $k=3$ ). To my knowledge, no studies have examined the impact of pictorial warnings on anticipated regret. Neither the experimental meta-analysis nor the observational systematic review included studies that measured anticipated regret (Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016; Noar, Hall, et al., 2016). Accordingly, anticipated regret merits greater examination in the context of pictorial cigarette pack warnings.

In sum, four risk appraisals – perceived likelihood of harm, perceived severity, fear, and anticipated regret – may play an important role in how pictorial warnings influence quit intentions. Based on the above-described theory and research, I expect that these four risk appraisals will mediate the effect of pictorial warnings on quit intentions.

However, communication theory and evidence suggest that the fear-evoking content of pictorial warnings may cause some smokers to experience reactance, originally defined as a motivation to restore one's freedom when that freedom is threatened (Brehm, 1966; Brehm & Brehm, 1981). Unlike most theoretical constructs that help to elucidate why and how individuals adopt health-promoting attitudes and behavior, reactance may help to explain why some individuals react in opposition to health messages or interventions (Rains, 2013). Scholars have explored two types of reactance in greater depth: *trait* reactance, a personality characteristic reflecting one's predisposition to be reactant across various situations, and *state* reactance (sometimes called psychological reactance or situational reactance), which refers to reactance in

response to a specific situation or message. As my dissertation focuses on state reactance, I hereafter use the term “reactance” to refer to this construct. Chapter 3 includes a detailed description of my definition and operationalization of reactance.

Examining reactance in the context of tobacco control may be particularly important given industry marketing around themes of “freedom.” A recent review of tobacco industry documents and news articles found that the tobacco industry has strategically incorporated themes of freedom in marketing and public relations messages (Friedman, Cheyne, Givelber, Gottlieb, & Daynard, 2015). For example, a marketing campaign for blu eCigs®, a prominent e-cigarette producer, employs the slogan “Take Back Your Freedom,” emphasizing individuals’ freedom to use tobacco products without interference from government regulation or public health interventions. Thus, tobacco industry rhetoric may heighten smokers’ feelings that their freedom to smoke is increasingly threatened, potentially exacerbating reactance to tobacco control campaigns.

Several theories, including the Theory of Psychological Reactance (Brehm, 1966; Brehm & Brehm, 1981), the Parallel Process Model (Leventhal, 1971), and the Extended Parallel Process Model (Witte, 1992) posit that health warning messages may provoke reactance. These theories contend that individuals may attempt to restore their freedom by rejecting the health message or derogating its source or content. The Extended Parallel Process Model suggests that fear may heighten reactance, especially when self-efficacy is low (Witte, 1992). Thus, the fear-evoking imagery of pictorial warnings may be more likely to provoke reactance than text-only warnings, potentially undermining their positive effects.

Evidence on pictorial warnings supports these hypothesized relationships. Although none of the studies in the observational systematic review measured reactance (Noar, Francis, Bridges,



Sontag, Ribisl, et al., 2016), the experimental meta-analysis found that pictorial warnings increased reactance more than text-only warnings ( $d=.50$ ,  $k=4$ ) (Noar, Hall, et al., 2016). However, the two studies that measured reactance looked only at the emotional element of reactance (Erceg-Hurn & Steed, 2011; Nonnemaker et al., 2010). Erceg-Hurn & Steed (2011) measured reactance using four items asking participants to rate how irritated, angry, annoyed, and aggravated the warnings made them. Similarly, Nonnemaker (2010) asked participants how much the pack of cigarettes made participants feel angry and annoyed. However, the authors combined anger and annoyance with other negative emotions such as disgust and worry. These emotions may operate very differently (Lerner, Gonzalez, Small, & Fischhoff, 2003; Lerner & Keltner, 2001), calling into question the rationale for combining the anger dimension of reactance with other negative emotions.

Our recent study on reactance randomly assigned 597 adult smokers to view a pictorial warning or text-only warning, finding that pictorial warnings elicited more reactance on five of the scale's factors: *anger*, *exaggeration*, *government*, *manipulation*, and *personal attack* (all  $p<.05$ ). These five dimensions of reactance each partially suppressed the positive relationship between pictorial warning exposure and intention to quit smoking ( $p<.05$ ; see Chapter 3). Based on the above-described theory and evidence, I expect that reactance will weaken the effect of pictorial warnings on quit intentions.

### **Moderation**

Finally, my dissertation will explore several variables that may moderate the relationship between pictorial warning exposure and reactance. First, the Theory of Psychological Reactance posits that the importance of the behavior in question can influence the extent to which persuasive messages provoke reactance such that reactance may be heightened when the

behavior is perceived as highly important to an individual (Brehm, 1966). Therefore, in the context of pictorial warnings, positive attitudes toward smoking (e.g., “Smoking is enjoyable”) may moderate the relationship between pictorial warnings and reactance. I expect that the positive relationship will be stronger among those with positive attitudes toward smoking than those without positive attitudes toward smoking. Another construct related to the importance of smoking is smoker prototypes (Gerrard et al., 2008), or individuals’ perceptions of a “typical smoker.” Research has found that smoker prototypes are strong predictors of attitudes and behavior (Gibbons & Eggleston, 1996; Gibbons & Gerrard, 1995; Hall, Ribisl, & Brewer, 2014). Those who view smoking as important may attribute positive characteristics (e.g., sexy or cool) to the “typical smoker” and subsequently may be more reactant to perceived threats to freedom (Brehm, 1966). Therefore, I predict that the positive relationship between pictorial warning exposure and reactance will be stronger for those with positive smoker prototypes than for those without positive smoker prototypes. Finally, nicotine dependence may be another proxy measure of the importance of smoking to an individual. Thus, I predict that the positive relationship between exposure to pictorial warnings and reactance will be stronger for those with high nicotine dependence than those with low nicotine dependence.

The Extended Parallel Process Model suggests that boomerang effects of reactance may be less pronounced among individuals with high *self-efficacy* to change their behavior and high *response efficacy*, defined as the belief that changing behavior will produce positive health benefits (Witte, 1992). In other words, high self-efficacy and response efficacy may reduce reactance and thus amplify the intended effects of health interventions. Indeed, Sheeran et al. (2014) observed the largest effects on intentions and behavior when risk appraisals, self-efficacy, and response efficacy were all heightened. As the pictorial warnings used in the parent study are

not designed to increase efficacy, I will examine *baseline* levels of self-efficacy and response efficacy as potential moderators. I predict that baseline quitting self-efficacy will moderate the positive relationship between pictorial warning exposure and reactance such that the relationship will be stronger for those with low quitting self-efficacy than those with high self-efficacy. Likewise, I predict that baseline response efficacy will moderate the positive relationship between pictorial warning exposure and reactance such that the relationship will be stronger for those with low response efficacy compared to those with high response efficacy.

Finally, reactance theory suggests that trait reactance, which is characterized by a high desire for autonomy and resistance to authority (Brehm & Brehm, 1981; Burgoon, Alvaro, Grandpre, & Voulodakis, 2002; Dillard & Shen, 2005), may amplify reactivity to health communication interventions. In support of this hypothesis, Dillard and Shen (2005) found that reactance to dental hygiene health messages was highest when both perceived message threat and trait reactance were high, and lowest when both were low. However, the authors did not find the same interaction when looking at messages about binge drinking (Dillard & Shen, 2005). Quick and Stephenson (2008) provide further support for trait reactance as a moderator of the relationship between health messages and reactance. The authors found that, in the context of sunscreen usage, the relationship between perceived message threat and reactance was stronger among people with high trait reactance compared to those with low trait reactance (Quick & Stephenson, 2008). Thus, I predict that trait reactance will moderate the positive relationship between pictorial warning exposure and reactance such that the relationship will be stronger for those with high trait reactance compared to those with low trait reactance.

### **Significance and Implications of the Model**

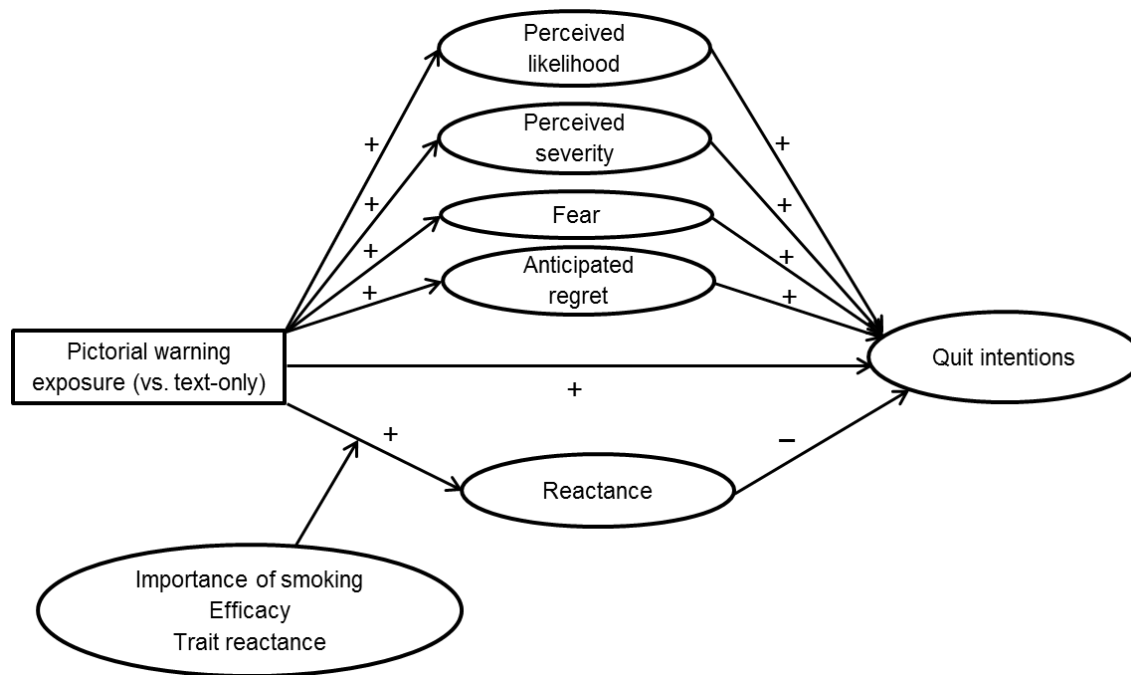
Exploring the mediators of the association between pictorial warnings and quit intentions can help policymakers develop more effective warnings that could lower smoking rates and reduce the health burden of smoking. A deeper understanding of the processes through which exposure to pictorial warnings influences quit intentions can inform the design of effective cigarette pack warnings that elicit minimal reactance. Examining moderators of the relationship between pictorial warning exposure and reactance may also highlight possibilities for designing better pictorial warnings. For example, if self-efficacy emerges as a significant moderator as expected, pictorial warnings that encourage smokers' quitting self-efficacy may help to minimize the extent to which the warnings generate reactance.

The findings of the dissertation research could guide the selection of new or additional warnings with the greatest impact in the US and the many countries with pictorial warnings already in place. This study's results could also be relevant to the development of effective warning messages for other tobacco products, such as hookah and electronic cigarettes. Finally, understanding the processes by which pictorial warnings impact psychosocial and behavioral outcomes may help refine existing social psychology, health behavior, and communication theories.

Figure 2.1. Original nine FDA pictorial warnings



Figure 2.2. Conceptual model



## CHAPTER 3: REACTANCE TO HEALTH WARNINGS SCALE: DEVELOPMENT AND VALIDATION<sup>1</sup>

### Introduction

Health messaging is an increasingly popular tool for encouraging people to engage in healthier behaviors, such as vaccination and cancer screening. However, reactance to persuasive health messages may undermine the impact of those messages. *Reactance* is “the motivational state that is hypothesized to occur when a freedom is eliminated or threatened” (Brehm 1981, p. 37). Two theories provide support for the idea that reactance to health warnings may undermine their impact. First, the Theory of Psychological Reactance (Brehm, 1966; Brehm & Brehm, 1981) posits that in response to feeling that one’s freedom is threatened, some individuals may experience reactance, which can, in turn, result in undesirable outcomes. Second, the Extended Parallel Process Model (EPPM) suggests that, under certain circumstances (e.g., low self-efficacy), fear-inducing messages may provoke resistance to those messages that includes, but is not limited to, defensive avoidance, denial, and reactance (Witte, 1992; Witte & Allen, 2000).

Reactance has been defined and operationalized in a variety of ways. Jack Brehm, the originator of the Theory of Psychological Reactance, argued that reactance could not be measured directly (Brehm & Brehm, 1981). However, in recent years, several researchers have

---

<sup>1</sup> This chapter previously appeared as an article in *Annals of Behavioral Medicine*. The original citation is as follows: Hall, M. G., Sheeran, P., Noar, S. M., Ribisl, K. M., Bach, L. E., & Brewer, N. T. (2016). Reactance to health warnings scale: Development and validation. *Annals of Behavioral Medicine*, 50(5), 736-750. doi: 10.1007/s12160-016-9799-3.

operationalized reactance as a combination of anger and counterarguments against the message, frequently measured using a thought-listing task (Dillard & Shen, 2005; Gollust & Cappella, 2014; Quick, 2012; Rains, 2013; Rains & Turner, 2007). In addition, EPPM defines reactance as the state that “occurs when perceived freedom is reduced and an individual believes that the communicator is trying to make him or her change” (Witte 1992, p. 332). Researchers testing EPPM have operationalized reactance as a combination of perceived manipulation, message minimization, and message derogation (Witte, 1994).

Drawing on this rich body of empirical and conceptual work, we define reactance as an emotional and cognitive resistance to a warning, characterized by 1) a perceived threat to one’s freedom, 2) anger, and 3) counterarguments against the warning such as denial or derogation. The threat to freedom component of reactance captures beliefs about being manipulated, personally affronted, and intruded upon; this component reflects cognitive resistance to a perceived loss of liberty engendered by the warning. The counterarguing component captures cognitive responses to the warning in terms of both its value (the warning provides no new or useful information) and its relevance to the self (the warning does not speak to me or my circumstances). Potential consequences of reactance, such as avoidance of the warning or increased urges to smoke, are not included in our conceptualization as these constructs should be construed as outcomes, and not components, of reactance.

Examining reactance in the context of tobacco control may be particularly important as tobacco remains the leading cause of preventable morbidity and mortality, causing nearly six million deaths each year worldwide (World Health Organization, 2013b). A recent review of tobacco industry documents and news articles found that the tobacco industry has strategically incorporated themes of freedom in marketing and public relations messages (Friedman et al.,



2015). For example, a marketing campaign for blu eCigs®, a prominent e-cigarette producer, employs the slogan “Take Back Your Freedom,” emphasizing individuals’ freedom to use tobacco products without interference from government regulation or public health interventions. Thus, tobacco industry rhetoric may heighten smokers’ feelings that their freedom to smoke is increasingly threatened, potentially exacerbating reactance to tobacco control campaigns.

Pictorial cigarette pack warnings with vivid images depicting the health consequences of smoking are an especially promising tobacco control strategy (Noar, Hall, & Brewer, 2015). Compared to text warnings, pictorial warnings are more effective at communicating the health risks of smoking, increasing quit intentions, and potentially encouraging cessation (Brewer, Hall, et al., 2016; Hammond, 2011; Huang, Chaloupka, & Fong, 2014; Noar, Hall, et al., 2016). A recent meta-analysis of 37 experimental cigarette pack warning studies found that pictorial warnings were more effective than text warnings for 20 of 25 outcomes, including intention to quit smoking (Noar, Hall, et al., 2016). However, the review found that pictorial warnings caused greater reactance than text warnings ( $d = -.46$ ,  $p < .001$ ). This finding supports fear appeals theory, which suggests that warnings that are threatening will produce greater reactance than warnings that are not threatening (Leventhal, 1971; Witte, 1992). Pictorial warnings are typically gruesome and vivid, and therefore likely to be more threatening, than text-only warnings. Thus, we propose our first hypothesis: Pictorial warnings will elicit greater reactance than text-only warnings (Hypothesis 1).

The Theory of Psychological Reactance suggests that reactance will be heightened when the behavior being challenged is perceived as highly important to the individual (Brehm, 1966). As smokers place greater importance on smoking than non-smokers, they may feel more strongly that health warnings threaten their freedom to smoke and therefore exhibit greater reactance.

This leads to our second hypothesis: Smokers will experience greater reactance to cigarette pack warnings than non-smokers (Hypothesis 2).

The Theory of Psychological Reactance also posits that the importance of the focal behavior in question and perceived threat to freedom can interact, such that reactance may be heightened when the behavior is perceived as highly important (Brehm, 1966; Brehm & Brehm, 1981).

Therefore, we offer a third hypothesis: Smoking status will moderate the relationship between pictorial warnings and reactance, such that pictorial warnings will elicit more reactance than text-only warnings among smokers, but this difference will be smaller for non-smokers (Hypothesis 3).

Fear appeals and reactance theory suggests that reactance to fear-inducing health messages may partially undermine the positive effect of those messages (Leventhal, 1971; Witte, 1992). Specifically, reactance may weaken the intended impact of the message (e.g., quitting smoking) or lead to boomerang effects (e.g., increased smoking). Experimental studies have focused on whether pictorial warnings increase reactance, but have not explored whether reactance undermines their positive effects (Erceg-Hurn & Steed, 2011; LaVoie, Quick, Riles, & Lambert, 2015; Nonnemaker et al., 2010). Thus, we explore the potential undermining effects of reactance through three additional hypotheses. Reactance will partially suppress the positive relationship between pictorial warning exposure and perceived effectiveness of the warnings (Hypotheses 4). Reactance will partially suppress the positive relationship between pictorial warning exposure and the warning's ability to motivate quitting. (Hypothesis 5). Reactance will partially mediate the positive relationship between pictorial warning exposure and avoidance of the warnings (Hypothesis 6).

Studying reactance can shed light on how smokers and non-smokers respond to cigarette pack warnings and can provide vital information for enhancing public health initiatives to curb tobacco use. A high-quality measure of reactance to health warnings may help researchers and policymakers to accurately characterize the effects of reactance on psychosocial and behavioral outcomes. However, the field lacks a validated and reliable measure of reactance to health warnings. In the present research, we therefore sought to develop and evaluate the psychometric properties of a new reactance scale using data from both a large-scale, national survey and an intensive longitudinal study of smokers. We sought to examine experimentally whether reactance weakens the ability of the warning to motivate quitting but strengthens motivation to avoid the warnings.

## **Methods**

### **Participants**

In May 2014, we recruited a convenience sample of 1,500 US cigarette smokers and non-smokers ages 18 or older through Amazon Mechanical Turk (MTurk). MTurk, a web-based platform, is widely used for social science research and is known to generate reliable and valid data (Buhrmester, Kwang, & Gosling, 2011; Paolacci & Chandler, 2014; Peer, Vosgerau, & Acquisti, 2014). The recruitment message encouraged smokers to participate. We excluded 87 respondents who failed standard procedures for ensuring data quality, leaving an analytic sample of 1,413 respondents.

In July and August 2014, we recruited 46 North Carolina smokers ages 18 or older to participate in a four-week cigarette pack labeling study previously described by Brewer et al. (2015). We defined current smoking as having smoked at least 100 cigarettes during one's lifetime and currently smoking every day or some days (Jamal et al., 2016). We excluded

pregnant women, people who smoke only roll-your-own cigarettes, and cigarillo-only smokers. Demographic characteristics of the online study and pack labeling study participants appear in Table 3.1.

## **Procedures**

Participants in the online study took a survey while viewing an image of an unbranded cigarette pack with a randomly assigned warning on the top half. They viewed one of five randomly assigned warnings with an image depicting the health consequences of smoking and related text ( $n=1,204$ , Figure 3.1) or one of the same five warnings without the image ( $n=209$ ). The pictorial warnings were a subset of the nine warnings that the US Food and Drug Administration (FDA) proposed for implementation in 2011, but are not currently in use due to a court challenge (Kraemer & Baig, 2013). We used unequal random assignment (6:1) to allocate more participants to the pictorial warning condition, allowing us to perform our scale development work with smokers who saw the pictorial warnings. Randomization to pictorial or text condition yielded equivalent groups on eight of nine variables, including trait reactance, although participants had lower levels of education in the text than in the pictorial condition ( $p<.05$ ; Table 3.1). Participants received \$3 for completing the survey.

Participants in the pack labeling study visited our study offices at baseline and then once a week for four weeks, completing a survey on a computer at each visit. Smokers brought eight days' worth of cigarettes to the first four appointments. We randomly assigned participants to receive one of five pictorial warnings also used in the online study. While participants were taking the survey, study staff removed the package cellophane and applied the same pictorial warning label to the top half of the front and rear panels of each cigarette pack. At the final appointment, each participant received information about smoking cessation resources.

Participants received a cash incentive at the end of each visit, totaling \$185. The University of North Carolina at Chapel Hill Institutional Review Board approved both study protocols.

## **Measures**

*Item development.* To develop the Reactance to Health Warnings Scale, we created 87 survey items that fit the reactance dimensions (i.e., anger, perceived threat to freedom, and counterarguing against the warning) described in the introduction. To develop the items, we relied on previously published measures (Dillard & Peck, 2000; Dillard & Shen, 2005; McQueen, Vernon, & Swank, 2013), qualitative studies that captured the natural language people use when talking about reactance (Moracco et al., 2016; Wolburg, 2006), and feedback from tobacco and reactance researchers on both item wording and whether our items reflected the dimensions we were intending to measure.

*Online study.* Smokers completed all 87 reactance items, while non-smokers answered a subset of 69 of the items that excluded 18 items relevant only to smokers. We randomized the order of the reactance items in five blocks. The five-point response scale ranged from “strongly disagree” (coded as 1) to “strongly agree” (coded as 5).

To allow us to examine construct validity of the scale, the survey assessed trait reactance (Hong & Page, 1989), trait anger (Novaco, 2003), internal locus of control (Levenson, 1974; Sapp & Harrod, 1993), state anxiety (Marteau & Bekker, 1992; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), social desirability (impression management subscale) (Paulhus, 1991), and smoker prototypes (Gerrard et al., 2008; Pepper et al., 2013). The survey assessed perceived effectiveness of the warning using two items that asked participants to rate how much the warning would discourage non-smokers from smoking and make non-smokers concerned about the health effects of smoking. Among smokers, the survey assessed avoidance with ten items that

asked how much smokers would try to avoid the warning (e.g., “How likely is it that you would try to avoid thinking about the warning on your cigarette packs?”), adapted from the Population Assessment of Tobacco and Health Study (Population Assessment of Tobacco and Health Study, 2014). Finally, among smokers, the survey assessed the warning’s motivational ability with the question “How much would having this warning on your cigarette packs make you want to quit smoking?” Cronbach’s alpha for multi-item measures was .70 or higher (for details, see Table 3.2).

*Pack labeling study.* We assessed reactance with the scale developed in the online study. Again, we randomized the order of the items. We report data on reactance for three time points: immediately after viewing the assigned warning that we had applied to their cigarette packs at the first appointment (i.e., baseline), at week 1, and at week 4.

## **Data Analysis**

Analyses used SPSS Statistics version 19.0 and Stata version 13.1 with two-tailed tests and a critical alpha of .05. Analyses used data from the online survey, unless otherwise noted.

*Factor analysis.* To identify reactance factors, we conducted exploratory factor analysis with direct oblimin rotation using data from smokers who viewed pictorial warnings online ( $n=510$ ), as this is the primary population of interest for pictorial cigarette pack warnings. To identify the number of reactance factors to retain, we used visual inspection of scree plots and eigenvalues greater than 1 (Kaiser & Caffrey, 1965). For each factor, we identified three items with high factor loadings and the greatest conceptual coherence. We then ran a confirmatory factor analysis using data from non-smokers ( $n=816$ ) as further validation of the results from the exploratory factor analysis. We evaluated several indicators of model fit, including the root mean square error of approximation ( $RMSEA<.08$ ) (Steiger, 1990), the Tucker-Lewis Index ( $TLI>.90$ )

(Tucker & Lewis, 1973) and the Bentler Comparative Fit Index ( $CFI > .90$ ) (Bentler, 1990). We estimated correlations between all nine factors and then calculated mean factor scores and internal reliability using Cronbach's alpha, separately for smokers and non-smokers. We also calculated factors' test-retest reliability between baseline, week 1, and week 4 using data from the pack labeling study.

*Validity.* To assess convergent, discriminant, and predictive validity, we examined the correlations between the reactance factors with hypothesized variables among participants in the online study. For convergent validity, we derived our hypotheses from the Theory of Psychological Reactance (Brehm, 1966; Brehm & Brehm, 1981), anticipating that reactance factors would correlate positively with higher trait reactance, being a smoker, and greater positive smoker prototypes. For discriminant validity, we expected that reactance factors would not be correlated with trait anger, state anxiety, internal locus of control, or socially desirable responding, as these are hypothesized to be conceptually distinct constructs from reactance. In terms of predictive validity, we drew upon the fear appeals literature (Leventhal, 1971; Witte, 1992) and hypothesized that reactance factors would be negatively associated with perceived effectiveness of the warnings and motivational ability, and positively associated with avoidance of the warnings. Predictive validity analyses initially controlled for trait reactance, but the pattern of results was similar and we thus report unadjusted correlations.

*Mediation of the impact of warnings.* Using data from smokers and non-smokers, we examined how study condition (pictorial vs. text warning) and smoking status affected perceived effectiveness and reactance factor scores using a 2x2 between-subjects analyses of variance. To determine whether reactance differed among the pictorial conditions, we performed analyses of variance with post-hoc Tukey tests.

We conducted mediational analyses for each reactance factor using three different outcomes, with the goal of determining whether suppression or mediation was occurring (Figure 3.2). Suppression occurs when the direct and mediated effects have opposite signs, in this case demonstrating that the mediator detracts from the effectiveness of pictorial warnings (MacKinnon, Krull, & Lockwood, 2000). In contrast, a direct and mediated effect with the same sign signals mediation, indicating that the mediator contributes to the effectiveness of pictorial warnings (MacKinnon et al., 2000). We report results as unstandardized path coefficients ( $\beta$ ).

Mediation analyses controlled for education, which differed across conditions. First, we examined the extent to which each reactance factor mediated the relationship between pictorial warning exposure and perceived effectiveness of the warning. Then, among smokers, we examined mediation between pictorial warning exposure and the warning's motivational ability. Finally, we repeated analyses with avoidance as the dependent variable, among smokers. We then ran multiple mediation analyses with each of the three outcomes using the factors that emerged as statistically significant mediators in simple mediation models. Mediation analyses used bootstrapped 95% confidence intervals with 5,000 repetitions; this approach does not assume that indirect effects are normally distributed (Hayes, 2009). Mediation results appear in Tables 3.8, 3.10, 3.11, 3.12, 3.13, and 3.14. In all tables, the *a* column lists the association between pictorial warning exposure and reactance factors. The *b* column depicts the association between the reactance factors and the outcome, controlling for pictorial warning exposure. The *c* column depicts the association between pictorial warning exposure and the outcome, and the *c'* column lists the association between pictorial warning exposure and the outcome, controlling for the reactance factors. The *mediated effect* column represents  $a*b$ , which is the same as  $c-c'$ .



*Moderation by smoking status.* Using data from smokers and non-smokers, we tested whether smoking status moderated the effect of pictorial warnings on reactance and perceived effectiveness using 2x2 between-participants analyses of variance.

## **Results**

### **Exploratory Factor Analysis**

Exploratory factor analysis of data from smokers exposed to pictorial warnings ( $n=510$ ) revealed a ten-factor solution. Eigenvalues for the factors ranged from 32.9 to 1.0. We examined other solutions (including four, six, and nine factors), but they yielded solutions that were less conceptually meaningful. We dropped one factor that did not have clear loadings.

The resulting 27-item scale had nine factors with clear conceptual meaning (Table 3.3). The confirmatory factor analysis model with non-smokers fit the data well (RMSEA=.05, CFI=.96, TLI=.95). Correlations between reactance factors appear in Table 3.4. The factors had high internal consistency among smokers in the online study (median  $\alpha=.83$ ) and in the pack labeling study (median  $\alpha=.72$ ; Table 3.5). The factors had good test-retest reliability at one week (median  $r=.69$ ), three weeks (median  $r=.62$ ), and four weeks (median  $r=.62$ ; Table 3.6) among smokers in the pack labeling study. A non-smoker version of the scale, which includes the six factors asked of non-smokers in the online study, also showed high reliability (median  $\alpha=.82$ ; Table 3.5).

### **Scale Validity**

Convergent validity analyses found that higher reactance factor scores were associated with higher trait reactance (median  $r=.30$ , Table 3.2) in the online study, as expected. Scores on all reactance factors, except for *common knowledge*, were higher among smokers, providing support for Hypothesis 2 (median  $r=.20$ ). Six of nine factors (all but *common knowledge*, *personal attack*, and *discounting*) correlated with having more positive smoker prototypes (median  $r=.15$ ).

Discriminant validity analyses revealed that most reactance factors correlated weakly and inconsistently with trait anger, internal locus of control, state anxiety, and social desirability (median  $r$  ranged from  $-.07$  to  $.08$ ).

Predictive validity analyses among online study smokers demonstrated that all reactance factors except for *common knowledge* and *discounting* were associated with lower perceived effectiveness of the warning (median  $r = -.15$ ; Table 3.2). Eight of nine factors (all but *discounting*) were associated with lower motivational ability (median  $r = -.28$ ). Eight of nine factors (all but *common knowledge*) were associated with greater avoidance of the warning (median  $r = .18$ ).

### **Mediation of Impact of Warnings**

*Reactance.* Supporting Hypothesis 1, pictorial warnings elicited greater reactance than text warnings on five factors, (*anger, exaggeration, government, manipulation, and personal attack*; all  $p < .05$ , Tables 3.7 and 3.8) among online study participants. In contrast, the text warnings engendered higher ratings of *common knowledge* than the pictorial warnings ( $p < .05$ ). Pictorial and text warnings elicited similar scores on the remaining two factors (*derogation* and *discounting*). Comparisons of the five warnings in the pictorial condition revealed few differences in reactance (Table 3.9).

*Perceived effectiveness.* Pictorial warnings generated higher perceived effectiveness than text warnings ( $\beta = .38$ ,  $p < .001$ ; Tables 3.7 and 3.8). Mediation analyses showed that four reactance factors (*anger, exaggeration, government, and manipulation*) suppressed the relationship between exposure to pictorial warnings and perceived effectiveness, providing support for Hypothesis 4. The decrease in warning effectiveness attributable to reactance ranged from  $\beta = -.05$  to  $-.09$  (all  $p < .05$ , Table 3.8). *Common knowledge* exhibited the opposite pattern,

mediating rather than suppressing the association. Pictorial warning exposure elicited lower levels of *common knowledge* which, in turn, led to lower perceived effectiveness (increase in path coefficients=.02;  $p<.05$ ). Derogation did not mediate the relationship between pictorial warning exposure and perceived effectiveness. Multiple mediation analyses of significant suppressors revealed that *exaggeration* and *government* each suppressed the relationship between pictorial warning exposure and perceived effectiveness (total mediated effect=-.10;  $p<.05$ ; Table 3.10).

*Warnings' motivational ability.* Smokers rated pictorial warnings as being more able to motivate quitting than text warnings ( $\beta=.30$ ,  $p<.001$ ; Tables 3.7 and 3.11). Supporting Hypothesis 5, mediation analyses showed that five reactance factors (*anger*, *exaggeration*, *government*, *manipulation*, and *personal attack*) each suppressed the relationship between pictorial warning exposure and participants' evaluation of the warning's ability to motivate quitting. The decrease in motivational ability attributable to reactance ranged from  $\beta=-.07$  to  $-.19$  (all  $p<.05$ ). Again, *common knowledge* mediated, rather than suppressed, the association ( $p<.05$ ). The remaining factors did not mediate or suppress the relationship between pictorial warning exposure and motivational ability. Multiple mediation analyses revealed that *anger*, *exaggeration*, and *government* each suppressed the relationship between pictorial warning exposure and warning's motivational ability (total mediated effect=-.19;  $p<.05$ ; Table 3.12).

*Avoidance.* Smokers reported wanting to avoid pictorial warnings more than text warnings ( $\beta=.57$ ,  $p<.001$ ; Tables 3.7 and 3.13). Pictorial warnings elicited greater *anger*, *exaggeration*, *government*, *manipulation*, and *personal attack*, which, in turn, were associated with higher avoidance, consistent with Hypothesis 6. The increase in path coefficients ranged from  $\beta=.05$  to  $.13$  (all  $p<.05$ ). The remaining factors did not mediate the association between pictorial

warnings and avoidance. Multiple mediation analyses revealed that *anger* remained the only significant mediator of the association between pictorial warning exposure and avoidance (total mediated effect=.09;  $p<.05$ ; Table 3.14).

### **Moderation by Smoking Status**

Smoking status did not moderate the effect of pictorial warnings on reactance or perceived effectiveness (Hypothesis 3; interaction with reactance factors  $F$  range=.00-.93, all  $p>.33$ ; Table 3.7).

## **Discussion**

The Reactance to Health Warnings Scale builds on decades of fear appeals theory and reactance research that conceptualizes reactance as an amalgam of perceived threat to freedom, anger, and counterarguing against the warning. Our findings support the importance of assessing these three features of reactance, using a 9-factor scale, in two samples (smokers and non-smokers recruited online, and smokers recruited in North Carolina). The Reactance to Health Warnings Scale had good psychometric properties; the scale was reliable and exhibited convergent, discriminant, and predictive validity. Pictorial warnings elicited greater reactance than text-only warnings on five of nine factors (Hypothesis 1), and scores on all but one reactance factor were higher among smokers than non-smokers (Hypothesis 2). We did not find support for Hypothesis 3, as smoking status did not moderate the effect of pictorial warnings on reactance. Potential explanations for this null finding include the smaller cell sizes for smokers and for the text-only condition. In addition, the potential threat to freedom imposed by the warning was hypothetical in nature for both smokers and non-smokers, which could have minimized differential reactions to pictorial warnings. Finally, the lack of an interaction could indicate that smokers and non-smokers simply do not experience differential levels of reactance

to pictorial warnings. Future research could provide insight as to whether this finding is replicated in other circumstances.

Crucially, reactance was negatively associated with perceived effectiveness of the warning and motivational ability, and was positively associated with avoidance. Moreover, reactance partially attenuated the impact of pictorial (vs. text) warnings on perceived effectiveness (Hypothesis 4) and motivational ability (Hypothesis 5) in an experimental test. Reactance also partially mediated the association between pictorial warnings and avoidance (Hypothesis 6).

The present research offers a more comprehensive and nuanced view of reactance compared to previous research. Previous studies distinguished between anger and negative cognitions as components of reactance (Dillard & Shen, 2005; Rains, 2013), and this distinction was also supported here. However, the present findings indicate that reactance to health warnings involves not merely anger and undifferentiated negative thoughts about the message; rather, cognitive features of reactance appear to involve a suite of eight distinct responses to messages. These eight factors appear to reflect two key pieces of the definition of reactance: perceived threat to freedom (e.g., *government* and *manipulation* factors) and counterarguing (e.g., *exaggeration* and *discounting* factors).

The importance of these distinctions became apparent in analyzing the impact of type of warning (pictorial vs. text) on outcomes. Five reactance factors – *anger*, *exaggeration*, *government*, *manipulation*, and *personal attack* – attenuated the impact of pictorial cigarette pack warnings on the warning’s motivational ability and mediated the impact on avoidance of the warnings. Four of these five factors (all but *personal attack*) weakened the impact of pictorial warnings on perceived effectiveness. In multiple mediation analyses, *anger* suppressed the impact of pictorial warnings on the warning’s motivational ability and avoidance. *Government*

and *exaggeration* both suppressed the impact of pictorial warnings on perceived effectiveness and motivational ability.

Taken together, these analyses indicate the key role of *anger* in attenuating the effectiveness of pictorial warnings. *Government* and *manipulation* – two factors that reflect the belief that one's freedom has been threatened – also detracted from the effectiveness of pictorial warnings. *Exaggeration*, a type of counterarguing, consistently weakened the impact of the warnings. In this study, other counterarguing factors (e.g., *self-relevance*, *common knowledge*, *derogation*, and *discounting*) did not suppress the impact of pictorial warnings. However, we must acknowledge that the present research concerned one particular set of warnings, and other counterarguing factors could weaken the impact of other warnings. For instance, it is possible that warnings that invite smokers to identify with images of smokers who have developed lung cancer could lead to counterarguing in the form of *self-relevance* or *discounting*, whereas warnings that emphasize the carcinogenic properties of cigarettes could engender *common knowledge* and *derogation* as forms of counterarguing. Further research is needed to test these possibilities.

Few experiments have examined whether pictorial warnings lead to greater reactance than text warnings. Erceg-Hurn and Steed (2011) randomly assigned 250 Australian adult smokers to view pictorial or text warnings; pictorial warnings led to more reactance than text warnings. However, the study measured only the emotional element of reactance (e.g., angry, annoyed), but not the cognitive components of reactance. Moreover, the study focused on assessing whether pictorial warnings predicted greater reactance, rather than whether reactance undermined message impact. More recently, LaVoie (2015) randomly assigned 435 US college students to view a pictorial or text-only warning, assessing reactance using the Dillard and Shen (2005)

measure of anger and cognition. They found that pictorial warnings increased counterarguing, but not anger, and they did not examine whether reactance weakened the impact of the warnings on smoking-related outcomes. The present research thus fills an important gap in the literature by undertaking formal analyses to test whether reactance attenuates the impact of pictorial warnings on key outcomes. Our findings also offer experimental evidence to support the results of one previous observational warning label study that found a negative relationship between exaggeration and quit intentions (Yong et al., 2014).

Understanding the role of reactance should help to inform tobacco control policy. The 2009 Family Smoking Prevention and Control Act mandated that pictorial warnings appear on the top half of the front and back of all cigarette packs in the US (United States Public Laws, 2009). However, tobacco industry litigation has prevented FDA from implementing the 9 warnings that it developed (Nonnemaker et al., 2010). FDA is currently in the process of developing a set of pictorial warnings that will withstand legal challenges (Kraemer & Baig, 2013). Experimental evidence supports the superiority of pictorial warnings over text warnings on numerous outcomes, including quit intentions (Noar, Hall, et al., 2016). Moreover, observational studies conducted before and after pictorial warning implementation have demonstrated increases in knowledge about smoking risks (Brennan, Durkin, Cotter, Harper, & Wakefield, 2011), calls to quitlines (Young et al., 2014), and foregoing cigarettes (Yong et al., 2013). The present research also highlights the promise of pictorial warnings as an effective tobacco control strategy, as pictorial warnings were viewed as more motivating than text warnings. Given the large body of research indicating the effectiveness of pictorial warnings, it would be unwise to conclude that pictorial warnings are counterproductive simply because they produce reactance, as others have done (LaVoie et al., 2015). However, our research suggests that reactance may *partially* weaken

the impact of pictorial warnings on perceived effectiveness and the ability of the warning to motivate quitting, although text-only warnings performed worse overall. The impact of reactance on smoking behavior represents a challenging but important direction for future research.

Strengths of our study include our use of an experimental design and the inclusion of both smokers and non-smokers. Moreover, our new scale has a strong conceptual grounding and may fill an important gap for researchers. However, our use of convenience samples means that the generalizability of findings to other populations will need to be established in future work. The magnitude of some correlations in our convergent validity analyses was modest; further testing may help to strengthen the case for the scale's construct validity.

## **Conclusions**

The Reactance to Health Warnings Scale is a valid and reliable measure of reactance to health warnings that benefits from experimental evidence that several components of reactance weakened the impact of exposure to pictorial warnings on multiple outcomes. This scale may prove useful to tobacco control researchers, for instance, in evaluating anti-smoking public service announcements or warnings about other tobacco products such as electronic cigarettes. Moreover, the Reactance to Health Warning Scale can readily be adapted to other types of anti-tobacco messages (e.g., public service announcements) and other health behaviors (e.g., diet, physical activity, sun protection), and could prove valuable to researchers in health psychology, health communication, and behavioral medicine. Future research should validate the scale in different populations (e.g., adolescents, Spanish-speakers), and should also examine the behavioral effects of reactance to health warnings.



Table 3.1. Participant characteristics

	Online study, pictorial condition (n=1,204)		Online study, text-only condition (n=209)		Pack carrying study (n=46)	
	n	(%)	n	(%)	n	(%)
Smoker						
No	694	(57.6)	122	(58.4)	0	(.0)
Yes	510	(42.4)	87	(41.6)	46	(100.0)
Age						
18-24 years	257	(21.3)	42	(20.1)	2	(4.4)
25-39 years	659	(54.7)	113	(54.1)	17	(37.0)
40-54 years	200	(16.6)	40	(19.1)	15	(32.6)
55+ years	88	(7.3)	14	(6.7)	12	(26.1)
Mean (SD)	33.5	(11.4)	34.1	10.9	42.5	(12.0)
Gender						
Female	565	(47.0)	102	(48.8)	26	(56.5)
Male	632	(52.6)	107	(51.2)	20	(43.5)
Transgender	4	(.3)	0	(.0)	0	(.0)
Sexual orientation						
Straight	1071	(89.4)	179	(86.5)	40	(87.0)
Gay	42	(3.5)	8	(3.9)	4	(8.7)
Bisexual	78	(6.5)	20	(9.7)	1	(2.2)
Other or missing	7	(.6)	0	(.0)	1	(2.2)
Hispanic	85	(7.1)	16	(7.7)	6	(13.3)
Race						
White	958	(79.6)	155	(74.2)	20	(43.5)
Black or African American	80	(6.6)	17	(8.1)	16	(34.8)
Asian	77	(6.4)	17	(8.1)	2	(4.4)
Other/Multiracial	80	(6.6)	18	(8.6)	8	(17.4)
American Indian or Alaska Native	9	(.7)	2	(1.0)	0	(.0)
Education						
High school degree or less	124	(10.3)	35	(16.8)	9	(19.6)
Some college	534	(44.4)	80	(38.5)	23	(50.0)
College graduate	433	(36.0)	77	(37.0)	11	(23.9)
Graduate degree	112	(9.3)	16	(7.7)	3	(6.5)
Household income, annual						
\$0-\$24,999	333	(27.7)	66	(31.6)	19	(46.3)
\$25,000-\$49,999	381	(31.7)	64	(30.6)	11	(26.8)
\$50,000-\$74,999	236	(19.6)	32	(15.3)	7	(17.1)
\$75,000+	252	(21.0)	47	(22.5)	4	(9.8)
Trait reactance, mean (SD)	2.97	(.69)	2.93	(.70)	2.97	(.59)

*Note.* Missing demographic data range from 0 to 8 participants. In online study, demographics were similar between conditions, except for education ( $p < .05$ ).

Table 3.2. Correlates of reactance to health warnings

	Mean (SD)	Range	$\alpha$	Anger $r$	Self- relevance $r$	Common knowledge $r$	Exagg- eration $r$	Factors Govern- ment $r$	Manip- ulation $r$	Personal attack $r$	Dero- gation $r$	Discou- nting $r$	Med- ian $r$
<b>Convergent/ discriminant validity</b>													
Trait reactance	2.96 (.69)	1-5	.86	.37**	.27**	.13**	.23**	.34**	.30**	.37**	.32**	.18**	.30
Smoker status				.28**	--	.00	.23**	.26**	.12**	--	.17**	--	.20
Positive smoker prototypes	2.69 (.73)	1-5	.78	.25**	.10*	-.09**	.28**	.25**	.15**	.02	.17**	.02	.15
Trait anger	2.94 (.63)	1-5	.93	.07*	.13*	.12**	-.01	.04	-.01	.14*	.02	.07	.07
Internal locus of control	3.50 (.65)	1-5	.81	-.13**	-.19**	.07*	-.15**	-.05	-.15**	-.06	-.09**	.01	-.09
State anxiety	1.78 (.61)	1-4	.87	.24**	.04	-.04	.10**	.08*	.14**	.14*	.08*	.03	.08
Social desirability	4.04 (.96)	1-7	.84	-.13**	.02	-.03	-.06*	-.11**	-.10**	-.07	-.12**	.01	-.07
<b>Predictive validity</b>													
Perceived effectiveness	2.88 (.91)	1-4	.83	-.22**	-.14**	-.06	-.19**	-.24**	-.15**	-.11*	-.36**	.03	-.15
Motivational ability	2.35 (1.06)	--	--	-.36**	-.18**	-.25**	-.33**	-.47**	-.28**	-.26**	-.52**	.02	-.28
Avoidance of warning	2.73 (.92)	1-5	.88	.39**	.16**	.02	.18**	.29**	.28**	.33**	.17**	.13**	.18

Note. Data from online study ( $n=1,413$ ). Shaded rows include data from smokers only,  $n=597$ .

--=not asked of non-smokers.

\*  $p < .05$ , \*\*  $p < .001$

Table 3.3. Reactance scale conceptualization

Factor	Factor definition
Anger	Feeling of annoyance or hostility toward health warning
Self-relevance	Perception that health warning is not personally relevant
Common knowledge	Belief that information in health warning is already well-known
Exaggeration	Belief that health warning is overstated
Government	Resistance to government intrusion via health warning
Manipulation	Perception of threat to freedom imposed by health warning
Personal attack	Belief that health warning is a personal insult or affront
Derogation	Belief that the health warning is worthless
Discounting	Disregarding immediacy of the harms in health warning

Table 3.4. Correlations among reactance scale factors

	<b>Factors</b>								
	1	2	3	4	5	6	7	8	9
Anger (1)	1.00	--	.06	.52	.59	.57	--	.65	--
Self-relevance (2)	<b>.37</b>	1.00	--	--	--	--	--	--	--
Common knowledge (3)	<b>.16</b>	<b>-.04</b>	1.00	-.07	.18	.10	--	.17	--
Exaggeration (4)	<b>.52</b>	<b>.60</b>	<b>.00</b>	1.00	.48	.42	--	.55	--
Government (5)	<b>.65</b>	<b>.31</b>	<b>.33</b>	<b>.45</b>	1.00	.44	--	.60	--
Manipulation (6)	<b>.67</b>	<b>.36</b>	<b>.12</b>	<b>.56</b>	<b>.54</b>	1.00	--	.46	--
Personal attack (7)	<b>.72</b>	<b>.36</b>	<b>.22</b>	<b>.45</b>	<b>.54</b>	<b>.60</b>	1.00	--	--
Derogation (8)	<b>.62</b>	<b>.40</b>	<b>.22</b>	<b>.58</b>	<b>.58</b>	<b>.56</b>	<b>.56</b>	1.00	--
Discounting (9)	<b>.17</b>	<b>.41</b>	<b>.11</b>	<b>.25</b>	<b>.18</b>	<b>.17</b>	<b>.15</b>	<b>.11</b>	1.00

*Note.* Bold data below diagonal are for smokers. Not bold data above the diagonal are for non-smokers. --=not asked of non-smokers.

Table 3.5. Psychometric properties of the Reactance to Health Warnings Scale

	Mean (SD)	Anger	Self-relevance	Common knowledge	Factor Loadings							Median $\alpha$
					Exaggeration	Government	Manipulation	Personal attack	Derogation	Discounting		
<b>SMOKERS</b> ( $n=510$ , online study)												
This warning makes me feel aggravated	2.65 (1.26)	.95										
This warning annoys me	2.78 (1.34)	.77										
This warning irritates me	2.89 (1.34)	.76										
This warning is meant for other smokers, not me <sup>a</sup>	2.14 (1.08)		.74									
This warning is not relevant to me	2.32 (1.09)		.71									
This warning is only meant for hard-core smokers	2.38 (1.15)		.69									
The information in this warning is common knowledge	4.06 (.93)			.73								
I've heard the information in this warning a million times	4.07 (1.00)			.71								
I already knew about the harms in this warning	4.26 (.93)			.67								
The health effect on this warning is overblown	2.41 (1.17)				.63							
This warning exaggerates the health effects of smoking	2.35 (1.15)				.61							
This warning is misleading	2.14 (1.17)				.59							
Smoking is legal, so the government should stop interfering with smokers' freedom	3.39 (1.23)					.90						
The government shouldn't require warnings like this on packs	3.10 (1.35)					.71						

	Mean (SD)	Factor Loadings									Med- ian $\alpha$
		Anger	Self- relevance	Common know- ledge	Exagg- eration	Govern- ment	Manip- ulation	Personal attack	Derog- ation	Discount- ing	
It's not the government's job to warn me about the risks of smoking	3.15 (1.27)					.71					
This warning is trying to manipulate me	3.23 (1.30)						.53				
This warning is manipulating smokers	2.99 (1.24)						.45				
This warning is trying to boss me around <sup>b</sup>	2.62 (1.24)						.34				
This warning tells me I'm bad because I smoke <sup>a</sup>	2.93 (1.29)							.53			
This warning tells me that I'm stupid <sup>c</sup>	2.69 (1.27)	.37						.45			
I am being told that I am a fool by this warning <sup>a</sup>	2.93 (1.27)							.34			
This warning is pointless	2.36 (1.20)								.67		
This warning is stupid	2.37 (1.20)								.62		
This warning is useless	2.44 (1.19)								.58		
I'll quit long before I suffer the health effect in this warning <sup>a</sup>	3.35 (1.07)									.55	
I would worry more about this warning if I expected to smoke for many years <sup>a</sup>	3.44 (1.18)									.48	
The health effect in this warning won't catch up to me for a long time <sup>a</sup>	2.96 (1.12)									.40	
Eigenvalues		32.9	6.0	3.9	2.2	1.8	1.6	1.4	1.1	1.0	
Factor mean (SD)	--	2.78 (1.22)	2.28 (1.10)	4.13 (.76)	2.30 (.98)	3.22 (1.12)	2.95 (1.08)	2.85 (1.10)	2.39 (1.08)	3.25 (.83)	
Cronbach's alpha	--	.92	.83	.75	.86	.84	.80	.83	.88	.58	.83
<b>SMOKERS</b> ( $n=46$ , pack- carrying study)											
Factor mean (SD, baseline)		2.04 (.97)	1.66 (.59)	3.71 (.82)	1.80 (.75)	2.40 (.89)	1.96 (.89)	2.03 (.91)	1.77 (.79)	2.49 (.86)	

	Mean (SD)	Factor Loadings									Median $\alpha$
		Anger	Self-relevance	Common knowledge	Exaggeration	Govern-ment	Manip-ulation	Personal attack	Derog-ation	Discount-ing	
Cronbach's alpha (baseline)		.92	.52	.69	.75	.67	.76	.78	.72	.65	.72
<b>NON-SMOKERS</b> ( $n=816$ , online study)											
Factor mean (SD)	--	2.13 (1.03)	--	4.13 (.64)	1.87 (.77)	2.68 (1.03)	2.68 (.96)	--	2.05 (.90)	--	
Cronbach's alpha	--	.91	--	.64	.80	.83	.77	--	.85	--	.82

*Note.* Table shows factor loadings greater than .30. SD = standard deviation. Eigenvalues and factor loadings are from the exploratory factor analysis with 87 items, showing the items we retained in the scale.

<sup>a</sup> Item not asked of non-smokers

<sup>b</sup> Wording used with non-smokers: "This warning is trying to boss smokers around."

<sup>c</sup> Wording used with non-smokers: "This warning tells smokers that they're stupid."

Table 3.6. Reactance scale test-retest reliability among smokers

	Baseline	Week 1	Week 4	Baseline - week 1	Baseline - week 4	Week 1 - week 4
	Mean (SD)	Mean (SD)	Mean (SD)	<i>r</i>	<i>r</i>	<i>r</i>
Anger	2.04 (1.03)	1.96 (.92)	1.96 (.96)	.72**	.68**	.89**
Self-relevance	1.66 (.58)	1.50 (.55)	1.54 (.51)	.55**	.62**	.53**
Common knowledge	3.68 (.84)	3.73 (.71)	3.61 (.61)	.57**	.51**	.51**
Exaggeration	1.79 (.74)	1.75 (.76)	1.70 (.73)	.75**	.51**	.58**
Government	2.37 (.88)	2.16 (.84)	2.24 (.87)	.69**	.72**	.69**
Manipulation	1.94 (.91)	1.94 (.87)	1.83 (.81)	.62**	.55**	.62**
Personal attack	2.04 (.96)	1.78 (.79)	1.77 (.73)	.71**	.66**	.81**
Derogation	1.62 (.68)	1.54 (.63)	1.50 (.59)	.79**	.72**	.73**
Discounting	2.52 (.87)	2.27 (.81)	2.33 (.72)	.67**	.44*	.55**
Median				.69	.62	.62

*Note.* Data from pack-carrying study ( $n=46$  smokers). SD = standard deviation.

\*  $p<.05$ , \*\*  $p<.001$



Table 3.7. Mean factor scores, by experimental condition and smoking status

	Text (n=209)	Pictorial (n=1,204)		Non- smokers (n=816)	Smokers (n=597)		Interaction
	Mean (SD)	Mean (SD)	<i>F</i>	Mean (SD)	Mean (SD)	<i>F</i>	<i>F</i>
<b>Reactance</b>							
Anger	2.00 (1.03)	2.40 (1.16)	22.24**	2.07 (1.01)	2.72 (1.21)	121.34**	.04
Self-relevance	2.22 (.92) <sup>a</sup>	2.28 (.96) <sup>a</sup>	.29	--	2.27 (.95)	--	--
Common knowledge	4.35 (.68)	4.13 (.69)	18.89**	4.16 (.64)	4.16 (.76)	.02	.01
Exaggeration	1.81 (.77)	2.05 (.89)	13.64**	1.84 (.77)	2.26 (.96)	79.42**	.93
Government	2.54 (1.03)	2.88 (1.10)	17.42**	2.59 (1.03)	3.17 (1.10)	105.43**	.13
Manipulation	2.25 (.93)	2.80 (1.01)	52.53**	2.61 (.97)	2.86 (1.07)	20.07**	.78
Personal attack	2.59 (1.05) <sup>a</sup>	2.85 (1.10) <sup>a</sup>	4.33*	--	2.81 (1.10)	--	--
Derogation	2.24 (1.08)	2.19 (.99)	.44	2.05 (.93)	2.41 (1.07)	44.22**	.32
Discounting	3.20 (.95) <sup>a</sup>	3.25 (.83) <sup>a</sup>	.23	--	3.24 (.85)	--	--
<b>Outcomes</b>							
Perceived effectiveness	2.51 (.92)	2.88 (.85)	33.18**		2.88 (.91)	4.17*	.00
Motivational ability	2.09 (.98) <sup>a</sup>	2.40 (1.07) <sup>a</sup>	6.48*	--	--	--	--
Avoidance	2.24 (.79) <sup>a</sup>	2.82 (.92) <sup>a</sup>	30.24**	--	--	--	--

*Note.* Data from online study ( $n=1,413$ ). <sup>a</sup> Data only from smokers (text-only  $n=87$ , pictorial  $n=510$ ). --=not asked of non-smokers. SD = standard deviation.

\*  $p<.05$ , \*\*  $p<.001$

Table 3.8. Mediators of association between pictorial warning exposure and perceived effectiveness

	a	b	c	c'	Mediated effect
Anger	.40**	-.17**	.38**	.45**	-.07*
Common knowledge	-.22**	-.10*	.38**	.36**	.02*
Exaggeration	.24**	-.21**	.38**	.43**	-.05*
Government	.35**	-.22**	.38**	.46**	-.08*
Manipulation	.53**	-.16**	.38**	.47**	-.09*
Derogation	-.05	-.35**	.38**	.37**	.02

*Note.* Data from online study ( $n=1,413$ ). Table reports path coefficients for single mediator models, controlling for education. Shaded rows indicate suppression of the overall positive relationship between pictorial warning exposure and perceived effectiveness.

\*  $p < .05$ , \*\*  $p < .001$

Table 3.9. Mean reactance scores by warning, among smokers and non-smokers

	Diseased gums	Hole in throat	Diseased lungs	Chest staples	Oxygen mask	<i>F</i>
Anger	2.46 (1.16)	2.36 (1.15)	2.31 (1.09)	2.45 (1.21)	2.44 (1.16)	.77
Self-relevance	2.23 (.87)	2.42 (1.05)	2.12 (.87)	2.32 (1.01)	2.31 (.98)	1.32
Common knowledge	4.07 <sup>a</sup> (.65)	4.04 <sup>a</sup> (.77)	4.17 (.68)	4.26 <sup>b</sup> (.60)	4.10 (.71)	3.95*
Exaggeration	2.16 <sup>a</sup> (.94)	2.09 (.90)	1.87 <sup>b</sup> (.74)	2.06 (.93)	2.10 <sup>a</sup> (.90)	3.69*
Government	2.91 (1.12)	2.85 (1.09)	2.86 (1.10)	2.92 (1.10)	2.88 (1.12)	.19
Manipulation	2.80 (1.03)	2.70 (1.03)	2.74 (.97)	2.91 (.99)	2.82 (1.05)	1.52
Personal attack	2.76 (1.05)	2.94 (1.14)	2.74 (1.02)	3.06 (1.20)	2.77 (1.08)	1.63
Derogation	2.15 (.95)	2.20 (1.02)	2.17 (.94)	2.31 (1.08)	2.15 (.99)	1.17
Discounting	3.27 (.81)	3.32 (.85)	3.13 (.81)	3.26 (.87)	3.28 (.82)	.76

*Note.* Shaded rows include data from smokers only. Post-hoc Tukey test revealed that the means marked with <sup>a</sup> were significantly different from the mean marked with <sup>b</sup>

\*  $p < .05$

Table 3.10. Multiple mediation of association between pictorial warning exposure and perceived effectiveness

	a	b	c	c'	Mediated effect
Anger	.40**	-.04	.38**	.48**	-.01
Exaggeration	.24**	-.07*	.38**	.48**	-.02*
Government	.35**	-.15**	.38**	.48**	-.05*
Manipulation	.53**	-.02	.38**	.48**	-.01
Total					-.10*

*Note.* Data from online study ( $n=1,413$ ). Table reports path coefficients for multiple mediator models, controlling for education. Shaded rows indicate suppression of the overall positive relationship between pictorial warning exposure and perceived effectiveness.

\*  $p < .05$ , \*\*  $p < .001$

Table 3.11. Mediators of association between pictorial warning exposure and motivational ability, among smokers

	a	b	c	c'	Mediated effect
Anger	.36**	-.34**	.30*	.42**	-.12*
Self-relevance	.05	-.21**	.30*	.31*	-.01
Common knowledge	-.23*	-.34**	.30*	.22	.08*
Exaggeration	.31*	-.38**	.30*	.42**	-.12*
Government	.31*	-.46**	.30*	.44**	-.14*
Manipulation	.61**	-.32**	.30*	.49**	-.19*
Personal attack	.25	-.27**	.30*	.36*	-.07*
Derogation	-.11	-.51**	.30*	.24*	.05
Discounting	.03	.01	.30*	.30*	.00

*Note.* Data from online study (smokers only,  $n=597$ ). Table reports path coefficients for single mediator models, controlling for education. Shaded rows indicate suppression of the overall positive relationship between pictorial warning exposure and intention to quit.

\*  $p < .05$ , \*\*  $p < .001$

Table 3.12. Multiple mediation of association between pictorial warning exposure and motivational ability, among smokers

	a	b	c	c'	Mediated effect
Anger	.36*	-.10	.30**	.48**	-.04*
Exaggeration	.31*	-.17**	.30**	.48**	-.05*
Government	.31*	-.36**	.30**	.48**	-.11*
Manipulation	.61**	-.01	.30**	.48**	-.01
Personal attack	.25	.08	.30**	.48**	.02
Total					-.19*

*Note.* Data from online study (smokers only,  $n=597$ ). Table reports path coefficients for multiple mediator models, controlling for education. Shaded rows indicate suppression of the overall positive relationship between pictorial warning exposure and motivational ability.

\*  $p < .05$ , \*\*  $p < .001$

Table 3.13. Mediators of association between pictorial warning exposure and avoidance of warning, among smokers

	a	b	c	c'	Mediated effect
Anger	.36*	.28**	.57**	.47**	.10*
Self-relevance	.05	.15**	.57**	.56**	.01
Common knowledge	-.23*	.05	.57**	.58**	-.01
Exaggeration	.31*	.16**	.57**	.52**	.05*
Government	.31*	.23**	.57**	.50**	.07*
Manipulation	.61**	.21**	.57**	.44**	.13*
Personal attack	.25	.27**	.57**	.50**	.07*
Derogation	-.11	.15**	.57**	.59**	-.02
Discounting	.03	.15**	.57**	.57*	.00

*Note.* Data from online study (smokers only,  $n=597$ ). Table reports path coefficients for single mediator models, controlling for education. Shaded rows indicate consistent mediation of the overall positive relationship between pictorial warning exposure and avoidance of warning.

\*  $p < .05$ , \*\*  $p < .001$

Table 3.14. Multiple mediation of association between pictorial warning exposure and avoidance, among smokers

	a	b	c	c'	Mediated effect
Anger	.36*	.22**	.57**	.48**	.08*
Exaggeration	.31*	-.05	.57**	.48**	-.02
Government	.31*	.06	.57**	.48**	.02
Manipulation	.61**	-.02	.57**	.48**	-.02
Personal attack	.25	.10*	.57**	.48**	.02
Total					.09*

*Note.* Data from online study (smokers only,  $n=597$ ). Table reports path coefficients for multiple mediator models, controlling for education. Shaded rows indicate suppression of the overall positive relationship between pictorial warning exposure and avoidance.

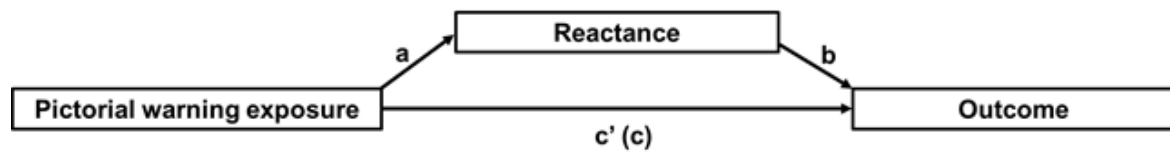
\*  $p<.05$ , \*\*  $p<.001$



Figure 3.1. Pictorial warnings used in experiment



Figure 3.2. Mediation pathways



## **CHAPTER 4. PARENT STUDY AND POWER CALCULATIONS**

### **Overview of Parent Study**

#### **Participants**

Data for the dissertation research came from a randomized trial (i.e., the parent study) funded by the National Cancer Institute (NCI) and FDA (P30CA016086-38S2). The parent study aimed to assess the impact of pictorial warnings on quit attempts among smokers in North Carolina and California (Brewer, Hall, et al., 2016). Participants were ages 18 or older, English-speakers, and current smokers, defined as having smoked at least 100 cigarettes during their lifetime and now smoking every day or some days. We excluded pregnant women, people who smoked only roll-your-own cigarettes, people concurrently enrolled in a smoking cessation trial, people who smoked fewer than 7 cigarettes per week, and people who at baseline reported living in the same household as another study participant. We chose the cutoff of 7 cigarettes per day to exclude very light smokers who might not purchase their own packs.

#### **Recruitment**

We recruited participants from September 2014 to August 2015 through Facebook, Craigslist, email lists, in-person recruitment, referrals from local retailers, flyers, yard signs, and bus and newspaper advertisements. The trial succeeded in recruiting a diverse sample (54% low-income, 18% gay or bisexual, and 47% Black).

#### **Methods**

Smokers were randomized to a pictorial condition ( $n=1,071$ ) or a text-only control condition ( $n=1,078$ ). Participants in the pictorial condition received one of four pictorial warnings selected

from the original nine FDA warnings on their cigarette packs (Figure 4.1). We chose these four warning images because they performed well in a previous internet study (Cameron, Pepper, & Brewer, 2015) and avoided many of the criticisms in the lawsuits (e.g., using a cartoon or a rare health harm of smoking). We removed the quitline number from the images, which was a source of contention in litigation against the warnings. Smokers in the control condition received one of four existing Surgeon General's text-only warnings on their cigarette packs.

Participants attended a baseline appointment and then follow-up appointments weekly over four weeks. At each appointment, participants filled out a 30-45 minute survey on a computer. Participants brought eight days' worth of cigarette packs to the first four appointments. For smokers assigned to pictorial warnings, research staff removed the package cellophane and applied the self-adhesive labels to the top half of the front and back panels of participants' cigarette packs, in accordance with the proposed FDA requirements (United States Public Laws, 2009). For participants with flip top packs, research staff cut through the label to allow the top to open freely. For smokers assigned to receive text-only warnings, research staff removed the package cellophane and applied the self-adhesive labels 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. Participants received a cash incentive at the end of each visit, up to a total of \$185 in North Carolina and \$200 in California, depending on the number of surveys completed. Participation incentives were higher in California because of the higher cost of living there. At the end of the final follow-up appointment, participants received information about local smoking cessation programs.

## Power Calculations

With a sample size of 2,149, I had sufficient statistical power to conduct analyses in all three aims. For Aim 1, I followed the MacCallum et al. approach to calculate power for CFA models (MacCallum, Browne, & Cai, 2006; MacCallum, Browne, & Sugawara, 1996). This approach focuses on determining the sample size necessary to have adequate model fit, according to the RMSEA. With a sample size of 2,149 and 4 degrees of freedom, I had >99% power for a well-specified CFA model.

For Aim 2, I used the expected effect of pictorial warning exposure on quit intentions to calculate statistical power for the effect of pictorial warnings on quit intentions. Our recent meta-analysis found an effect size of  $d=.54$  (95% CI .29-.79) for quit intentions, pooled from eight experiments that compared pictorial and text-only warnings (Noar, Hall, et al., 2016). I had statistical power to detect an effect of that size with a sample of  $n=110$ , far fewer than the 2,149 study participants.

For the mediation and moderation analyses in Aims 2 and 3, I followed the MacCallum et al. approach to calculate power for structural models (MacCallum et al., 2006; MacCallum et al., 1996). For mediation analyses, I had >99% power for a well-specified model with a sample size of 2,149 and 265 degrees of freedom. Similarly, for moderation analyses, I had >99% power for a well-specified model with 266 degrees of freedom.

Figure 4.1. Warnings used in parent study

Panel A. Pictorial warnings used in experiment



Panel B. Text-only warnings used in experiment

**SURGEON GENERAL'S WARNING:**  
Smoking Causes Lung Cancer, Heart Disease,  
Emphysema, and May Complicate Pregnancy.

**SURGEON GENERAL'S WARNING:**  
Smoking by Pregnant Women May Result  
in Fetal Injury, Premature Birth, and  
Low Birth Weight.

**SURGEON GENERAL'S WARNING:**  
Quitting Smoking Now Greatly Reduces  
Serious Risks to Your Health.

**SURGEON GENERAL'S WARNING:**  
Cigarette Smoke Contains  
Carbon Monoxide.

## CHAPTER 5: A BRIEF MEASURE OF REACTANCE TO HEALTH WARNINGS<sup>2</sup>

### Introduction

Health messages aim to encourage people to engage in healthier behaviors, such as quitting smoking or getting vaccinated. However, these messages sometimes elicit opposition due to feelings that one's autonomy is being threatened. Termed *reactance*, theorists suggest that this negative reaction to persuasive messages can reduce message effectiveness (Brehm, 1966; Brehm & Brehm, 1981; Witte, 1992). Drawing on the rich body of empirical and conceptual work on reactance (Dillard & Shen, 2005; LaVail, Anker, Reinhart, & Feeley, 2010; Quick, 2012; Quick & Stephenson, 2007; Rains, 2013; Witte, 1992, 1994), we define reactance as an emotional and cognitive resistance to a message, characterized by 1) perceived threat to freedom, 2) anger toward the message, and 3) counterarguments against the message, such as denial or derogation. Based on this definition, we developed and evaluated the validity of a 9-factor, 27-item Reactance to Health Warnings Scale (RHWS; Hall et al., 2016) in the context of pictorial cigarette pack warnings. We found that the RHWS had high reliability and good construct validity (Hall et al., 2016). As expected, reactance factors were positively correlated with trait reactance (i.e., a personality characteristic reflecting a predisposition to reactance), being a smoker, and exposure to pictorial cigarette pack warnings (vs. a text-only warning control).

---

<sup>2</sup> This chapter previously appeared as an article in *Journal of Behavioral Medicine*. The original citation is as follows: Hall, M. G., Sheeran, P., Noar, S. M., Ribisl, K. M., Boynton, M. H., & Brewer, N. T. (2017). A brief measure of reactance to health warnings. *Journal of Behavioral Medicine*. Advance online publication. doi: 10.1007/s10865-016-9821-z.

Although the RHWS exhibits strong psychometric properties, its length may pose a challenge in many research contexts. For instance, researchers evaluating multiple candidate messages or images may wish to assess reactance, but administering 27 items for each of multiple messages would be overly burdensome and repetitive for study participants. Moreover, many studies of tobacco product warnings, disclosures, and public media campaigns are currently underway to assess their viability and effectiveness for communicating the risks of tobacco use; administration of a short measure of reactance could help researchers to select effective messages that elicit minimal reactance and thereby have a greater impact on tobacco-related beliefs and behaviors. Given these considerations, the current study describes the development and validation of a short reactance scale that could be used not only in the context of anti-tobacco messaging, but also for assessing reactance in other health messaging domains.

## **Methods**

### **Study 1**

*Participants.* From September 2014 to August 2015, we recruited a convenience sample of adult smokers in North Carolina and California, US to participate in a trial comparing the impact of pictorial versus text-only warnings (Brewer, Hall, et al., 2016). Participants were 18 years of age or older, proficient in English, and current smokers, defined as having smoked at least 100 cigarettes during their lifetime and now smoking every day or some days. Exclusion criteria included pregnancy, current enrollment in a smoking cessation trial, smoking only roll-your-own cigarettes, smoking fewer than seven cigarettes per week, and living in the same household as another study participant. Details regarding recruitment, design, and methods can be found in Chapter 4 and Brewer, Hall, et al. (2016).



*Procedures.* Smokers received warnings on their own cigarette packs for four weeks (Brewer et al., 2015). Participants brought in an eight-day supply of cigarettes weekly. They were randomly assigned to have one of four pictorial warnings applied to the top half of the front and back panels of their cigarettes packs (Figure 5.1), or one of four text-only warnings applied to the side of their cigarette packs, for the duration of the study. Randomization created groups that did not differ on demographics assessed (all  $p > .05$ ) (Brewer, Hall, et al., 2016). Participants completed two computer surveys at the first study visit (i.e., baseline and immediately after seeing their assigned warning, or immediate post-test), and one survey at each visit thereafter. Participants received a cash incentive at the end of each visit, up to \$185 in North Carolina and \$200 in California. At the end of the final follow-up appointment, participants received information about local smoking cessation programs.

*Measures.* Appendix I includes exact item wording for all Study 1 and Study 2 measures. The immediate post-test survey at the first study visit assessed demographic characteristics, trait reactance (11 items,  $\alpha = .87$ , with response options ranging from strongly disagree (coded as 1) to strongly agree (coded as 5)) (Hong & Page, 1989), and positive smoker prototypes (4 items,  $\alpha = .84$ ) (Gerrard et al., 2008; McCool, Cameron, & Robinson, 2011). We assessed message reactance using the 27-item RHWS (Hall et al., 2016) at the immediate post-test survey, the week 1 follow-up survey, and the week 4 follow-up survey. The outcome variables used to assess predictive validity were obtained at the week 4 follow-up survey, and comprised perceived effectiveness of the warning (six items,  $\alpha = .90$ , “How much did having this warning on your cigarette packs make you want to quit smoking? How much did having this warning on your cigarette packs make you concerned about the health effects of smoking? How much would having this warning on cigarette packs...Make other smokers concerned about the health effects

of smoking? Make other smokers want to quit smoking? Make non-smokers concerned about the health effects of smoking? Discourage non-smokers from starting to smoke?”), support for requiring pictorial warnings on cigarette packs (one item: “If the US required that graphic warnings covered the top half of the front and back of cigarette packs, would you... strongly oppose this policy, somewhat oppose this policy, somewhat support this policy, or strongly support this policy?”), quit intentions (three items,  $\alpha=.94$ , e.g., “How interested are you in quitting smoking in the next month?”) (Klein, Zajac, & Monin, 2009), avoidance of the warning (three items,  $\alpha=.90$ , e.g., “In the last week, how often have you tried to avoid looking at the warning label on your cigarette packs?”) (Population Assessment of Tobacco and Health Study, 2014), and forgoing a cigarette (one item: “In the last week, how often have you stopped yourself from having a cigarette because you wanted to smoke less?”) (Li et al., 2014). We also assessed the number of cigarettes smoked per day.

*Data Analysis.* Analyses used Stata/SE version 14.1 with two-tailed tests and a critical alpha of .05. In Study 1, reactance at immediate post-test did not differ among the four text-only warnings ( $F<1$ ) or among the four pictorial warnings ( $F<1$ ). For Study 2, we previously reported that comparisons of the five warnings in the pictorial condition revealed few differences in reactance (Hall et al., 2016). Thus, in both studies, we combined the warnings into two groups (text-only vs. pictorial) for all analyses.

To prioritize items for the brief measure, we used item response theory (IRT)-based modeling (De Ayala, 2013; Embretson & Reise, 2013) with immediate post-test data from Study 1. For each of the nine reactance subscales, we selected the item with the highest factor loading from our previous validation study (Hall et al., 2016) that was at or below an eighth-grade reading level (Table 5.1). Then, we entered these nine items into a graded-response IRT model.

After testing IRT assumptions, we eliminated two items that violated the assumption of local dependence and one that violated the assumption of monotonicity (De Ayala, 2013; Embretson & Reise, 2013). Then, we ran a second IRT model with the remaining six items, ultimately selecting the three items for the Brief RHWS that contributed the most information about the underlying latent construct of reactance based on the item information curves (the items are listed in Table 5.3).

We ran a confirmatory factor analysis with the three Brief RHWS items at immediate post-test to evaluate factor loadings, although we could not determine model fit because the model was just-identified (Bollen, 1989). We then calculated mean scores and assessed internal consistency using Cronbach's alpha. We also assessed test-retest reliability for reactance between immediate post-test, week 1, and week 4. For convergent validity, we derived our predictions from the Theory of Psychological Reactance (Brehm, 1966; Brehm & Brehm, 1981), anticipating that higher Brief RHWS scores would be correlated with the RHWS long form, higher trait reactance, greater positive smoker prototypes, and exposure to pictorial warnings (i.e., random assignment to the pictorial condition). In terms of predictive validity, we drew upon the fear appeals literature (Witte, 1992; Witte & Allen, 2000), expecting that higher Brief RHWS scores at immediate post-test would be correlated with several deleterious consequences including lower perceived effectiveness, less support for pictorial warning policy, lower quit intentions, greater avoidance of warnings, a lower likelihood of forgoing a cigarette at the week 4 follow-up survey, and smoking more cigarettes per day. Finally, we ran these validity analyses using the RHWS long form in order to compare the validity of the long form to the Brief RHWS.

Validity analyses controlled for study arm and used pairwise deletion for missing data, using cases with complete data on the variables of interest for each model. Convergent validity

analyses treated reactance as the outcome and thus used linear regression with standardized coefficients. For predictive validity analyses, we present standardized regression coefficients for continuous outcomes and odds ratios and 95% confidence intervals for dichotomous outcomes.

## **Study 2**

*Participants.* In May 2014, we used Amazon Mechanical Turk (MTurk) to recruit a convenience sample of 1,500 US smokers and non-smokers 18 years of age or older. MTurk is a web-based crowd-sourcing platform that is widely used for social science research and shown to generate reliable and valid data (Buhrmester et al., 2011; Paolacci & Chandler, 2014; Peer et al., 2014). We excluded 87 respondents who failed standard procedures for ensuring data quality, resulting in a final sample size of 1,413 respondents. While we used this sample to validate the long form of the scale, we use it here to test the psychometric properties of the brief measure. The University of North Carolina Institutional Review Board approved the procedures for both studies.

*Procedures.* Smokers viewed the warnings on a computer screen. Participants took a survey while viewing an image of an unbranded cigarette pack with a randomly assigned warning on the top half. They viewed one of five warnings with an image depicting the health consequences of smoking and related text ( $n=1,204$ , Figure 5.1) or one of the same five warnings without the image ( $n=209$ ). Randomization to pictorial or text condition yielded equivalent groups on eight of nine demographic variables; participants had lower levels of education in the text than in the pictorial condition ( $p<.05$ ). Participants received \$3 for completing the online survey.

*Measures.* The survey assessed demographics, the 27-item RHWS, and trait reactance using the same measures as Study 1. The survey also assessed positive smoker prototypes using an expanded 6-item version of the scale ( $\alpha=.86$ ) (Gerrard et al., 2008; McCool et al., 2011). Among

smokers, the survey assessed perceived effectiveness of the warning (four items,  $\alpha=.85$ , “How much would having this warning on your cigarette packs... Make you concerned about the health effects of smoking? Make you concerned about the health effects of smoking? Discourage non-smokers from smoking? Make non-smokers concerned about the health effects of smoking?”) and avoidance (ten items,  $\alpha=.89$ , e.g., “Imagine that all cigarette packs had this warning. How likely is it that you would try to avoid looking at the warning on your cigarette packs?”) (Population Assessment of Tobacco and Health Study, 2014).

*Data Analysis.* We calculated mean scores of the Brief RHWS and internal consistency using Cronbach’s alpha. We calculated the same correlational coefficients examined in Study 1 to assess convergent validity, expecting that the Brief RHWS would be correlated with the RHWS long form, higher trait reactance, higher positive smoker prototypes, and exposure to pictorial warnings. We also predicted that smokers would exhibit more reactance than non-smokers because warnings may more directly threaten smokers’ perceived freedom to use cigarettes. For concurrent criterion validity, we expected that reactance would be associated with lower perceived message effectiveness and greater avoidance of the warnings, as in Study 1. As in Study 1, we ran these validity analyses using the RHWS long form. Validity analyses controlled for study arm and education.

## **Results**

About half (48%) of the 2,149 Study 1 participants were male, with a mean age of 40 years (Table 5.2). Study 1 participants were diverse, including a substantial number of sexual minority, African American, low-education, and low-income smokers. About half (47%) of the 1,413 Study 2 participants were male, with a mean age of 34 years. Ten percent were gay, lesbian, or bisexual, and 55% had less than a college education.

## **Scale Psychometrics**

The three items in the Brief RHWS each had a strong association with the underlying latent construct of reactance, as demonstrated by the high factor loadings from confirmatory factor analysis (Figure 5.2). The Brief RHWS exhibited acceptable reliability in Study 1 ( $\alpha=.75$  at immediate post-test,  $.77$  at Week 1, and  $.80$  at Week 4; Table 5.3) and Study 2 ( $\alpha=.65$ ). In Study 1, the measure had good test-retest reliability at one week ( $r=.70$ ), three weeks ( $r=.68$ ), and four weeks ( $r=.59$ ).

## **Convergent Validity**

Analyses supported the convergent validity of the Brief RHWS. The brief scale was highly correlated with the long form in Study 1 ( $\beta=.85$ ,  $p<.001$ ; Table 5.4), a finding replicated in Study 2 ( $\beta=.88$ ,  $p<.001$ ). In Study 1, the Brief RHWS was correlated with higher trait reactance, greater positive smoker prototypes, and exposure to pictorial warnings cigarette packs (all  $p<.001$ ; Table 5.4). Again, Study 2 replicated these findings, and also demonstrated that reactance was higher among smokers than non-smokers ( $\beta=.23$ ,  $p<.001$ , data not shown). The brief form and the long form performed similarly in terms of convergent validity in both studies (Table 5.5).

## **Predictive Validity**

The Brief RHWS also exhibited predictive validity. Longitudinal analyses indicated that Brief RHWS scores at immediate post-test predicted lower perceived effectiveness of the warnings at the week 4 follow-up survey in Study 1, controlling for study arm ( $\beta=-.15$ ,  $p<.001$ ; Table 5.4). In these same analyses, Brief RHWS scores were associated with less support for requiring pictorial warnings on cigarette packs ( $\beta=-.30$ ,  $p<.001$ ) and lower intentions to quit smoking at the end of the trial ( $\beta=-.18$ ,  $p<.001$ ). These results were similar when controlling for baseline levels of support for requiring pictorial warnings and quit intentions. Brief RHWS

scores were associated with greater avoidance of the warnings ( $\beta=.09, p<.001$ ) and lower odds of forgoing a cigarette (OR=.82, 95% CI=.73-.92). The Brief RHWS was also associated with smoking more cigarettes per day ( $\beta=.07, p<.05$ ).

Concurrent criterion validity analyses in Study 2 followed a very similar pattern to Study 1. Among smokers, Brief RHWS scores were associated with lower perceived effectiveness of the warnings ( $\beta=-.36, p<.001$ ) and greater avoidance of the warning ( $\beta=.30, p<.001$ ), controlling for study arm and education. The Brief RHWS and the long form performed comparably in terms of predictive validity in both studies (Table 5.5).

## **Discussion**

Our brief scale is an efficient and psychometrically strong measure of reactance to health messages. The three items in the Brief RHWS reflect the conceptualization of reactance as an amalgam of perceived threat to freedom, anger in response to the warning, and counterarguing against the warning. The scale exhibited good test-retest reliability and acceptable internal consistency reliability among US adults exposed to pictorial cigarette pack warnings. The internal consistency reliability was lower in Study 2 than Study 1; future studies should evaluate the reliability of the Brief RHWS to ensure that it is adequate. The brief measure correlated with its long form, higher trait reactance, higher positive smoker prototypes, exposure to pictorial warnings, and being a smoker, supporting the measure's convergent validity. In support of predictive validity, the brief measure correlated with greater avoidance of warnings, lower perceived effectiveness warnings, less support for requiring pictorial warnings on cigarette packs, lower quit intentions, a lower likelihood of forgoing a cigarette, and smoking more cigarettes per day. The Brief RHWS exhibited comparable validity to the long form, indicating that researchers can use the brief form without sacrificing construct validity.

The brief form builds on the strengths of several distinct reactance measurement approaches. A widely-used measure, developed by Dillard & Shen (2005), assesses anger toward and counterarguments against a message, using four close-ended questions assessing anger and an open-ended thought-listing task to assess counterarguments about the warning (Dillard & Shen, 2005; Gollust & Cappella, 2014; Quick, 2012; Rains, 2013; Rains & Turner, 2007). Some prior studies on pictorial warnings have often focused on the emotional element of reactance (Cho et al., 2016; Erceg-Hurn & Steed, 2011). Other researchers testing Extended Parallel Process Model have measured reactance as a combination of perceived manipulation, message minimization, and message derogation (Witte, 1994). Organ donation researchers have assessed reactance with a four-item scale assessing frustration toward being told how to feel (LaVail et al., 2010; Lindsey, 2005; Reinhart, Marshall, Feeley, & Tutzauer, 2007). Our measure builds on this work by incorporating the key affective and cognitive components of reactance, and by including a close-ended measure of counterarguing that may be less burdensome for participants and researchers.

Design and development of health warnings may benefit from taking message reactance into account in order to potentially maximize the beneficial impact of the warnings. In the early stages of developing warnings and campaigns, evaluators commonly use perceived effectiveness as a metric for identifying effective messages (Davis, Nonnemaker, Duke, & Farrelly, 2013). We propose reactance as a useful adjunct to perceived effectiveness. Measuring reactance could identify outlier messages that elicit particularly high amounts of reactance and therefore may be likely to be ineffective or lead to unintended consequences. Looking at reactance alone is likely not the best way to narrow down a list of candidate messages because effective messages often simultaneously elicit reactance, as is the case for pictorial warnings (Hall et al., 2016).



Furthermore, in our own work, we have found little variation in message reactance among pictorial warnings (Hall et al., 2016), perhaps because we looked at a small number of warnings that had already been pre-tested by other researchers (Cameron et al., 2015). Thus, assessing message reactance may offer less useful information at later stages of message development after messages have already been refined.

Pictorial cigarette pack warnings cause greater message reactance than text warnings, as several studies and a recent meta-analysis have demonstrated (Erceg-Hurn & Steed, 2011; Hall et al., 2016; LaVoie et al., 2015; Noar, Hall, et al., 2016). However, given the large body of research indicating the effectiveness of pictorial warnings, it would be unwise to conclude that pictorial warnings are counterproductive because they produce reactance, as others have asserted (LaVoie et al., 2015). Experimental and observational evidence supports the superiority of pictorial warnings over text warnings on numerous outcomes, including quit intentions (Noar, Hall, et al., 2016), quit attempts (Brewer, Hall, et al., 2016), knowledge about smoking risks (Brennan et al., 2011), and foregoing cigarettes (Yong et al., 2013). Moreover, pictorial warning implementation is associated with decreases in the number of cigarettes smoked and may have played a role in the reductions in smoking prevalence that we have seen in many countries (Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016). Despite the role reactance may play in weakening the warnings' impact, pictorial warnings remain a promising strategy for reducing smoking, far better than text-only warnings at changing attitudes, intentions, and behavior (Brewer, Hall, et al., 2016; Noar, Hall, et al., 2016).

Reactance could undermine the political will to implement pictorial warnings on cigarette packs or other policy changes. Public support can influence the ability of policymakers to successfully advocate for, enact, and enforce health policies as well as the effectiveness of the

new policies (Diepeveen, Ling, Suhrcke, Roland, & Marteau, 2013). The relationship between reactance and support for public health policies remains an important area for future research.

Strengths of our studies include consistent validity findings across both studies, the use of an experimental design in both studies, naturalistic exposure to warnings on smokers' actual packs (Study 1), the longitudinal follow-up assessment (Study 1), and the inclusion of both smokers and non-smokers (Study 2). However, our use of convenience samples may limit the generalizability of our findings to other populations. The magnitude of some of the correlations in our validity analyses was modest. Although we followed smokers for four weeks in Study 1, the impact of reactance on attitudes and behavior over a longer period of time remains unknown. Finally, we did not include previously validated reactance scales in our surveys due to space constraints.

## **Conclusions**

The Brief Reactance to Health Warnings Scale captures the construct well while maintaining good reliability and validity among smokers exposed to pictorial warnings. We encourage researchers to measure reactance when developing and evaluating health messages in order to understand whether reactance weakens the effects of those messages. Researchers could use this scale as one of a battery of measures to help develop and select pictorial warnings for implementation. The scale may also hold utility beyond the context of pictorial cigarette pack warnings, for example, in evaluating health warnings and other messages for other tobacco products, alcohol, risky sex, exercise, or food and beverages. The scale could also be used or adapted for different types of health communication message formats, such as mass media campaigns.

Table 5.1. Reactance items selected for item response theory testing, Study 1

Subscale	Item	Factor loading	Read-ability
Anger	This warning makes me feel aggravated	.95	8.8
Anger	This warning annoys me	.77	4.4
Anger	This warning irritates me	.76	9.4
Exaggeration	The health effect on this warning is overblown	.63	7.6
Exaggeration	This warning exaggerates the health effects of smoking	.61	10.3
Exaggeration	This warning is misleading	.59	10.0
Government	Smoking is legal, so the government should stop interfering with smokers' freedom	.90	11.7
Government	The government shouldn't require warnings like this on packs	.71	10.6
Government	It's not the government's job to warn me about the risks of smoking	.71	5.5
Manipulation	This warning is trying to manipulate me	.53	7.6
Manipulation	This warning is manipulating smokers	.45	12.3
Manipulation	This warning is trying to boss me around	.34	3.9
Personal attack	This warning tells me I'm bad because I smoke	.53	2.8
Personal attack	This warning tells me that I'm stupid	.45	2.8
Personal attack	I am being told that I am a fool by this warning	.34	2.2
Common knowledge	The information in this warning is common knowledge	.73	9.5
Common knowledge	I've heard the information in this warning a million times	.71	6.9
Common knowledge	I already knew about the harms in this warning	.67	6.2
Denial	I'll quit long before I suffer the health effect in this warning	.55	4.7
Denial	The health effect in this warning won't catch up to me for a long time	.48	3.9
Denial	I would worry more about this warning if I expected to smoke for many years	.40	7.0
Derogation	This warning is useless	.67	8.4
Derogation	This warning is stupid	.62	4.4
Derogation	This warning is pointless	.58	6.0
Self-relevance	This warning is meant for other smokers, not me	.74	4.2

Self-relevance	This warning is not relevant to me	.71	5.4
Self-relevance	This warning is only meant for hard-core smokers	.69	4.7

---

*Note.* Shaded rows depict items selected for item response theory model. Readability is the reading grade level of the message, calculated as an average of five readability scores, obtained from [readability-score.com](http://readability-score.com). Factor loadings from previously-reported data in Hall et al. (2016).

Table 5.2. Participant characteristics at baseline

	Study 1				Study 2			
	Text-only warnings ( <i>n</i> =1,078)		Pictorial warnings ( <i>n</i> =1,071)		Text-only warnings ( <i>n</i> =209)		Pictorial warnings ( <i>n</i> =1,204)	
	<i>n</i>	(%)	<i>n</i>	(%)	<i>n</i>	(%)	<i>n</i>	(%)
Smoker								
No	0	(.0)	0	(.0)	122	(58.4)	694	(57.6)
Yes	1,078	(100.0)	1,071	(100.0)	87	(41.6)	510	(42.4)
Age								
18-24 years	171	(16.1)	152	(14.5)	42	(20.1)	257	(21.3)
25-39 years	377	(35.5)	398	(37.9)	113	(54.1)	659	(54.7)
40-54 years	338	(31.8)	304	(29.0)	40	(19.1)	200	(16.6)
55+ years	176	(16.6)	195	(18.6)	14	(6.7)	88	(7.3)
Mean years (SD)	39.7	(13.4)	39.8	(13.7)	34.1	10.9	33.5	11.4
Gender								
Male	507	(47.4)	532	(50.0)	102	(48.8)	565	(47.0)
Female	548	(51.2)	512	(48.2)	107	(51.2)	632	(52.6)
Transgender	15	(1.4)	19	(1.8)	0	(.0)	4	(.3)
Gay, lesbian, or bisexual	173	(16.3)	195	(18.8)	28	(13.4)	120	(10.0)
Hispanic	92	(8.6)	89	(8.5)	16	(7.7)	85	(7.1)
Race								
Black or African American	484	(45.8)	510	(48.9)	17	(8.1)	80	(6.6)
White	393	(37.2)	358	(34.3)	155	(74.2)	958	(79.6)
Other/multiracial	134	(12.7)	117	(11.2)	18	(8.6)	78	(6.5)
Asian	28	(2.7)	42	(4.0)	17	(8.1)	77	(6.4)
American Indian or Alaska Native	7	(.6)	11	(1.0)	2	(1.0)	9	(.7)
Native Hawaiian/other Pacific Islander	11	(1.0)	6	(.6)	0	(.0)	2	(.2)
Education								
High school degree or less	333	(31.1)	344	(32.5)	35	(16.8)	124	(10.3)
Some college	519	(48.5)	502	(47.4)	80	(38.5)	534	(44.4)
College graduate	156	(14.6)	156	(14.7)	77	(37.0)	433	(36.0)
Graduate degree	63	(5.9)	58	(5.5)	16	(7.7)	112	(9.3)
Low income ( $\leq$ 150% of Federal Poverty Level)								
No	506	(47.0)	477	(44.8)	--	--	--	--
Yes	570	(53.0)	589	(55.2)	--	--	--	--
Household income, annual								

\$0-\$24,999	566	(53.3)	589	(55.8)	66	(31.6)	333	(27.7)
\$25,000-\$49,999	272	(25.6)	266	(25.2)	64	(30.6)	381	(31.7)
\$50,000-\$74,999	110	(10.3)	92	(8.7)	32	(15.3)	236	(19.6)
\$75,000+	115	(10.8)	109	(10.3)	47	(22.5)	252	(21.0)
Study site								
California	594	(55.1)	592	(55.3)	--	--	--	--
North Carolina	484	(44.9)	479	(44.7)	--	--	--	--
Cigarettes smoked per day, mean (SD)	9.1	(6.5)	9.0	(7.2)	--	--	--	--
Trait reactance, mean (SD)	2.86	(.7)	2.89	(.7)	2.93	(.7)	2.97	(.7)

*Note.* -- not assessed. Missing demographic data range from 0.0% to 2.2%. Demographics did not differ by trial arm in Study 1. Demographics did not differ by trial arm in Study 2, except for education ( $p<.05$ ).

Table 5.3. Brief Reactance to Health Warnings Scale

	Study 1			Study 2
	Immediate post-test ( <i>n</i> =2,149)	Week 1 ( <i>n</i> =1,854)	Week 4 ( <i>n</i> =1,901)	( <i>n</i> =1,413)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Item 1. This warning is trying to manipulate me	2.16 (1.15)	2.01 (1.07)	2.03 (1.04)	3.02 (1.30)
Item 2. The health effect on this warning is overblown	1.96 (1.01)	1.90 (.95)	1.90 (.93)	2.08 (1.05)
Item 3. This warning annoys me	2.14 (1.10)	2.03 (1.04)	2.02 (1.00)	2.36 (1.25)
Brief RHWS	2.08 (.89)	1.98 (.85)	1.98 (.84)	2.49 (.93)
Cronbach's alpha, Brief RHWS	.75	.77	.80	.65

*Note.* Response scale ranged from 1 (strongly disagree) to 5 (strongly agree). Missing data range from 0.0% to 0.7%.

Table 5.4. Correlates of reactance to health warnings (brief form)

	Study 1				Study 2 – smokers			Study 2 – non-smokers		
	Range	<i>n</i>	Mean (SD)	$\beta$	<i>n</i>	Mean (SD)	$\beta$	<i>n</i>	Mean (SD)	$\beta$
Convergent validity (correlates at immediate post-test)										
Reactance long form	1-5	2,106	2.30 (.63)	.85**	594	2.87 (.69)	.88**	--	--	--
Trait reactance	1-5	2,043	2.87 (.70)	.32**	594	3.05 (.72)	.37**	808	2.90 (.67)	.27**
Positive smoker prototypes	1-5	2,122	1.76 (.86)	.19**	594	2.42 (.90)	.15**	808	1.87 (.76)	.09*
Exposure to pictorial warning	--	2,135	--	.21**	594	--	.20**	808	--	.18**
Other validity										
Perceived message effectiveness	1-4	1,882	2.66 (.86)	-.15**	592	2.70 (.85)	-.36**	--	--	--
Support for pictorial warning policy	1-4	1,887	3.30 (.84)	-.30**	--	--	--	--	--	--
Quit intentions	1-4	1,890	2.63 (1.09)	-.18**	--	--	--	--	--	--
Avoidance of warning	1-5	1,847	2.02 (1.14)	.09**	594	2.74 (.93)	.30**	--	--	--
Forgoing a cigarette	--	1,889	--	OR=.82* <sup>a</sup>	--	--	--	--	--	--
Cigarettes per day	1-60	1,890	7.34 (6.78)	.07*	--	--	--	--	--	--

*Note.*  $\beta$ s are standardized regression coefficients. -- not assessed. Study 1 analyses controlled for study condition. Study 2 analyses controlled for study condition and education. For predictive validity analyses, we assessed predictors at immediate post-test and the outcome at week 4.

<sup>a</sup>95% confidence interval [.73, .92]

\* $p < .05$ , \*\* $p < .001$ .



Table 5.5. Correlates of reactance to health warnings (long form)

	Study 1			Study 2 – smokers	
	Range	<i>n</i>	$\beta$	<i>n</i>	$\beta$
Convergent validity (correlates at immediate post-test)					
Trait reactance	1-5	2,020	.37**	596	.46**
Positive smoker prototypes	1-5	2,096	.23**	596	.12*
Exposure to pictorial warning	--	2,106	.15**	596	.09*
Predictive validity		Longitudinal (correlates at 4 weeks)		Concurrent criterion validity	
Perceived effectiveness	1-4	1,856	-.19**	596	-.43**
Support for pictorial warning policy	1-4	1,860	-.31**	--	--
Quit intentions	1-4	1,863	-.17**	--	--
Avoidance of warning	1-5	1,824	.09**	596	.32**
Forgoing a cigarette	--	1,889	OR=.75 <sup>a</sup>	--	--
Cigarettes per day	1-60	1,863	.06*	--	--

*Note.*  $\beta$ s are standardized regression coefficients. -- not assessed. Study 1 analyses controlled for study condition. Study 2 analyses controlled for study condition and education.

<sup>a</sup>95% confidence interval [.64, .88]

\* $p < .05$ , \*\* $p < .001$ .

Figure 5.1. Pictorial warnings used in Studies 1 and 2

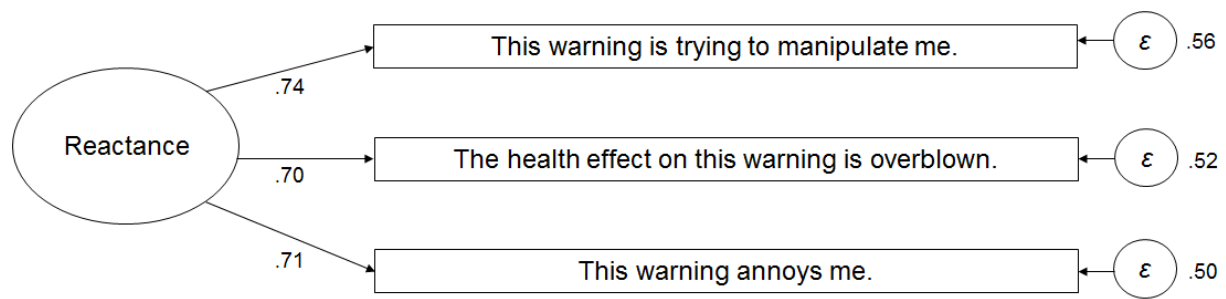
Panel A. Study 1 warnings (applied to smokers' cigarette packs)



Panel B. Study 2 warnings (viewed on a computer screen)



Figure 5.2. Confirmatory factor analysis for Brief Reactance to Health Warnings Scale, Study 1



## **CHAPTER 6: MEDIATORS OF THE EFFECT OF PICTORIAL CIGARETTE PACK WARNINGS ON QUIT INTENTIONS**

### **Introduction**

Tobacco use is the leading cause of preventable morbidity and mortality worldwide, causing nearly six million deaths each year (World Health Organization, 2013b). In an attempt to lower smoking rates, the World Health Organization Framework Convention on Tobacco Control calls for its signatory countries to implement large pictorial images on cigarette packs based on evidence that pictorial warnings may be more effective than text-only warnings (World Health Organization, 2013a). Indeed, systematic reviews and a recent randomized controlled trial demonstrate that pictorial warnings elicit stronger quit intentions (Brewer, Hall, et al., 2016; Noar, Hall, et al., 2016) and subsequent cessation behavior (Brewer, Hall, et al., 2016; Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016). However, the mechanisms by which pictorial warnings influence quit intentions and subsequent cessation behavior are poorly understood. Consequently, the U.S. Food and Drug Administration has called for researchers to study a wide range of emotional and cognitive mechanisms of pictorial warnings' effects (Andrews, Choiniere, & Portnoy, 2015). Characterizing these processes can help policymakers design warnings that elicit responses that increase quit intentions and, ultimately, quit attempts and smoking cessation.

The 2009 Family Smoking Prevention and Tobacco Control Act requires pictorial warnings on cigarette packs in the US (United States Public Laws, 2009). However,

implementation of this facet of the law has been stalled by a 2012 lawsuit brought on by the tobacco industry (R.J. Reynolds Tobacco Company vs United States Food and Drug Administration, 2011). In the court case, the warnings were criticized for being “unabashed attempts to evoke emotion” (R.J. Reynolds Tobacco Company vs United States Food and Drug Administration, 2011). Indeed, research has shown that pictorial warnings elicit fear and other negative emotions (Emery, Romer, Sheerin, Jamieson, & Peters, 2014; Evans et al., 2015; Noar, Hall, et al., 2016). But negative emotions may contribute to warnings’ effectiveness by activating changes in risk perceptions. Two prior studies have shown that pictorial warnings increased negative affective reactions that subsequently were associated with cognitive outcomes, including risk perceptions and quit intentions (Emery et al., 2014; Evans et al., 2015). In other words, the emotion evoked by pictorial warnings may be fundamental to the warnings’ ability to change subsequent risk perceptions and smoking behavior.

However, in addition to negative affect, pictorial warnings may elicit another type of reaction called *message reactance*, defined as a cognitive and emotional resistance to a health message in response to a perceived threat to one’s freedom (Brehm, 1966; Brehm & Brehm, 1981). Several studies have found that pictorial warnings elicit greater reactance than text-only warnings (Erceg-Hurn & Steed, 2011; Hall et al., 2016; Hall et al., 2017; LaVoie et al., 2015), and reactance may partially weaken the impact of pictorial warnings (Hall et al., 2016). More research is needed to understand the extent to which reactance weakens the effect of pictorial warnings on intentions and behavior.

In the current study, we sought to determine the mechanisms by which pictorial cigarette pack warnings elicit stronger quit intentions. Specifically, we aimed to understand whether pictorial warnings heightened negative affect and reactance, and whether negative affect and

reactance indirectly influenced quit intentions via risk appraisals (i.e., perceived likelihood of harm from smoking, perceived severity of harm from smoking, and anticipated regret of smoking if it caused health harms).

## **Methods**

### **Participants**

From September 2014 to August 2015, we recruited a convenience sample of adult smokers in North Carolina and California, U.S. to participate in a trial comparing the impact of pictorial versus text-only warnings (Brewer, Hall, et al., 2016). Participants were age 18 or older, proficient in English, and current smokers, defined as having smoked at least 100 cigarettes during their lifetime and now smoking every day or some days. Exclusion criteria included pregnancy, current enrollment in a smoking cessation trial, smoking only roll-your-own cigarettes, smoking fewer than seven cigarettes per week, and living in the same household as another study participant. Details regarding recruitment, design, and methods can be found in Chapter 4 and Brewer et al. (2016).

### **Procedures**

In our study, smokers received warnings on their own cigarette packs for four weeks (Brewer et al., 2015; Brewer, Hall, et al., 2016). Participants brought in an eight-day supply of cigarettes weekly. They were randomly assigned to have one of four pictorial warnings applied to the top half of the front and back panels of their cigarette packs (Figure 6.1), or one of four text-only warnings applied to the side of their cigarette packs, for the duration of the study. Randomization created groups that did not differ on demographics assessed (all  $p > .05$ ) (Brewer, Hall, et al., 2016). Study participants were diverse, including a substantial number of sexual minority, African American, low-education, and low-income smokers (Table 6.1).

Participants completed two computer surveys at the first study visit (i.e., baseline and immediately after seeing their assigned warning, which was immediate post-test), and one survey at each visit thereafter. Participants received a cash incentive at the end of each visit, up to \$185 in North Carolina and \$200 in California. At the end of the final follow-up appointment, participants received information about local smoking cessation programs. The University of North Carolina Institutional Review Board approved the procedures for this study.

## **Measures**

Appendix I includes exact item wording for all measures. The baseline survey and the week 2 follow-up survey assessed perceived likelihood of harm from smoking (three items,  $\alpha=.90$  at baseline and  $\alpha=.92$  at week 2, e.g., “What is the chance that you will one day get cancer if you continue to smoke cigarettes?”), perceived severity of harm from smoking (three items,  $\alpha=.95$  at baseline and  $\alpha=.96$  at week 2, e.g., “How much would getting cancer because of smoking affect your life?”), and anticipated regret of smoking if it caused health harms (three items,  $\alpha=.97$  at baseline and  $\alpha=.98$  at week 2, e.g., “If smoking made you get cancer, how much would you regret smoking?”). We originally planned to examine fear as a mediator (see Chapters 2 and 4), but sensitivity analyses revealed that fear and other negative affect exhibited an identical pattern in simple mediation analyses, and confirmatory factor analysis supported treating negative affect as a unidimensional measure. Therefore, we treated negative affect elicited by the warning (assessed at immediate post-test) as a unidimensional measure, which included fear, guilt, disgust, anxiety, and sadness (15 items,  $\alpha=.97$ , e.g., “How much did the warning on your cigarette packs make you feel afraid?”) (Nonnemaker et al., 2015). The immediate post-test survey also assessed message reactance using the Brief Reactance to Health Warnings Scale (three items,  $\alpha=.75$ , e.g., “This warning is trying to manipulate me.”) (Hall et al., 2017). We

measured quit intentions at the baseline survey and the week 4 follow-up survey (three items,  $\alpha=.87$  at baseline and  $\alpha=.94$  at week 4, e.g., “How interested are you in quitting smoking in the next month?”) (Klein et al., 2009). Finally, at the week 1, week 2, week 3, and week 4 follow-up visits, we asked participants “During the last week, did you stop smoking for 1 day or longer because you were trying to quit smoking?” At the week 4 follow-up, we also asked “Since you started the study, did you stop smoking for 1 day or longer because you were trying to quit smoking?” We considered participants to have made a quit attempt if they answered “yes” to any of the quit attempt questions.

### **Data Analysis**

Analyses used Stata/SE version 14.1 and Mplus version 7.4 with two-tailed tests and a critical alpha of 0.05. We combined the warnings into two groups (text-only vs. pictorial) for all analyses.

We conducted mediational analyses using structural equation modeling to identify mediators and suppressor variables. Suppression occurs when the direct and mediated effects have opposite signs, in this case demonstrating that the mediator detracts from the effectiveness of pictorial warnings (MacKinnon et al., 2000). In contrast, a direct and mediated effect with the same sign signals mediation, indicating that the mediator contributes to the effectiveness of pictorial warnings (MacKinnon et al., 2000). Candidate mediator/suppressor variables were negative affect which we parceled in the model to reduce the number of parameters to fit (Kline, 2011), perceived likelihood of harm from smoking, perceived severity of harm from smoking, anticipated regret of smoking if it caused health harms, and message reactance. We originally fit a parallel mediation model in which the mediation pathways occurred at the same time (see Chapters 2 and 4), but the structural equation modeling respecification process (Bollen, 1989;



Kline, 2011) ultimately pointed toward a serial mediation model. The final serial model tested theoretically-driven predictions (Noar, Hall, et al., 2016; Rogers, 1975; Slovic, Finucane, Peters, & MacGregor, 2007; Witte, 1992) about the indirect effects of pictorial warnings on quit intentions first via negative affect and message reactance, and then through perceived likelihood, perceived severity, and anticipated regret. The model also examined whether quit intentions were associated with a greater likelihood of making a quit attempt. We used the earliest available post-exposure assessment of each mediator (i.e., immediate post-test for fear and message reactance, and week 2 follow-up for perceived likelihood, perceived severity, and anticipated regret). The outcome for mediational analysis was quit intentions at week 4.

The model employed full information maximum likelihood estimation to handle missing data, an approach commonly recommended for structural equation models (Bollen, 1989; Kline, 2011; C. L. Peters & Enders, 2002). We report results as standardized path coefficients ( $\beta$ s), using weighted least squares estimation for dichotomous outcomes (Muthén & Muthén, 2009). Mediation analyses used bootstrapped 95% confidence intervals with 1,000 repetitions, as this approach does not assume that indirect effects are normally distributed (Hayes, 2009). We also evaluated several indicators of acceptable model fit, including the root mean square error of approximation (RMSEA<.08) (Steiger, 1990), the Tucker-Lewis Index (TLI>.90) (Tucker & Lewis, 1973) and the Bentler Comparative Fit Index (CFI>.90) (Bentler, 1990).

## **Results**

Results reported in this chapter are preliminary findings. Please refer to the peer reviewed published paper for final results. Correlations between the variables ranged from -.23 to .49 (Table 6.2). The serial mediation model exhibited excellent fit (RMSEA=.035 [95% CI=.032, .039], CFI=.998, TLI=.997; Figure 6.2). Pictorial warnings generated higher quit

intentions than text warnings ( $\beta=.15, p<.05$ ), which were in turn associated with a greater likelihood of making a quit attempt ( $p<.001$ ; Figure 6.2). Mean quit intentions among those who made a quit attempt were 3.25 ( $SD=.82$ ) and were 2.19 ( $SD=1.00$ ) among those who did not make a quit attempt.

As expected, negative affect mediated the association between pictorial warnings and quit intentions, such that pictorial warning exposure increased negative affect ( $\beta=.76, p<.001$ ; Figure 6.2) which, in turn, was associated with greater quit intentions ( $\beta=.32, p<.001$ ; mediated effect $=.25, p<.001$ ; Table 6.3). Negative affect was also associated with greater risk appraisals (i.e., perceived likelihood, perceived severity, and anticipated regret; all  $p<.001$ ). As predicted, perceived likelihood and anticipated regret were associated with greater quit intentions (both  $p<.001$ ). However, perceived severity was unexpectedly associated with lower quit intentions. These statistically significant indirect effects indicated that the association between risk appraisals and quit intentions was driven by increases in negative affect elicited by the warnings (Table 6.3).

Pictorial warnings also increased message reactance ( $\beta=.50, p<.001$ ), and message reactance was subsequently associated with lower quit intentions ( $\beta=-.11, p<.001$ ; mediated effect $=-.06, p<.001$ ). In other words, the association between pictorial warnings and quit intentions was stronger after removing the effect of message reactance. Message reactance was associated with lower risk appraisals (i.e., perceived likelihood, perceived severity, and anticipated regret; all  $p<.001$ ). Again, the statistically significant indirect effects demonstrated that the association between risk appraisals and quit intentions was shaped by increases in message reactance (Table 6.3).

## Discussion

Pictorial cigarette pack warnings elicited stronger quit intentions than text-only warnings; stronger quit intentions were associated with subsequent quit attempts. Negative affect (including fear, guilt, disgust, anxiety, and sadness) was a key driver of the effect of pictorial warnings on quit intentions. Compared to text-only warnings, pictorial warnings increased negative affect, which was associated with greater quit intentions. Prior experimental studies have found that pictorial warnings increase fear and negative affect (Emery et al., 2014; Evans et al., 2015; Noar, Hall, et al., 2016), and meta-analyses have demonstrated that negative affect is an important motivator of change across multiple health behaviors, including smoking (Sheeran et al., 2014; Tannenbaum et al., 2015; Witte & Allen, 2000). Given its importance, further studies may wish to investigate more deeply the role of negative affect in pictorial warning effectiveness. For instance, do smokers respond negatively to getting the disease illustrated on their pictorial warning, of other similar diseases, of dying from smoking, or of negative consequences that would result from disease or death? To date, this has not been examined with such precision. While some posit that discrete negative emotions play distinct roles in shaping intentions and behaviors, we found that these five negative emotions were highly correlated and functioned quite similarly, indicating that generalized negative affect may be a key mechanism by which pictorial cigarette pack warnings exert their effect on smoking-related cognitions and behaviors.

We also found that negative affect was associated with increases in three types of risk appraisals, including perceived likelihood of harm from smoking, perceived severity of harm from smoking, and anticipated regret of smoking if it caused health harms. Perceived likelihood and anticipated regret were subsequently associated with stronger quit intentions. In other words, pictorial warnings changed risk appraisals and quit intentions indirectly through negative

emotions. These findings are in line with prior research (Emery et al., 2014; Evans et al., 2015) and with the *affect heuristic* that suggests that risk perceptions change behavior through individuals' emotions (Slovic, Finucane, Peters, & MacGregor, 2004; Slovic et al., 2007). Our research suggests that the emotion evoked by the warnings is a precursor to beneficial changes in risk perceptions and behavior. This is an important point that the US courts failed to grasp when criticizing pictorial warnings simply for evoking emotion (*R.J. Reynolds Tobacco Company vs United States Food and Drug Administration*, 2011).

As expected, message reactance partially weakened the effect of pictorial warnings on quit intentions. Message reactance was also associated with lower risk appraisals. Previous studies have found that pictorial warnings cause greater reactance than text warnings (Erceg-Hurn & Steed, 2011; Hall et al., 2016; LaVoie et al., 2015; Noar, Hall, et al., 2016), but few studies have examined whether message reactance leads to deleterious consequences, such as lower quit intentions (Cho et al., 2016; Hall et al., 2016). Our study adds to this body of research by experimentally examining suppression effects of message reactance after repeated exposure to pictorial warnings. However, given the overwhelming amount of research demonstrating the effectiveness of pictorial warnings, it would be unwise to conclude that pictorial warnings are counterproductive simply because they produce reactance, as others have argued (LaVoie et al., 2015). Although we found that message reactance weakened the effect of pictorial warnings, the weakening effect was small, and more importantly, the warnings strengthened quit intentions and sparked quit attempts. Reactance is unlikely to undo the positive effects of warnings, but measuring message reactance can help to identify individuals who are resistant to the warnings and therefore may benefit from alternative policies or interventions. Moreover, message

reactance could be particularly useful as a way of vetting candidate warnings in the early stages of message development and testing.

Study strengths include the use of an experimental design, a large and diverse sample of smokers who received the warnings on the cigarette packs they used every day, and the longitudinal data collection period which allowed us to establish the temporality of mediated effects. However, the generalizability of these findings to different contexts or over a longer period of time has yet to be established. We unexpectedly found that perceived severity of harm was associated with lower quit intentions, perhaps because the perceived severity items (e.g., “How much would getting cancer because of smoking affect your life?”) could have sparked feelings of fatalism (Powe & Finnie, 2003) in smokers, which in turn, could have lowered quit intentions. Relying on self-report could bias the study results if participants inferred the purpose of the study. Finally, many of the mediated pathways were observational rather than experimental in nature, limiting our ability to draw causal inference.

## **Conclusions**

Understanding how pictorial warnings exert their influence can help researchers and policymakers design more effective warnings. Pictorial warnings elicited stronger quit intentions, which subsequently were associated with more quit attempts. However, message reactance partially suppressed pictorial warnings’ effect on quit intentions. We found that negative affect was a key mechanism by which pictorial warnings changed quit intentions, and that pictorial warnings influenced risk perceptions indirectly via negative affect.

Table 6.1. Participant characteristics ( $n=2,149$ )

	Text-only warnings ( $n=1,078$ )		Pictorial warnings ( $n=1,071$ )	
	$n$	(%)	$n$	(%)
<b>Demographics</b>				
Age				
18-24 years	171	(16.1)	152	(14.5)
25-39 years	377	(35.5)	398	(37.9)
40-54 years	338	(31.8)	304	(29.0)
55+ years	176	(16.6)	195	(18.6)
Mean (SD)	39.7	(13.4)	39.8	(13.7)
Gender				
Male	507	(47.4)	532	(50.0)
Female	548	(51.2)	512	(48.2)
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				
Black or African American	484	(45.8)	510	(48.9)
White	393	(37.2)	358	(34.3)
Other/multiracial	134	(12.7)	117	(11.2)
Asian	28	(2.7)	42	(4.0)
American Indian or Alaska Native	7	(0.6)	11	(1.0)
Native Hawaiian or other Pacific Islander	11	(1.0)	6	(0.6)
Education				
High school degree 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 degree	63	(5.9)	58	(5.5)
Household income, annual				
\$0-\$24,999	566	(53.3)	589	(55.8)
\$25,000-\$49,999	272	(25.6)	266	(25.2)
\$50,000-\$74,999	110	(10.3)	92	(8.7)
\$75,000+	115	(10.8)	109	(10.3)
Low income ( $\leq 150\%$ of Federal Poverty Level)				
No	506	(47.0)	477	(44.8)
Yes	570	(53.0)	589	(55.2)
Study site				
California	594	(55.1)	592	(55.3)
North Carolina	484	(44.9)	479	(44.7)
Cigarettes smoked per day, mean (SD)	8.8	(6.6)	8.7	(7.3)
Smoking frequency				
Non-daily	211	(19.6)	207	(19.3)
Daily	866	(80.4)	864	(80.7)
<b>Mediators and outcomes at baseline, mean (SD)</b>				
Perceived likelihood of harm from smoking	3.3	(0.9)	3.3	(0.9)
Perceived severity of harm from smoking	3.7	(0.6)	3.7	(0.6)
Anticipated regret of smoking if it caused health harms	3.6	(0.8)	3.6	(0.8)
Quit intentions	2.2	(0.9)	2.3	(0.9)

*Note.* Study characteristics and outcomes at baseline did not differ by trial arm (Brewer, Hall, et al., 2016). Missing demographic data range from 0.7% to 2.2%. Response scale for perceived likelihood of harm from smoking ranged from 1-5, with 5 indicating higher perceived likelihood. Response scale for perceived severity of harm from smoking, anticipated regret of smoking if it caused health harms, and quit intentions ranged from 1-4, with 4 indicating higher quantity or endorsement. The baseline surveys could not assess negative affect or message reactance as participants had not yet seen the messages these reactions pertain to.

Table 6.2. Means and bivariate correlations among variables assessed in multiple mediation

	Mean (SD)	1	2	3	4	5	6	7	8
Pictorial warnings (1)	--	1.00	--	--	--	--	--	--	--
Negative affect (2)	2.21 (1.17)	.39**	1.00	--	--	--	--	--	--
Perc. likelihood (3)	3.41 (0.87)	.03	.25**	1.00	--	--	--	--	--
Perc. severity (4)	3.70 (0.62)	-.01	.07**	.40**	1.00	--	--	--	--
Anticipated regret (5)	3.63 (0.75)	-.07*	.08**	.26**	.49**	1.00	--	--	--
Message reactance (6)	2.08 (0.89)	.21**	.05*	-.23**	-.14**	-.12**	1.00	--	--
Quit intentions (7)	2.55 (1.07)	.07*	.35**	.27**	.11**	.18**	-.14**	1.00	--
Quit attempts (8)	--	.06*	.21**	.11**	-.05*	.01	-.06*	.47**	1.00

*Note.* Pictorial warnings were coded as 0=text-only, 1=pictorial. Quit attempts at any point during the 4 week trial were coded as 0=yes, 1=no. Response scale for negative affect, perceived likelihood, and message reactance ranged from 1-5, with 5 indicating higher quantity or endorsement. Response scale for perceived severity, anticipated regret, and quit intentions ranged from 1-4, with 4 indicating higher quantity or endorsement.

\*  $p < .05$ , \*\*  $p < .001$



Table 6.3. Mediation of association between pictorial warning exposure and quit intentions ( $n=2,149$ )

Mediation path	Mediated effect $\beta_a * \beta_b$
Pictorial warning → negative affect → quit intentions	.25**
Pictorial warning → negative affect → likelihood → quit intentions	.05**
Pictorial warning → negative affect → severity → quit intentions	-.02**
Pictorial warning → negative affect → regret → quit intentions	.03**
Pictorial warning → reactance → quit intentions	-.06*
Pictorial warning → reactance → likelihood → quit intentions	-.04**
Pictorial warning → reactance → severity → quit intentions	.03**
Pictorial warning → reactance → regret → quit intentions	-.03**

*Note.* Table reports standardized path coefficients for mediated effects. Mediators measured at immediate post-test (negative affect, message reactance) or the week 2 follow-up survey (perceived likelihood, perceived severity, anticipated regret). Quit intentions measured at week 4.

\*  $p < .05$ , \*\*  $p < .001$

Figure 6.1. Warnings used in trial

Panel A. Pictorial warnings used in experiment



Panel B. Text-only warnings used in experiment

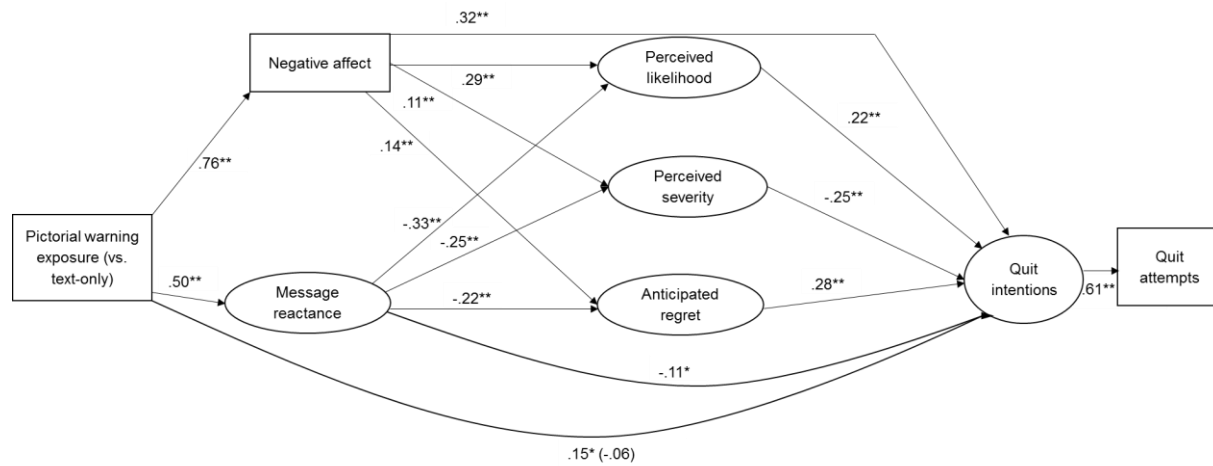
**SURGEON GENERAL'S WARNING:**  
Smoking Causes Lung Cancer, Heart Disease,  
Emphysema, and May Complicate Pregnancy.

**SURGEON GENERAL'S WARNING:**  
Quitting Smoking Now Greatly Reduces  
Serious Risks to Your Health.

**SURGEON GENERAL'S WARNING:**  
Smoking by Pregnant Women May Result  
in Fetal Injury, Premature Birth, and  
Low Birth Weight.

**SURGEON GENERAL'S WARNING:**  
Cigarette Smoke Contains  
Carbon Monoxide.

Figure 6.2. Structural equation model assessing impact of pictorial warnings on quit intentions and quit attempts ( $n=2,149$ )



*Note.* To simplify presentation, we omitted factor loadings, residuals, and correlations between variables. Values in parentheses indicate the effect of pictorial warnings on quit intentions, after controlling for the mediators. RMSEA=.035 [95% CI=.032, .039], CFI=.998, TLI=.997.

## **CHAPTER 7: DISCUSSION**

Recent reviews have found that pictorial warnings out-perform text-only warnings in terms of attracting attention, garnering affective and cognitive reactions, and increasing intentions to quit smoking (Noar, Francis, Bridges, Sontag, Brewer, et al., 2016; Noar, Francis, Bridges, Sontag, Ribisl, et al., 2016; Noar, Hall, et al., 2016). Pictorial warnings also help people quit smoking (Brewer, Hall, et al., 2016) and could reduce smoking rates in the US by at least 5% (D. T. Levy, Mays, Yuan, Hammond, & Thrasher, 2016). Given the overwhelming evidence pointing toward the effectiveness of pictorial warnings, it is a travesty that the tobacco industry has thwarted the implementation of this common-sense policy in the US. Two of the prevailing arguments against pictorial warnings are that they might cause reactance in smokers (LaVoie et al., 2015; Ruiter & Kok, 2005) and that they evoke emotion (R.J. Reynolds Tobacco Company vs United States Food and Drug Administration, 2011). My dissertation explored two questions related to these criticisms: 1) do pictorial warnings cause reactance, and if so, is reactance detrimental to public health? and 2) do pictorial warnings cause negative emotions, and if so, is that problematic? The short answers to these questions are: 1) pictorial warnings cause some reactance, but not enough to offset the benefits of the warnings, and 2) pictorial warnings elicit negative emotions, but these emotions are precisely why the warnings are effective. This chapter will explore these two issues in greater depth, with a focus on the practical and theoretical implications of the dissertation findings.

## **Reactance Overview**

To develop a theoretically-driven measure of reactance (Chapters 3 and 5), I consulted the original texts on reactance (the Theory of Psychological Reactance, developed by Jack Brehm in the 1960s), as well as more recent investigations including fear appeals theory and the health communications literature. This theoretical groundwork informed my conceptualization of reactance as an amalgam of perceived threat to freedom, anger, and counterarguing against a persuasive health message. I then developed a 27-item Reactance to Health Warnings Scale (Chapter 3) and a 3-item brief version of the scale (Chapter 5), both of which exhibited strong psychometric properties in multiple samples of US adults.

The validation of the scale found that, in an online sample, five of the nine reactance subscales weakened the effect of pictorial warnings on smokers' evaluation of the warning's ability to motivate quitting (Chapter 3). Reactance was also associated with lower perceived message effectiveness and greater avoidance of the warnings. Similarly, the validation of the short form (Chapter 5) revealed that reactance was associated with lower perceived message effectiveness, greater avoidance, and less support for requiring pictorial warnings on cigarette packs. Chapter 6 found that, in a four-week randomized trial, reactance partially weakened the effect of pictorial warnings on quit intentions. However, the indirect effect was small in magnitude.

## **Mediators Overview**

The mechanisms by which pictorial warnings influence quit intentions and subsequent cessation behavior are poorly understood. Characterizing these processes can help policymakers and researchers design warnings that elicit responses that increase quit intentions and, ultimately, smoking cessation. This dissertation presented a theoretically-driven serial mediation model

(Chapter 6) in which negative emotions were the main driver of the relationship between pictorial cigarette pack warnings and quit intentions. Negative emotions were also associated with greater perceived likelihood of quitting smoking and more anticipated regret of continuing to smoke, which in turn facilitated quit intentions and quit attempts. In other words, pictorial warnings changed risk appraisals and quit intentions indirectly through negative emotions.

### **Practical Implications of the Dissertation Research**

My dissertation points toward several practical implications for researchers and policymakers. First, I found that pictorial warnings were more effective than text-only warnings in two studies, despite the effects of reactance. In Chapter 3, an online experiment revealed that both smokers and non-smokers rated the pictorial warnings as more effective than text-only warnings; smokers also thought that the pictorial warnings would motivate them to quit smoking. The four-week randomized controlled trial revealed that, compared to text-only warnings, pictorial warnings elicited stronger quit intentions and sparked more quit attempts (Chapter 6). This brings us to the first and more important practical implication of this research:

**Policymakers should wholeheartedly support pictorial cigarette pack warnings because they are more effective than text-only warnings.**

Second, in Chapters 3 and 6, I found that reactance partially weakened the effects of the warnings. Smokers also had more reactance than non-smokers, likely because the behavior targeted by the warnings (i.e., smoking) means more to them. As with any policy designed for the masses, pictorial warnings may not work for everyone. **Thus, smokers who exhibit message reactance may be less receptive to pictorial warnings and subsequently benefit from different types of interventions.**

In Chapter 5, I found that pictorial warnings simultaneously produced greater reactance (which hindered quit attempts) and negative emotions (which promoted quit attempts). These competing mechanisms functioned simultaneously, but ultimately, the negative emotions had a greater effect on quit attempts. It may not be possible to eliminate reactance altogether. **In fact, the best warnings may be those that elicit strong reactions of all kinds, including reactance.**

Finally, the US courts have criticized pictorial warnings for being “unabashed attempts to evoke emotion” (R.J. Reynolds Tobacco Company vs United States Food and Drug Administration, 2011). Indeed, this dissertation indicated that pictorial warnings caused negative emotions, including fear and guilt. But a recent legal analysis of the pictorial warning lawsuits concluded that the “warnings do not bypass reason simply by reaching for the heart,” and that the emotions evoked by the warnings should not deem them unconstitutional (Goodman, 2013, p. 290). My dissertation found that pictorial warnings were effective *because* of the emotions they sparked, which should come as no surprise to the tobacco industry, who has a long-standing history of arousing emotion in order to sell cigarettes. **The US courts should not reject pictorial warnings for being emotionally powerful; this is precisely *why* pictorial warnings are more effective than the status quo.**

### **Theoretical Implications of the Dissertation Research**

In addition to these practical conclusions, I propose several theoretical implications based on my dissertation research. First, a variety of academic disciplines have taken an interest in reactance – from psychology to public health to communications – creating a rich body of evidence about reactance, but also ambiguity in terms of how to define, conceptualize, and measure the construct. Some researchers studying reactance have treated perceived threat to freedom as a manipulation check, rather than as part of reactance. Others have measured only the

emotional element of reactance. **Building on careful interpretation and synthesis of reactance theory and research, I define reactance as an emotional and cognitive resistance to a warning, characterized by 1) a perceived threat to one's freedom, 2) anger toward the warning, and 3) counterarguments against the warning.**

Second, the Theory of Psychological Reactance posits that health messages may be ineffective if reactance causes boomerang effects. But it is unwise to assume that persuasive messages are ineffective simply because they produce reactance, without looking at whether reactance is associated with harmful consequences. Notably, LaVoie et al., (2015) recently received large amounts of media attention for arguing that pictorial warnings were counterproductive simply because they produced reactance (a dangerous assumption given the tenuous legal status of pictorial warnings in the US). Although this dissertation found that message reactance weakened the effect of pictorial warnings, the weakening effect was small in magnitude, and more importantly, the warnings promoted smoking cessation on the whole.

**Reactance is not inherently problematic. It is only detrimental if it produces harmful effects.**

However, the theoretical literature on reactance does not clearly define the possible harmful effects of reactance. Researchers have traditionally examined whether reactance produces the opposite effect as intended (e.g., makes people smoke *more*) or weakens the effectiveness of an intervention (e.g., does not help people quit smoking). But reactance could lead to other types of problems unrelated to the behavior targeted by a persuasive message. For example, in Chapter 5, reactance was associated with lower political support for requiring pictorial warnings on cigarette packs – an association that was stronger than those between reactance and quit



intentions or smoking quantity. **Researchers should consider a variety of potential unintended consequences when studying the effects of reactance.**

Finally, many traditional theories of health behavior, such as the Health Belief Model (Rosenstock, 1974), hypothesize that cognitive processes drive health decisions. But a growing theoretical literature recognizes the importance of emotions in shaping health-related beliefs, attitudes, and behaviors (Loewenstein et al., 2001; E. Peters et al., 2006; Slovic et al., 2007; Slovic, Peters, Finucane, & Macgregor, 2005). In Chapter 6, negative emotions were the major driver of the effect of pictorial warnings on intentions and behavior. These emotions appeared to activate deeper cognitive changes in perceived likelihood and anticipated regret, which facilitated quit attempts. These findings provide support for the *affect heuristic* that suggests that risk perception alters behavior through a process in which individuals first rely on their “gut-level” feelings (Slovic et al., 2004; Slovic et al., 2007). **Health behavior theories should not overlook the importance of emotions in shaping health-related risk perceptions and behavior.**

### **Conclusions**

My dissertation found that pictorial cigarette pack warnings elicited reactance, but not enough to offset the overall impact of the warnings. Pictorial warnings caused negative emotions, and that these emotions were the primary driver of the warnings’ beneficial effects on quit intentions and cessation behavior. Policymakers should unequivocally embrace pictorial warnings as a strategy to curb the tobacco epidemic.

## APPENDIX I: MEASURES

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Independent variable	Exposure to pictorial warnings	N/A (manipulated variable)	0=text-only warning 1=pictorial warning		X					
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	The following statements concern your general attitudes. Read each statement and please indicate how much you agree or disagree with each statement.  I become angry when my freedom of choice is restricted	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	I become frustrated when I am unable to make free and independent decisions	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	When something is prohibited, I usually think “that’s exactly what I am going to do”	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	Regulations trigger a sense of resistance in me	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	I find contradicting others stimulating	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	When someone forces me to do something, I feel like doing the opposite	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	I resist the attempts of others to influence me	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	It makes me angry when another person is held up as a role model for me to follow	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	I consider advice from others to be an intrusion	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	Advice and recommendations usually induce me to do just the opposite	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Trait reactance	It irritates me when someone points out things which are obvious to me	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hong and Page (1989)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Positive smoker prototypes, RCT	How much do the following characteristics describe a typical cigarette smoker your age?  Cool	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Positive smoker prototypes, RCT	Smart	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Positive smoker prototypes, RCT	Sexy	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)		X				
Convergent validity (Aim 1), moderator (Aim 3)	Positive smoker prototypes, RCT	Healthy	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)		X				
Convergent validity (Aim 1)	Positive smoker prototypes, MTurk	How much do the following characteristics describe a typical cigarette smoker your age?  Cool	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)	X					

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Convergent validity (Aim 1)	Positive smoker prototypes, MTurk	Stylish	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)	X					
Convergent validity (Aim 1)	Positive smoker prototypes, MTurk	Independent	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)	X					
Convergent validity (Aim 1)	Positive smoker prototypes, MTurk	Classy	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)	X					
Convergent validity (Aim 1)	Positive smoker prototypes, MTurk	Intelligent	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)	X					
Convergent validity (Aim 1)	Positive smoker prototypes, MTurk	Sexy	1=Not at all 2=A little bit 3=Somewhat 4=Quite a bit 5=Very much	Gerrard et al. (2008) and McCool et al. (2011)	X					
Predictive validity (Aim 1)	Perceived effectiveness, RCT	How much did having this warning on your cigarette packs make you concerned about the health effects of smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot							X
Predictive validity (Aim 1)	Perceived effectiveness, RCT	How much did having this warning on your cigarette packs make you want to quit smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot							X
Predictive validity (Aim 1)	Perceived effectiveness, RCT	How much would having this warning on cigarette packs...  Make other smokers concerned about the health effects of smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot							X
Predictive validity (Aim 1)	Perceived effectiveness, RCT	Make other smokers want to quit smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot							X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Predictive validity (Aim 1)	Perceived effectiveness, RCT	Make non-smokers concerned about the health effects of smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot							X
Predictive validity (Aim 1)	Perceived effectiveness, RCT	Discourage non-smokers from starting to smoke?	1=Not at all 2=A little 3=Somewhat 4=A lot							X
Concurrent criterion validity (Aim 1)	Perceived effectiveness, MTurk	How much would having this warning on your cigarette packs... Make you concerned about the health effects of smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot		X					
Concurrent criterion validity (Aim 1)	Perceived effectiveness, MTurk	Make you concerned about the health effects of smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot		X					
Concurrent criterion validity (Aim 1)	Perceived effectiveness, MTurk	Discourage non-smokers from smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot		X					
Concurrent criterion validity (Aim 1)	Perceived effectiveness, MTurk	Make non-smokers concerned about the health effects of smoking?	1=Not at all 2=A little 3=Somewhat 4=A lot		X					
Predictive validity (Aim 1)	Support for pictorial warning policy	If the US required that graphic warnings covered the top half of the front and back of cigarette packs, would you...	1=Strongly support this policy 2=Somewhat support this policy 3=Somewhat oppose this policy 4=Strongly oppose this policy							X
Predictive validity (Aim 1), dependent variable (Aims 2 and 3)	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 et al. (2009)						X

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Predictive validity (Aim 1), dependent variable (Aims 2 and 3)	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 et al. (2009)						X
Predictive validity (Aim 1), dependent variable (Aims 2 and 3)	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 et al. (2009)						X
Predictive validity (Aim 1)	Avoidance	In the last week, how often have you tried to avoid <u>thinking about</u> the warning label on your cigarette packs?	1=Never 2=Rarely 3=Sometimes 4=Often 5=All of the time	Adapted from Population Assessment of Tobacco and Health Study (2014)						X
Predictive validity (Aim 1)	Avoidance	In the last week, how often have you tried to avoid <u>looking at</u> the warning label on your cigarette packs?	1=Never 2=Rarely 3=Sometimes 4=Often 5=All of the time	Adapted from Population Assessment of Tobacco and Health Study (2014)						X
Predictive validity (Aim 1)	Avoidance	In the last week, how often have you put your cigarettes away because you didn’t want others to see the warning label on the pack?	1=Never 2=Rarely 3=Sometimes 4=Often 5=All of the time	Adapted from Population Assessment of Tobacco and Health Study (2014)						X
Concurrent criterion validity (Aim 1)	Avoidance	Imagine that all cigarette packs had this warning. How likely is it that you would try to avoid thinking about the warning on your cigarette packs?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would try to put the warning out of your mind?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would try to forget about what was on the warning?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would try to avoid looking at the warning on your cigarette packs?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would keep the pack out of sight to avoid looking at the warning?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would put your cigarettes away because you didn't want others to see the warning on the pack?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would transfer cigarettes to another container to avoid looking at the warning?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					



Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would place a cover or case over your cigarette pack to avoid looking at the warning?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would try to scratch the warning off the pack?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Concurrent criterion validity (Aim 1)	Avoidance	How likely is it that you would try to tear the warning off the pack?	1=Not at all likely 2=A little likely 3=Fairly likely 4=Very likely 5=Extremely likely	Adapted from Population Assessment of Tobacco and Health Study (2014)	X					
Predictive validity (Aim 1)	Forgoing a cigarette	In the last week, how often have you stopped yourself from having a cigarette because you wanted to <u>smoke less</u> ?	0=Never 1=1 or more times	Li et al. (2014)						X
Predictive validity (Aim 1)	Cigarettes per day	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.	# of cigarettes	Adapted from Population Assessment of Tobacco and Health Study (2014)						X
Mediator (Aim 2)	Perceived likelihood of harm from smoking	What is the chance that you will one day get <u>cancer</u> if you continue to smoke cigarettes?	1=No chance 2=Low chance 3=Moderate chance 4=High chance 5=Certain		X			X		

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2)	Perceived likelihood of harm from smoking	What is the chance that you will one day get <u>heart disease</u> if you continue to smoke cigarettes?	1=No chance 2=Low chance 3=Moderate chance 4=High chance 5=Certain		X			X		
Mediator (Aim 2)	Perceived likelihood of harm from smoking	What is the chance that you will one day get a <u>permanent breathing problem</u> if you continue to smoke cigarettes?	1=No chance 2=Low chance 3=Moderate chance 4=High chance 5=Certain		X			X		
Mediator (Aim 2)	Perceived severity of harm from smoking	How much would getting <u>cancer</u> because of smoking affect your life?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X			X		
Mediator (Aim 2)	Perceived severity of harm from smoking	How much would getting <u>heart disease</u> because of smoking affect your life?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X			X		
Mediator (Aim 2)	Perceived severity of harm from smoking	How much would getting a <u>permanent breathing problem</u> because of smoking affect your life?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X			X		
Mediator (Aim 2)	Anticipated regret of smoking if it caused health harms	If smoking made you get <u>cancer</u> , how much would you regret smoking?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X			X		
Mediator (Aim 2)	Anticipated regret of smoking if it caused health harms	If smoking made you get <u>heart disease</u> , how much would you regret smoking?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X			X		
Mediator (Aim 2)	Anticipated regret of smoking if it caused health harms	If smoking made you get a <u>permanent breathing problem</u> , how much would you regret smoking?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X			X		

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2)	Negative affect	The next questions are about the warning labels we put on your cigarette packs. How much did the warning on your cigarette packs make you feel...	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
		Blue								
Mediator (Aim 2)	Negative affect	Afraid	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Anxious	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Repelled	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	On edge	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Ashamed	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Uneasy	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Sad	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Scared	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2)	Negative affect	Grossed out	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Regretful	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Frightened	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Guilty	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Disgusted	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Negative affect	Depressed	1=Not at all 2=A little 3=Somewhat 4=Very 5=Extremely	Adapted from Nonnemaker et al. (2015)		X				
Mediator (Aim 2)	Brief Reactance to Health Warnings Scale	Please say how much you agree or disagree with each statement below about the warning we put on your packs.  This warning annoys me	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hall et al. (2016)		X				
Mediator (Aim 2)	Brief Reactance to Health Warnings Scale	This warning is trying to manipulate me	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hall et al. (2016)		X				

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Mediator (Aim 2)	Brief Reactance to Health Warnings Scale	The health effect on this warning is overblown	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Hall et al. (2016)		X				
Moderator (Aim 3)	Positive attitudes toward smoking	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 and Baker (1991)		X				
Moderator (Aim 3)	Positive attitudes toward smoking	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 (1991)		X				
Moderator (Aim 3)	Positive attitudes toward smoking	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 (1991)		X				
Moderator (Aim 3)	Positive attitudes toward smoking	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 (1991)		X				
Moderator (Aim 3)	Positive attitudes toward smoking	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 (1991)		X				

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Moderator (Aim 3)	Positive attitudes toward smoking	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 (1991)	X					
Moderator (Aim 3)	Positive attitudes toward smoking	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 (1991)	X					
Moderator (Aim 3)	Positive attitudes toward smoking	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 (1991)	X					
Moderator (Aim 3)	Nicotine dependence	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	Heatherton, Kozlowski, Frecker, and Fagerstrom (1991)	X					
Moderator (Aim 3)	Self-efficacy to quit smoking	I believe I have the ability 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 (2007)	X					
Moderator (Aim 3)	Self-efficacy to quit smoking	I see myself as being capable of 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 (2007)	X					

Variable Type	Construct	Item	Response scale	Source	t1	t2	t3	t4	t5	t6
Moderator (Aim 3)	Self-efficacy to quit smoking	I feel I have personal control over 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 (2007)	X					
Moderator (Aim 3)	Self-efficacy to quit smoking	My quitting smoking in the next 2 months would be difficult.	1=Strongly disagree 2=Disagree 3=Neither agree nor disagree 4=Agree 5=Strongly agree	Adapted from Armitage (2007)	X					
Moderator (Aim 3)	Self-efficacy to quit smoking	I am confident that I will be able 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 (2007)	X					
Moderator (Aim 3)	Response efficacy of quitting smoking	How much would quitting smoking lower your chances of getting <u>cancer</u> ?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X					
Moderator (Aim 3)	Response efficacy of quitting smoking	How much would quitting smoking lower your chances of getting <u>heart disease</u> ?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X					
Moderator (Aim 3)	Response efficacy of quitting smoking	How much would quitting smoking lower your chances of getting a <u>permanent breathing problem</u> ?	1=Not at all 2=A little 3=A moderate amount 4=A lot		X					

## APPENDIX II: AIM 3 FINDINGS

Given the exploratory nature of the Aim 3 analyses and the dearth of statistically significant findings, I present the findings here as an appendix. Using data from the parent study, I examined moderators of the relationship between pictorial warnings and reactance (see Chapter 4), as well as the relationship between reactance and quit intentions. Candidate moderators were importance of smoking (measured as positive attitudes toward smoking, positive smoker prototypes, and nicotine dependence; see Appendix I), efficacy (including self-efficacy and response efficacy), and trait reactance.

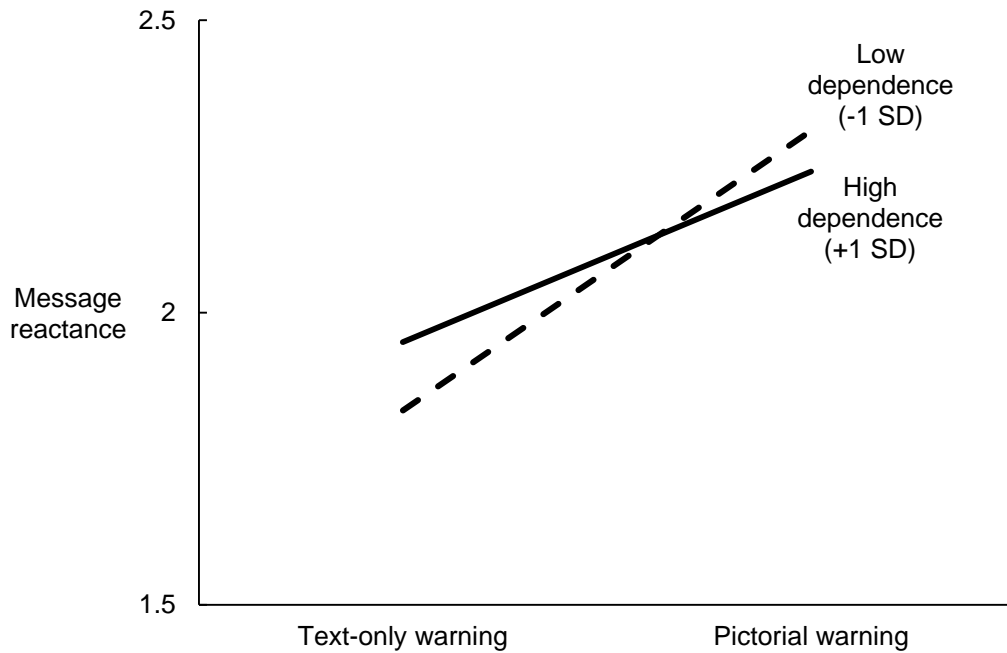
Of the 12 predicted interactions, two were statistically significant. Contrary to my prediction, the positive relationship between pictorial warning exposure and message reactance was weaker for those with high nicotine dependence compared to those with low nicotine dependence ( $p < .001$ , Figure A.1). As expected, the positive association between pictorial warnings and message reactance was stronger for those with high trait reactance than for those with low trait reactance ( $p < .001$ , Figure A.1).

I anticipated that nicotine dependence would strengthen the positive relationship between pictorial warnings and message reactance, but found the opposite. It is possible that highly addicted smokers believe their own behavior is not modifiable, and therefore have more muted reactions to the warning than less addicted smokers. I also found that trait reactance strengthened the relationship between pictorial warnings and message reactance. Smokers with high trait reactance may benefit from alternate types of warnings that are perceived as less dogmatic or less threatening to their autonomy. The remaining 10 predictions were not statistically significant, perhaps because interactions with measured variables are often underpowered (Aguinis, 1995). These exploratory findings require replication in larger samples.

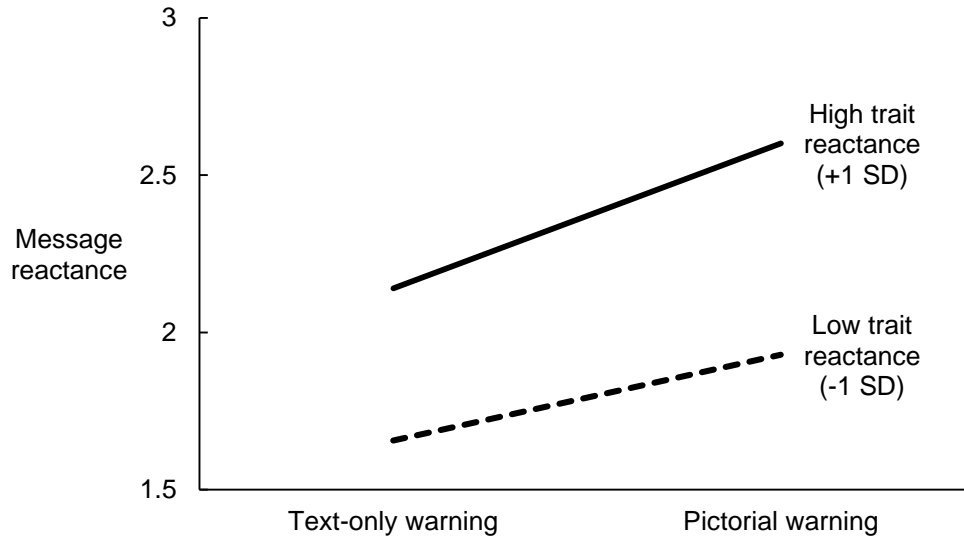


Figure A.1. Moderation of the relationship between pictorial warning exposure and message reactance ( $n=2,149$ )

Panel A. Nicotine dependence weakened the impact of pictorial warnings on message reactance



Panel B. Trait reactance strengthened the impact of pictorial warnings on message reactance



## REFERENCES

- Aguinis, H. (1995). Statistical power problems with moderated multiple regression in management research. *Journal of Management*, 21(6), 1141-1158.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.
- Andrews, J. C., Choiniere, C. J., & Portnoy, D. B. (2015). Opportunities for consumer research from the Food and Drug Administration's Center for Tobacco Products. *Journal of Public Policy & Marketing*, 34(1), 119-130.
- Armitage, C. J. (2007). Efficacy of a brief worksite intervention to reduce smoking: the roles of behavioral and implementation intentions. *Journal of Occupational Health Psychology*, 12(4), 376-390. doi:10.1037/1076-8998.12.4.376
- Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin*, 107(2), 238-246.
- Bollen, K. A. (1989). *Structural equations with latent variables*. New York, NY: Wiley.
- Brandon, T. H., & Baker, T. B. (1991). The Smoking Consequences Questionnaire: The subjective expected utility of smoking in college students. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*, 3(3), 484-491.
- Brehm, J. W. (1966). *A theory of psychological reactance*. New York, NY: Academic Press.
- Brehm, J. W., & Brehm, S. S. (1981). *Psychological reactance: A theory of freedom and control*. New York, NY: Academic Press
- Brennan, E., Durkin, S. J., Cotter, T., Harper, T., & Wakefield, M. A. (2011). Mass media campaigns designed to support new pictorial health warnings on cigarette packets: evidence of a complementary relationship. *Tobacco Control*, 20(6), 412-418. doi:10.1136/tc.2010.039321
- Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology*, 26(2), 136-145. doi:10.1037/0278-6133.26.2.136
- Brewer, N. T., DeFrank, J. T., & Gilkey, M. B. (2016). Anticipated regret and health behavior: A meta-analysis. *Health Psychology*, 35(11), 1264-1275.
- Brewer, N. T., Hall, M. G., Lee, J. G., Peebles, K., Noar, S. M., & Ribisl, K. M. (2015). Testing warning messages on smokers' cigarette packages: a standardised protocol. *Tobacco Control*, 25(2), 153-159. doi:10.1136/tobaccocontrol-2014-051661

- Brewer, N. T., Hall, M. G., Noar, S. M., Parada, H., Stein-Seroussi, A., Bach, L. E., . . . Ribisl, K. M. (2016). Effect of pictorial cigarette pack warnings on changes in smoking behavior: A randomized clinical trial. *JAMA Internal Medicine*, 176(7), 905-912. doi:10.1001/jamainternmed.2016.2621
- Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science*, 6(1), 3-5. doi:10.1177/1745691610393980
- Burgoon, M., Alvaro, E., Grandpre, J., & Voulodakis, M. (2002). Revisiting the theory of psychological reactance. In J. P. Dillard & M. Pfau (Eds.), *The persuasion handbook* (pp. 213-232). Thousand Oaks, CA: Sage Publications.
- Cameron, L. D., Pepper, J. K., & Brewer, N. T. (2015). Responses of young adults to graphic warning labels for cigarette packages. *Tobacco Control*, 24(e1), e14-22. doi:10.1136/tobaccocontrol-2012-050645
- Canadian Cancer Society. (2016). Cigarette package health warnings: International status report. Ontario, Canada: Canadian Cancer Society.
- Cho, Y. J., Thrasher, J. F., Swayampakala, K., Yong, H. H., McKeever, R., Hammond, D., . . . Borland, R. (2016). Does reactance against cigarette warning labels matter? Warning label responses and downstream smoking cessation amongst adult smokers in Australia, Canada, Mexico and the United States. *PloS One*, 11(7), e0159245. doi:10.1371/journal.pone.0159245
- Davis, K. C., Nonnemaker, J., Duke, J., & Farrelly, M. C. (2013). Perceived effectiveness of cessation advertisements: the importance of audience reactions and practical implications for media campaign planning. *Health Communication*, 28(5), 461-472. doi:10.1080/10410236.2012.696535
- De Ayala, R. J. (2013). *Theory and practice of item response theory*. New York, NY: Guilford Publications.
- Diepeveen, S., Ling, T., Suhrcke, M., Roland, M., & Marteau, T. M. (2013). Public acceptability of government intervention to change health-related behaviours: A systematic review and narrative synthesis. *BMC Public Health*, 13, 756. doi:10.1186/1471-2458-13-756
- Dillard, J. P., & Peck, E. (2000). Affect and persuasion emotional responses to public service announcements. *Communication Research*, 27(4), 461-495.
- Dillard, J. P., & Shen, L. (2005). On the nature of reactance and its role in persuasive health communication. *Communication Monographs*, 72(2), 144-168.
- DiMatteo, M. R., Haskard, K. B., & Williams, S. L. (2007). Health beliefs, disease severity, and patient adherence: a meta-analysis. *Medical Care*, 45(6), 521-528. doi:10.1097/MLR.0b013e318032937e

- Embretson, S. E., & Reise, S. P. (2013). *Item response theory*. Mahwah, NJ: Psychology Press.
- Emery, L. F., Romer, D., Sheerin, K. M., Jamieson, K. H., & Peters, E. (2014). Affective and cognitive mediators of the impact of cigarette warning labels. *Nicotine & Tobacco Research, 16*(3), 263-269. doi:10.1093/ntr/ntt124
- Erceg-Hurn, D. M., & Steed, L. G. (2011). Does exposure to cigarette health warnings elicit psychological reactance in smokers? *Journal of Applied Social Psychology, 41*(1), 219-237. doi:10.1111/j.1559-1816.2010.00710.x
- Evans, A. T., Peters, E., Strasser, A. A., Emery, L. F., Sheerin, K. M., & Romer, D. (2015). Graphic warning labels elicit affective and thoughtful responses from smokers: Results of a randomized clinical trial. *PloS One, 10*(12), e0142879. doi:10.1371/journal.pone.0142879
- Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2), 407-429.
- Friedman, L. C., Cheyne, A., Givelber, D., Gottlieb, M. A., & Daynard, R. A. (2015). Tobacco industry use of personal responsibility rhetoric in public relations and litigation: disguising freedom to blame as freedom of choice. *American Journal of Public Health, 105*(2), 250-260. doi:10.2105/ajph.2014.302226
- Gerrard, M., Gibbons, F. X., & Bushman, B. J. (1996). Relation between perceived vulnerability to HIV and precautionary sexual behavior. *Psychological Bulletin, 119*(3), 390-409.
- Gerrard, M., Gibbons, F. X., Houlihan, A. E., Stock, M. L., & Pomery, E. A. (2008). A dual-process approach to health risk decision making: The prototype willingness model. *Developmental Review, 28*(1), 29-61.
- Gibbons, F. X., & Eggleston, T. J. (1996). Smoker networks and the "typical smoker": a prospective analysis of smoking cessation. *Health Psychology, 15*(6), 469-477. doi:10.1037/0278-6133.15.6.469
- Gibbons, F. X., & Gerrard, M. (1995). Predicting young adults' health risk behavior. *Journal of Personality and Social Psychology, 69*(3), 505-517. doi:10.1037/0022-3514.69.3.505
- Gollust, S. E., & Cappella, J. N. (2014). Understanding public resistance to messages about health disparities. *Journal of Health Communication, 19*(4), 493-510. doi:10.1080/10810730.2013.821561
- Goodman, E. P. (2013). Visual gut punch: persuasion, emotion, and the constitutional meaning of graphic disclosure. *Cornell Law Review, 99*(3), 513-570.
- Hall, M. G., Ribisl, K. M., & Brewer, N. T. (2014). Smokers' and nonsmokers' beliefs about harmful tobacco constituents: Implications for FDA communication efforts. *Nicotine & Tobacco Research, 16*(3), 343-350. doi:10.1093/ntr/ntt158

- Hall, M. G., Sheeran, P., Noar, S. M., Ribisl, K. M., Bach, L. E., & Brewer, N. T. (2016). Reactance to health warnings scale: Development and validation. *Annals of Behavioral Medicine*, 50(5), 736-750. doi:10.1007/s12160-016-9799-3
- Hall, M. G., Sheeran, P., Noar, S. M., Ribisl, K. M., Boynton, M. H., & Brewer, N. T. (2017). A brief measure of reactance to health warnings. *Journal of Behavioral Medicine*. doi:10.1007/s10865-016-9821-z
- Hammond, D. (2011). Health warning messages on tobacco products: A review. *Tobacco Control*, 20(5), 327-337.
- Harrison, J. A., Mullen, P. D., & Green, L. W. (1992). A meta-analysis of studies of the health belief model with adults. *Health Education Research*, 7(1), 107-116.
- Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, 76(4), 408-420.
- Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerstrom, K. O. (1991). The Fagerstrom Test for Nicotine Dependence: A revision of the Fagerstrom Tolerance Questionnaire. *British Journal of Addiction*, 86(9), 1119-1127.
- Hellman, R., Cummings, K., Haughey, B., Zielezny, M., & O'Shea, R. (1991). Predictors of attempting and succeeding at smoking cessation. *Health Education Research*, 6(1), 77-86.
- Hong, S.-M., & Page, S. (1989). A psychological reactance scale: Development, factor structure and reliability. *Psychological Reports*, 64(3c), 1323-1326.
- Huang, J., Chaloupka, F. J., & Fong, G. T. (2014). Cigarette graphic warning labels and smoking prevalence in Canada: a critical examination and reformulation of the FDA regulatory impact analysis. *Tobacco Control*, 23 Suppl 1, i7-12. doi:10.1136/tobaccocontrol-2013-051170
- Hyland, A., Borland, R., Li, Q., Yong, H. H., McNeill, A., Fong, G. T., . . . Cummings, K. (2006). Individual-level predictors of cessation behaviours among participants in the International Tobacco Control (ITC) Four Country Survey. *Tobacco Control*, 15(suppl 3), iii83-iii94.
- Institute of Medicine. (2007). *Ending the tobacco problem: A blueprint for the nation*. Washington, DC: Institute of Medicine.
- Jamal, A., King, B. A., Neff, L. J., Whitmill, J., Babb, S. D., & Graffunder, C. M. (2016). Current cigarette smoking among adults - United States, 2005-2015. *MMWR: Morbidity and Mortality Weekly Report*, 65(44), 1205-1211. doi:10.15585/mmwr.mm6544a2
- Kaiser, H. F., & Caffrey, J. (1965). Alpha factor analysis. *Psychometrika*, 30(1), 1-14.

- Katapodi, M. C., Lee, K. A., Facione, N. C., & Dodd, M. J. (2004). Predictors of perceived breast cancer risk and the relation between perceived risk and breast cancer screening: a meta-analytic review. *Preventive Medicine*, 38(4), 388-402. doi:10.1016/j.ypmed.2003.11.012
- Klein, W. M., Zajac, L. E., & Monin, M. M. (2009). Worry as a moderator of the association between risk perceptions and quitting intentions in young adult and adult smokers. *Annals of Behavioral Medicine*, 38(3), 256-261. doi:10.1007/s12160-009-9143-2
- Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York, NY: Guilford Press.
- Kraemer, J. D., & Baig, S. A. (2013). Analysis of legal and scientific issues in court challenges to graphic tobacco warnings. *American Journal of Preventive Medicine*, 45(3), 334-342. doi:10.1016/j.amepre.2013.05.004
- LaVail, K. H., Anker, A. E., Reinhart, A., & Feeley, T. H. (2010). The persuasive effects of audiovisual PSAs to promote organ donation: The mediating role of psychological reactance. *Communication Studies*, 61(1), 46-69.
- LaVoie, N. R., Quick, B. L., Riles, J. M., & Lambert, N. J. (2015). Are graphic cigarette warning labels an effective message strategy? A test of psychological reactance theory and source appraisal. *Communication Research*, Advance online publication. doi:10.1177/0093650215609669
- Lazuras, L., Chatzipolychroni, E., Rodafinos, A., & Eiser, J. R. (2012). Social cognitive predictors of smoking cessation intentions among smoker employees: The roles of anticipated regret and social norms. *Addictive Behaviors*, 37(3), 339-341. doi:10.1016/j.addbeh.2011.11.008
- Lerner, Gonzalez, Small, & Fischhoff. (2003). Effects of fear and anger on perceived risks of terrorism a national field experiment. *Psychological Science*, 14(2), 144-150.
- Lerner, & Keltner. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology*, 81(1), 146-159.
- Levenson, H. (1974). Activism and powerful others: Distinctions within the concept of internal-external control. *Journal of Personality Assessment*, 38(4), 377-383.
- Leventhal, H. (1971). Fear appeals and persuasion: The differentiation of a motivational construct. *American Journal of Public Health*, 61(6), 1208-1224.
- Levy, D. T., Mays, D., Yuan, Z., Hammond, D., & Thrasher, J. F. (2016). Public health benefits from pictorial health warnings on US cigarette packs: A SimSmoke simulation. *Tobacco Control*. doi:10.1136/tobaccocontrol-2016-053087
- Levy, S., & Guttman, L. (1976). Worry, fear, and concern differentiated. *Israel Annals of Psychiatry and Related Disciplines*, 14(3), 211-228.

- Li, L., Borland, R., Fong, G. T., Jiang, Y., Yang, Y., Wang, L., . . . Thrasher, J. F. (2014). Smoking-related thoughts and microbehaviours, and their predictive power for quitting: findings from the International Tobacco Control (ITC) China Survey. *Tobacco Control*, Advance online publication. doi:10.1136/tobaccocontrol-2013-051384.
- Lindsey, L. L. M. (2005). Anticipated guilt as behavioral motivation an examination of appeals to help unknown others through bone marrow donation. *Human Communication Research*, 31(4), 453-481. doi:10.1093/hcr/31.4.453
- Loewenstein, G. F., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin*, 127(2), 267-286.
- MacCallum, R. C., Browne, M. W., & Cai, L. (2006). Testing differences between nested covariance structure models: Power analysis and null hypotheses. *Psychological Methods*, 11(1), 19-35.
- MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, 1(2), 130-149.
- MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the mediation, confounding and suppression effect. *Prevention Science*, 1(4), 173-181.
- Marteau, T. M., & Bekker, H. (1992). The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). *British Journal of Clinical Psychology*, 31(3), 301-306.
- McCool, J., Cameron, L. D., & Robinson, E. (2011). Do parents have any influence over how young people appraise tobacco images in the media? *Journal of Adolescent Health*, 48(2), 170-175. doi:10.1016/j.jadohealth.2010.06.012
- McQueen, A., Vernon, S. W., & Swank, P. R. (2013). Construct definition and scale development for defensive information processing: An application to colorectal cancer screening. *Health Psychology*, 32(2), 190-202. doi:10.1037/a0027311
- Miller, C. L., Hill, D. J., Quester, P. G., & Hiller, J. E. (2011). The impact of Australia's new graphic cigarette packet warnings on smokers' beliefs and attitudes. *Australasian Marketing Journal (AMJ)*, 19(3), 181-188.
- Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: a meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology*, 30(1), 106-143.
- Monarrez-Espino, J., Liu, B., Greiner, F., Bremberg, S., & Galanti, R. (2014). Systematic review of the effect of pictorial warnings on cigarette packages in smoking behavior. *American Journal of Public Health*, 104(10), e11-30. doi:10.2105/ajph.2014.302129

- Moracco, K. E., Morgan, J. C., Mendel, J., Teal, R., Noar, S. M., Ribisl, K. M., . . . Brewer, N. T. (2016). "My first thought was croutons": Perceptions of cigarettes and cigarette smoke constituents among adult smokers and nonsmokers. *Nicotine and Tobacco Research*, 18(7), 1566-1574. doi:10.1093/ntr/ntv281
- Muthén, B., & Muthén, B. O. (2009). *Statistical analysis with latent variables*: Wiley Hoboken.
- Noar, S. M., Francis, D. B., Bridges, C., Sontag, J. M., Brewer, N. T., & Ribisl, K. M. (2016). Effects of strengthening cigarette pack warnings on attention and message processing: A systematic review. *Journalism & Mass Communication Quarterly*, 1-27. doi:10.1177/1077699016674188
- Noar, S. M., Francis, D. B., Bridges, C., Sontag, J. M., Ribisl, K. M., & Brewer, N. T. (2016). The impact of strengthening cigarette pack warnings: Systematic review of longitudinal observational studies. *Social Science and Medicine*, 164, 118-129. doi:10.1016/j.socscimed.2016.06.011
- Noar, S. M., Hall, M. G., & Brewer, N. T. (2015). Pictorial cigarette pack warnings have important effects. *American Journal of Public Health*, 105(3), e1. doi:10.2105/ajph.2014.302510
- Noar, S. M., Hall, M. G., Francis, D. B., Ribisl, K. M., Pepper, J. K., & Brewer, N. T. (2016). Pictorial cigarette pack warnings: A meta-analysis of experimental studies. *Tobacco Control*, 25(3), 341-354.
- Nonnemaker, J., Choiniere, C. J., Farrelly, M. C., Kamyab, K., & Davis, K. C. (2015). Reactions to graphic health warnings in the United States. *Health Education Research*, 30(1), 46-56. doi:10.1093/her/cyu036
- Nonnemaker, J., Farrelly, M., Kamyab, K., Busey, A., & Mann, N. (2010). *Experimental study of graphic cigarette warning labels: Final results report*. Research Triangle Park, NC: RTI International.
- Novaco, R. W. (2003). The Novaco anger scale and provocation inventory. *Los Angeles, CA: Western Psychological Services*.
- Paolacci, G., & Chandler, J. (2014). Inside the Turk: Understanding Mechanical Turk as a participant pool. *Current Directions in Psychological Science*, 23(3), 184-188.
- Paulhus, D. L. (1991). Measurement and control of response bias. In J. P. Robinson, P. R. Shaver, & L. S. Wrightsman (Eds.), *Measures of personality and social psychological attitudes* (pp. 17-59). San Diego, CA: Academic Press.
- Peer, E., Vosgerau, J., & Acquisti, A. (2014). Reputation as a sufficient condition for data quality on Amazon Mechanical Turk. *Behavior Research Methods*, 46(4), 1023-1031.



- Pepper, J. K., Reiter, P. L., McRee, A. L., Cameron, L. D., Gilkey, M. B., & Brewer, N. T. (2013). Adolescent males' awareness of and willingness to try electronic cigarettes. *Journal of Adolescent Health, 52*(2), 144-150. doi:10.1016/j.jadohealth.2012.09.014
- Peters, C. L., & Enders, C. (2002). A primer for the estimation of structural equation models in the presence of missing data: Maximum likelihood algorithms. *Journal of Targeting, Measurement and Analysis for Marketing, 11*(1), 81-95.
- Peters, E., Lipkus, I., & Diefenbach, M. A. (2006). The functions of affect in health communications and in the construction of health preferences. *Journal of Communication, 56*(s1), S140-S162.
- Population Assessment of Tobacco and Health Study. (2014). PATH: Population Assessment of Tobacco and Health. Retrieved from <http://www.pathstudyinfo.nih.gov/UI/HomeMobile.aspx>
- Powe, B. D., & Finnie, R. (2003). Cancer fatalism: The state of the science. *Cancer Nursing, 26*(6), 454-467.
- Quick, B. L. (2012). What is the best measure of psychological reactance? An empirical test of two measures. *Health Communication, 27*(1), 1-9. doi:10.1080/10410236.2011.567446
- Quick, B. L., & Stephenson, M. T. (2007). Further evidence that psychological reactance can be modeled as a combination of anger and negative cognitions. *Communication Research, 34*(3), 255-276.
- Quick, B. L., & Stephenson, M. T. (2008). Examining the role of trait reactance and sensation seeking on perceived threat, state reactance, and reactance restoration. *Human Communication Research, 34*(3), 448-476.
- R.J. Reynolds Tobacco Company vs United States Food and Drug Administration. (2011). *Civil Case No. 11-1482 (RJL)*. Retrieved from
- Rains, S. A. (2013). The nature of psychological reactance revisited: A meta-analytic review. *Human Communication Research, 39*(1), 47-73.
- Rains, S. A., & Turner, M. M. (2007). Psychological reactance and persuasive health communication: A test and extension of the intertwined model. *Human Communication Research, 33*(2), 241-269.
- Reinhart, A. M., Marshall, H. M., Feeley, T. H., & Tutzauer, F. (2007). The persuasive effects of message framing in organ donation: The mediating role of psychological reactance. *Communication Monographs, 74*(2), 229-255.
- Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *The Journal of Psychology, 91*(1), 93-114.

- Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education and Behavior*, 2(4), 328-335.
- Ruiter, R. A., & Kok, G. (2005). Saying is not (always) doing: Cigarette warning labels are useless. *European Journal of Public Health*, 15(3), 329. doi:10.1093/eurpub/cki095
- Sandberg, T., & Conner, M. (2008). Anticipated regret as an additional predictor in the theory of planned behaviour: A meta-analysis. *British Journal of Social Psychology*, 47(Pt 4), 589-606. doi:10.1348/014466607x258704
- Sapp, S. G., & Harrod, W. J. (1993). Reliability and validity of a brief version of Levenson's locus of control scale. *Psychological Reports*, 72(2), 539-550.
- Schneider, S., Gadinger, M., & Fischer, A. (2012). Does the effect go up in smoke? A randomized controlled trial of pictorial warnings on cigarette packaging. *Patient Education and Counseling*, 86(1), 77-83. doi:10.1016/j.pec.2011.03.005
- Sheeran, P., Harris, P. R., & Epton, T. (2014). Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychological Bulletin*, 140(2), 511-543. doi:10.1037/a0033065
- Slovic, Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24(2), 311-322. doi:10.1111/j.0272-4332.2004.00433.x
- Slovic, Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European journal of operational research*, 177(3), 1333-1352.
- Slovic, Peters, E., Finucane, M. L., & Macgregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology*, 24(4 Suppl), S35-40. doi:10.1037/0278-6133.24.4.s35
- Spielberger, C. D., Gorsuch, R. L., Lushene, R. E., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the state-trait anxiety inventory*. Palo Alto, CA: Consulting Psychologists Press.
- Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate behavioral research*, 25(2), 173-180.
- Sussenbach, P., Niemeier, S., & Glock, S. (2013). Effects of and attention to graphic warning labels on cigarette packages. *Psychology & Health*, 28(10), 1192-1206. doi:10.1080/08870446.2013.799161
- Tannenbaum, M. B., Hepler, J., Zimmerman, R. S., Saul, L., Jacobs, S., Wilson, K., & Albarracin, D. (2015). Appealing to fear: A meta-analysis of fear appeal effectiveness and theories. *Psychological Bulletin*, 141(6), 1178-1204. doi:10.1037/a0039729
- Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika*, 38(1), 1-10.

- United States Public Laws. (2009). *Family smoking prevention and tobacco control act of 2009. 111th Congress, 1st Session. Public Law 111-31 [H.R. 1256]*. Retrieved from <http://www.fda.gov/TobaccoProducts/GuidanceComplianceRegulatoryInformation/ucm298595.htm>
- Wardle, H., Pickup, D., Lee, L., Hall, J., Pickering, K., Grieg, K., . . . Mackintosh, A. M. (2010). *Evaluating the impact of picture health warnings on cigarette packets*. London, UK: Public Health Research Consortium.
- Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communications Monographs*, 59(4), 329-349.
- Witte, K. (1994). Fear control and danger control: A test of the extended parallel process model (EPPM). *Communications Monographs*, 61(2), 113-134.
- Witte, K., & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education and Behavior*, 27(5), 591-615.
- Wolburg, J. M. (2006). College students' responses to antismoking messages: Denial, defiance, and other boomerang effects. *Journal of Consumer Affairs*, 40(2), 294-323.
- World Health Organization. (2013a). Framework Convention on Tobacco Control. Retrieved from <http://www.who.int/fctc/en/>
- World Health Organization. (2013b). *WHO report on the global tobacco epidemic, 2013: Enforcing bans on tobacco advertising, promotion and sponsorship*. Geneva, Switzerland: World Health Organization.
- Yong, H. H., Borland, R., Thrasher, J. F., Thompson, M. E., Nagelhout, G. E., Fong, G. T., . . . Cummings, K. M. (2014). Mediation pathways of the impact of cigarette warning labels on quit attempts. *Health Psychology*. doi:10.1037/hea0000056
- Yong, H. H., Fong, G. T., Driezen, P., Borland, R., Quah, A. C., Sirirassamee, B., . . . Omar, M. (2013). Adult smokers' reactions to pictorial health warning labels on cigarette packs in Thailand and moderating effects of type of cigarette smoked: findings from the international tobacco control southeast Asia survey. *Nicotine and Tobacco Research*, 15(8), 1339-1347. doi:10.1093/ntr/nts241
- Young, J. M., Stacey, I., Dobbins, T. A., Dunlop, S., Dessaix, A. L., & Currow, D. C. (2014). Association between tobacco plain packaging and Quitline calls: a population-based, interrupted time-series analysis. *Medical Journal of Australia*, 200(1), 29-32.
- Zeelenberg, M., & Pieters, R. (2007). A theory of regret regulation 1.0. *Journal of Consumer Psychology*, 17(1), 3-18.