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# Path analysis of warning label effects on negative emotions and quit attempts: A longitudinal study of smokers in Australia, Canada, Mexico, and the US

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## ABSTRACT

**Background:** Cigarette pack health warning labels can elicit negative emotions among smokers, yet little is known about how these negative emotions influence behavior change.

**Objective:** Guided by psychological theories emphasizing the role of emotions on risk concern and behavior change, we investigated whether smokers who reported stronger negative emotional responses when viewing warnings reported stronger responses to warnings in daily life and were more likely to try to quit at follow-up. **Methods:** We analyzed data from 5439 adult smokers from Australia, Canada, Mexico, and the US, who were surveyed every four months from September 2012 to September 2014. Participants were shown warnings already implemented on packs in their country and reported negative emotional responses (i.e., fear, disgust, worry), which were averaged (range = 1 to 9). Country-stratified logistic and linear generalized estimating equations were used to analyze the effect of negative emotional responses on self-reported responses to warnings in daily life (i.e., attention, risk concern, avoidance of warnings, forgoing planned cigarettes) and quit attempts at follow-up. Models were adjusted for socio-demographic and smoking-related characteristics, survey wave, and the number of prior surveys answered.

**Results:** Smokers who reported stronger negative emotions were more likely to make quit attempts at follow-up (Adjusted ORs ranged from 1.09 [95% CI 1.04 to 1.14] to 1.17 [95% CI 1.12 to 1.23];  $p < .001$ ) than those who reported lower negative emotions. This relationship was mediated through attention to warnings and behavioral responses to warnings. There was no significant interaction of negative emotions with self-efficacy or nicotine dependence.

**Conclusion:** Negative emotions elicited by warnings encourage behavior change, promoting attention to warnings and behavioral responses that positively predict quit attempts.

## 1. Introduction

The World Health Organization's Framework Convention on Tobacco Control (FCTC) calls for nations to implement pictorial health warnings on tobacco packaging. Compared to text-only health warnings, pictorial health warnings are more likely to promote attention,

recall, cognitive elaboration of risks, negative attitudes toward smoking, quit intentions (Noar et al., 2015), and quit attempts (Brewer et al., 2016). Pictorial health warnings, however, have not yet been implemented in many countries (Canadian Cancer Society, 2016), including the US. Some researchers argue that pictorial warnings that elicit strong negative emotions will lead to adverse consequences

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(Erceg-Hurn and Steed, 2011; Ruiter and Kok, 2005), which has been used to argue against pictorial warnings, especially those with strong, graphic imagery (Bayer et al., 2013). While pictorial warnings with graphic portrayals of smoking-related harms can elicit stronger negative emotions than text-only warnings (Brewer et al., 2016; Evans et al., 2016; Nonnemaker et al., 2015; Schneider et al., 2012), it remains unclear whether these negative emotions compromise the psychological and behavioral objectives of warning labels. This article examines how negative emotions aroused by health warnings are associated with key cognitive and behavioral responses to warnings.

### 1.1. Negative emotions and pictorial warnings

Negative emotions reported by smokers in response to warnings on cigarette packs include fear, disgust, and worry (Byrne et al., 2015; Emery et al., 2014; Hammond et al., 2004; Kees et al., 2010; Newman-Norlund et al., 2014; Nonnemaker et al., 2015; Yong et al., 2014). Fear refers to an emotion experienced when perceiving a serious and personally relevant threat (Yzer et al., 2012). Disgust is an emotion that functions as a mechanism to avoid diseases (Oaten et al., 2009) and is elicited by bodily excretions (e.g., blood) and body parts (e.g., intestines, wounds, and dead bodies) (Curtis and Biran, 2001). Worry is a cognitively oriented emotion that can stimulate constructive problem solving (Dijkstra and Brosschot, 2003; Magnan et al., 2009; McCauley et al., 2007). Whether to conceptualize these emotions as discrete or as a single dimension of negative valence is a classical scientific debate (Lindquist et al., 2013). Some researchers who support the natural kind hypothesis—a hypothesis that discrete emotions exist in nature—argue that different negative emotions produce different responses and have specific effects on behavior (Lench et al., 2011). In line with this hypothesis, some researchers suggest that the effects of fear on risk perceptions is the opposite as that found for anger (Lerner and Keltner, 2001). On the contrary, others support the psychological construction hypothesis, suggesting that different emotions are experienced as transformed forms of a core affect (Russell, 2003).

Dual-process information processing theories support the idea that negative emotions can promote desired responses to health warnings, such as risk perception and decision-making (E. Peters et al., 2016). These theories distinguish between slow, deliberative engagement with information and more automatic, intuitive engagement (Chaiken, 1980; Kahneman, 2011). For instance, affect heuristics (Slovic et al., 2007) play an important role in judgment, decision making, and behavior motivation. The Context, Executive and Operational Systems (CEOS) theory also emphasizes how strong negative affect motivates behavior change (Borland, 2014). According to the theory, however, the motivating role of negative affect on behavior change may be inhibited where the behavior to change also elicits competing positive affective responses, as is the case with smoking. Hence, action to avoid the harm of engaging in the behavior (e.g., attempting to quit) can depend on the relative strength of affective concerns and their impact on desire to smoke.

Consistent with dual-process theories, neurological studies showed that more emotionally arousing pictorial warnings produce stronger activation of brain regions associated with decision-making and memory formation among smokers (Green et al., 2016; Newman-Norlund et al., 2014; Wang et al., 2015). As found in fMRI research on smoking cessation ads (Falk et al., 2011), stronger brain activation prompted by graphic cigarette warnings predict decreases in smoking (Riddle et al., 2016). Similarly, in some experimental studies with self-reported measures, negative affective reactions provoked by warnings cued further processing of warning information (Evans et al., 2017) and, ultimately, motivated smoking cessation (Evans et al., 2015; E. Peters et al., 2016). Other studies also found that the stronger negative emotional responses to pictorial warnings mediate their effects on stronger risk perceptions and intentions to quit (Byrne et al., 2015; Emery et al., 2014; Evans et al., 2015, 2016; Kees et al., 2010).

A long history of work exists on the use of and potential concerns about fear appeals in persuasive messages to promote health protective behavior (Yzer et al., 2012). Early on, Janis (1967) hypothesized an inverted U-shaped relationship between fear and attitude change. However, challenging this, Sutton (1992) showed a positive, linear relationship between fear and acceptance of recommended behavior. The extended parallel process model (EPPM) built on this work but suggested that fear appeals are most effective for those with high self-efficacy to engage in the recommended behavior (Witte, 1994). Further, those with low self-efficacy may engage defensive avoidance by not attending to the messages, denying their relevance, or undermining message credibility (Witte, 1994). Researchers who suggest that pictorial warnings could backfire if they elicit negative emotions have used this theoretical approach to support their argument (G.-J. Y. Peters et al., 2013; Ruiter and Kok, 2005). Some laboratory experiments suggest that graphic warnings elicit reactance (Erceg-Hurn and Steed, 2011; Hall et al., 2016, 2017; LaVoie et al., 2017) and smokers avoid health warnings (Kessels and Ruiter, 2012; Maynard et al., 2014), both of which are argued to be maladaptive warning responses.

The experimental studies reviewed above, however, contrasts with a recent observational study finding that affective state reactance or warning avoidance has no adverse effect on subsequent quit attempts (Cho et al., 2016). This study, along with other observational studies, found that smokers who report avoiding warnings are more likely to make quit attempts (Fathelrahman et al., 2013; J. F. Thrasher et al., 2016b; Yong et al., 2014), although another study found that the relationship was not statistically significant when controlling for other psychosocial predictors of cessation (Borland et al., 2009a). Similarly, neurobiological research suggests that unpleasant stimuli elicit aversive emotions that characterize defensive motives (Bradley et al., 2001). According to Volchan et al. (2013), for instance, smokers perceived the most aversive cigarette pack warnings to be the most effective. While negative emotions might stimulate avoidance of warnings on specific occasions, taken together, the likelihood of maintaining avoidance over repeated exposures to warnings is limited. Moreover, emotionally arousing health warnings can stimulate smokers to forgo planned cigarettes, a desirable avoidance reaction that predicts quit attempts among adult smokers (Borland, 1997; Borland et al., 2009a; Li et al., 2015; Partos et al., 2014; James F Thrasher et al., 2016a; J. F. Thrasher et al., 2016b).

Further studies are needed to examine longer-term behavioral impacts of negative emotions elicited by health warnings under natural exposure conditions. Most previous studies of negative emotions elicited by pictorial warnings have documented only the short-term impacts of the negative emotions, using single session, experimental designs, where smokers are forced to view and evaluate warnings. The exception is one randomized field trial with a four-week follow-up (Evans et al., 2015). The study found that negative affect elicited by health warnings indirectly increased risk perceptions and quit intentions but did not assess behavioral responses. Two longitudinal, observational studies have found that negative emotions aroused by warnings can promote quit attempts (Hammond et al., 2004; Yong et al., 2014). These studies, however, relied on smokers' recall of affective responses to warnings in general. The current longitudinal study evaluated smokers' responses to specific warnings on packs over time, which may allow more detailed examination of this issue.

It is important to consider the moderating effect of nicotine dependence when evaluating the effect of smoking cessation messages for developing effective messages. Cessation messages often produce more desirable effects among less addicted smokers (Moorman & van den Putte, 2008; Szklo and Coutinho, 2010; James F Thrasher et al., 2007). Dependence is also inversely associated with quit attempts and maintenance (Vangeli et al., 2011). Furthermore, the information may help develop tailored cessation messages for specific groups of smokers in settings with limited resources.

## 1.2. Study objectives & hypotheses

This study aimed to evaluate whether negative emotional responses to warnings promote desirable outcomes. We advance prior research by evaluating smokers' responses to specific warnings that are already on cigarette packs and linking these responses to the level of attention to and engagement with warnings in real life, as well as subsequent quit attempts. Based on dual-process theories and the relevant empirical findings discussed above, we also examine potential mechanisms by which negative emotions may increase future quit attempts. Examining the mechanisms may help validate the importance of the relationship between negative emotions and long-term behavior while ruling out other potential causal processes.

This study tests the following hypotheses: H1: Smokers who reported stronger negative emotional responses (i.e., fear, disgust, and worry), would be more likely to attempt to quit smoking by a four-month follow-up. H2: Consistent with EPPM, self-efficacy will moderate the relationship between negative emotions and quit attempts, such that the association will be stronger among smokers with higher self-efficacy. H3: The association between negative emotion and quit attempts would be weaker among heavier smokers. H4: Smokers who reported stronger negative emotional responses to warnings would be more likely to: (a) pay attention to health warnings, (b) perceive health risks, (c) avoid warnings; and (d) forgo planned cigarettes due to warnings; Lastly, we examine whether shorter-term cognitive and behavioral responses to warnings; H5: (a) attention to health warnings, (b) risk concern, (c) avoiding warnings, and (d) forgoing planned cigarettes because of warnings would mediate the relationship between negative emotions and quit attempts at follow up.

## 2. Methods

### 2.1. Sample

Global Market Insight (GMI, 2011) recruited convenience samples of adult smokers from online consumer panels in Australia, Canada, Mexico, and the US. The four countries were selected to improve the generalizability of study results because novel warning labels were introduced in the same year in each country, except for the US. To qualify for the survey, participants had to be 18–64 years old and report smoking at least 100 cigarettes in their lifetime and at least once in the previous month. The inclusion criteria were designed to recruit established smokers with a varying range of dependence. Surveys were conducted every four months from September 2012 (Wave 1) to September 2014 (Wave 7) in Australia, Canada, and Mexico. However, we used five waves of data starting in January 2013 (Wave 2) to September 2014 (Wave 7) for Australia because warnings shown to respondents to assess negative emotions at Wave 1 were not in circulation at that time, which allows to examine the effect of cigarette pack warnings to which participants were normally exposed. In the US, data collection started and ended four months later due to parent project aims, providing six waves of data (from January 2013 [Wave 2] to January 2015 [Wave 8]). The sample was replenished at each wave to maintain sample sizes of approximately 1000 smokers in each country, except in the US, where an additional oversample of 400 Latinos was recruited to allow comparisons with Mexico. Response rates to survey invitations sent by e-mail ranged across waves, from 7% to 22% in Australia, 6%–22% in Canada, 7%–17% in Mexico, and 3%–27% in the US.

Smokers who did not participate in at least two consecutive waves of data were not eligible ( $N = 8371$ ) because our dependent variable was quit attempts at follow-up. After additionally excluding smokers due to item non-response on one or more items ( $N = 624$ ), a total of 5439 smokers were included in the analysis ( $N = 1127$  for Australia;  $N = 1290$  for Canada;  $N = 1392$  for Mexico;  $N = 1630$  for the US). Of those, 2629 smokers provided 1 wave-pair, 1191 smokers provided 2 wave-pairs, 659 smokers provided 3 wave-pairs, 385 smokers provided

4 wave-pairs, 373 smokers provided 5 wave-pairs, and 202 smokers provided 6 wave-pairs, yielding a total of 11,605 observations.

### 2.2. Survey procedures

An online, self-administered survey included questions (in the following order) about socio-demographics, smoking-related characteristics and smoking behavior, cognitive and behavioral responses to warnings in general, and questions about specific pack warnings implemented by the country in which the participant resided. All participants agreed to participate by agreeing to written informed consent. For questions about specific warnings, participants were shown images of warnings that were on their packs at the time of the survey (Australia = 11 of 14 pictorial warnings; Canada = 8 of 16 pictorial warnings; Mexico = 15 of 18 pictorial warnings; US = all four text-only warnings), with warnings presented in random order (See [online supplement for examples](#)). For Australia, Canada and Mexico, the warnings were chosen based on the comparability of message content across countries (e.g. lung cancer, which was present in all countries' warnings; gangrene, which was present in all the countries except the US) and the novelty of the content (e.g. bladder cancer in Australia and Canada; blindness in Canada; breast cancer in Mexico). Participants could see warnings for as long as they wanted. Since Canada and the US had the same warnings over the entire study period, participants viewed the same set of warnings in each wave. The total number of warnings shown to participants differed by survey wave in Australia and Mexico because, over the study period, Australia rotated two sets of seven warnings and Mexico changed warnings every six months. In any particular survey, participants viewed up to eight warnings, with an average of six warnings shown to participants in both countries. All questions were asked in every wave, except for a question about subsequent quit attempts in Wave 1. The study was approved by the institutional review board at the University of South Carolina.

### 2.3. Measures

#### 2.3.1. Dependent variable

*Subsequent quit attempts.* Participants were asked if they had made any attempts to stop smoking in the prior four months ("yes" or "no"). Quit attempts for the previous 4 months reported in the wave after the predictors were measured was the primary outcome variable.

#### 2.3.2. Independent variable

*Negative emotions scale.* Participants rated their negative emotional responses to each warning image shown in the survey, including fear ("How much does this warning make you feel afraid?"), disgust ("How disgusting is this warning label?"), and worry ("How much does this warning make you feel worried about the health risks of smoking?"). Responses ranged from 1 (not at all) to 9 (extremely). Responses for each question were averaged across warnings. These three items had high reliability (Cronbach's  $\alpha = 0.89$  to  $0.94$ , across countries) and were averaged to derive an overall negative emotions scale.

#### 2.3.3. Mediating variables

*Cognitive responses to warnings.* *Attention to warnings* was assessed by first asking participants how often, if at all, they had noticed warnings on cigarette packages in the last month. After categorizing those who had never noticed warnings as those who had never attended to warnings, participants were asked how often they had read or looked closely at the warnings in the last month, with a response scale ranging from 1 (never) to 5 (very often). *Risk concern* was assessed by asking to what extent the warnings made them think about the health risks of smoking, with a response scale ranging from 1 (not at all) to 9 (extremely).

*Two short-term behavioral responses to warnings were used: Avoiding warnings:* "In the last month, have you made any effort to avoid looking

at or thinking about the warnings – such as covering them up, keeping them out of sight, using a cigarette case, avoiding certain warnings, or any other means?” (“yes” or “no?”); and *Forgoing cigarettes due to warnings* by asking participants if the warnings had stopped them from having a cigarette when they were about to smoke one in the last month, with a response scale ranging from 1 (never) to 4 (many times). The response was dichotomized to contrast those who did and did not forgo cigarettes due to warnings, as in previous studies (e.g., Borland et al., 2009b; Cho et al., 2016).

#### 2.3.4. Moderating variables

*Self-efficacy.* Self-efficacy was assessed using the question “If you decided to give up smoking completely in the next six months, how sure are you that you would succeed?” (International Agency for Research on Cancer, 2008) with a response scale ranged from 1 (not at all sure) to 9 (extremely sure) and verbal anchors for every other option (i.e., 3 [a little], 5 [moderately], 7 [very much]). Since self-efficacy responses showed a multi-modal distribution, the variable was recoded to a five-level variable by combining 1 with 2, 3 with 4, 5 with 6, and 8 with 9.

The *Heaviness of Smoking Index* was assessed by combining information on the average number of cigarettes smoked per day (0: 1–10, 1: 11–20, 2: 21–30, 3: 31+) with the time to the first cigarette of the day (0: ≤5, 1: 6–30, 2: 31–60, 3: 61+ min) and ranged from 0 to 6 (Heatherton et al., 1989). For non-daily smokers, we asked the average number of cigarettes smoked per week and the time to the first cigarette of the day on the days on which they smoked.

#### 2.3.5. Covariates

*Socio-demographic characteristics.* Age was categorized into five groups (18–25, 26–34, 35–44, 45–54, and 55–64). Sex was assessed by asking participants to indicate their sex, male or female. *Education level* was assessed using six response options in each country (eight response options in Mexico) and was categorized as high school or less, some college or university, or university or more. *Annual household income level* was assessed using eight response options in each country (nine response options in Mexico, where monthly household income level was assessed) and classified into three groups: low (\$29,999 or less in Australia, Canada, United States; \$5000 pesos or less in Mexico), middle (\$30,000–\$59,999; \$5001–\$10,000 pesos in Mexico), or high (\$60,000 or more; \$10,001 or more in pesos Mexico).

*Smoking-related characteristics.* *Intention to quit* was assessed by the question “Are you planning to quit smoking?” with six response options (within the next month, within the next 6 months, sometime in the future, beyond 6 months, not planning to quit, and don't know). The responses were dichotomized so that the intention to quit smoking within six months was either “yes” or “no/don't know.” *Previous quit attempt* was assessed by asking “Have you made any attempts to stop smoking in the past four months?” with a possible response of “yes” or “no.”

### 2.4. Analysis

For all analyses, Stata 13 was used and only participants with complete data on all variables ( $N = 5439$ ) were included. Descriptive statistics were calculated and country differences on all variables were examined using  $\chi^2$  tests and F-tests, followed by a Tukey's post hoc test for cross-country comparisons of negative emotions scale. To test H1, that is, to examine whether smokers who reported greater negative emotions after viewing warnings (time “ $t$ ”) report a greater likelihood of subsequent quit attempt (time “ $t+1$ ”), logistic Generalized Estimating Equation (GEE) regression models were estimated. The potential moderating effect of self-efficacy (H2) (or the *heaviness of smoking index*, used as a proxy for nicotine dependence [H3]) was examined by testing interactions between the negative emotions scale and self-efficacy (or nicotine dependence) on additive and multiplicative scales. A total of four models were fitted to regress subsequent quit

attempts on the negative emotions scale, moderating variables, and interaction terms, separately for each of two moderating variables (self-efficacy or dependence) and two interaction terms (multiplicative or additive). For additive interactions, we used the “nlcom” command to compute marginal relative excess risk due to interaction (RERI) estimates, their standard errors, and 95% confidence intervals (VanderWeele and Knol, 2014).

The hypotheses on the relationship between negative emotions and mediators (H4) were cross-sectionally tested using another set of logistic and linear GEE models which regressed attention to warnings, risk concern, avoiding warnings, and forgoing cigarettes due to warnings (time “ $t$ ”) on negative emotions (time “ $t$ ”). Since smokers in each country viewed specific warnings in their country, all analyses were stratified by country. Given the similar pattern of results among countries, however, we also conducted pooled analyses (See [online supplement](#)).

Mediation hypotheses (H5) were tested using a single test of an indirect effect (Zhao et al., 2010). We examined if there is an indirect effect of negative emotions on cessation by way of each of the four hypothesized mediators, using the product-of-coefficients approach with the user-written “binary\_mediation” command. The variance inflation factor values were less than 2.5 for all potential mediators, indicating small multicollinearity effects. Therefore, these models were estimated first separately for each of the four mediators and then simultaneously. Bootstrapping with replacement for 500 replicates was used to obtain 95% confidence bias-corrected confidence intervals. When the confidence intervals do not include 0, the indirect effect of a mediator was considered statistically significant. All models testing hypotheses were adjusted for covariates, survey wave, and the number of prior surveys answered. The models testing hypotheses 1, 4, and 5 were also adjusted for self-efficacy and heaviness of smoking index.

We conducted four sensitivity analyses. First, given the debate over the natural kind hypothesis, we examined whether discrete negative emotions have differential effects on warning responses by re-estimating all models using only the average for each emotion indicator (fear, disgust, worry), analyzed separately. Second, to assess potential bias due to missing data, we reran all models adjusting for propensity scores calculated using variables potentially associated with loss to follow-up and item non-response but not included in main analyses (e.g., employment status, marital status, overall health, and number of consumer surveys completed in the last month). Third, to assess the generalizability of the findings, the first four hypotheses were re-tested additionally adjusting for weights created to weight the data to be nationally representative of smokers in each country. Finally, to examine whether cross-sectional analyses of the relationship between negative emotions (time “ $t$ ”) and general mediating variables (time “ $t$ ”) are credible, we regressed general warning responses four months later (time “ $t+1$ ”) on negative emotional responses to specific warnings (time “ $t$ ”). The pattern of results for all sensitivity analyses was generally consistent in direction, strength, and statistical significance. As our interpretation of results would not change if these analyses were presented, we do not report them.

## 3. Results

### 3.1. Sample characteristics

Table 1 presents characteristics of the study sample, by country and pooled across countries. The US samples reported the lowest negative emotions scale, consistent with their warnings being text-only.

### 3.2. Negative emotions and subsequent quit attempts (H1)

Consistent with H1, in all countries, smokers who reported stronger negative emotions were significantly more likely to report quit attempts at follow-up than those who reported weaker negative emotions,

**Table 1**  
Sample characteristics by country, effective and sustainable cigarette warning label policy study survey, % or mean (SE).<sup>a</sup>

	Australia (N = 1127 smokers)	Canada (N = 1290 smokers)	Mexico (N = 1392 smokers)	US (N = 1630 smokers)	Total (N = 5439 smokers)
<b>Main dependent variable</b>					
Subsequent quit attempts*	38%	40%	57%	39%	43%
<b>Main independent variable</b>					
Negative emotions scale*	4.6 (0.05)	5.2 (0.04)	5.9 (0.04)	4.4 (0.04)	5.0 (0.02)
<b>Mediating variables</b>					
Attention to warnings*	2.3 (0.02)	2.4 (0.02)	3.0 (0.02)	2.1 (0.02)	2.4 (0.01)
Risk concern*	4.3 (0.05)	4.6 (0.05)	5.9 (0.01)	4.4 (0.04)	4.8 (0.02)
Avoiding warnings*	34%	32%	40%	19%	30%
Forgoing cigarettes due to warnings*	23%	22%	43%	27%	28%
<b>Moderating variable</b>					
Self-efficacy*	2.8 (0.02)	2.9 (0.02)	3.2 (0.02)	2.9 (0.02)	2.9 (0.01)
Heaviness of smoking index*	2.9 (0.03)	2.5 (0.02)	0.9 (0.02)	2.5 (0.02)	2.2 (0.01)
<b>Socio-demographic characteristics</b>					
Age*					
18-24	4%	7%	16%	9%	9%
25-34	20%	20%	31%	26%	24%
35-44	23%	22%	23%	21%	22%
45-54	26%	25%	16%	22%	22%
55-64	26%	26%	14%	22%	22%
Female*	50%	51%	44%	46%	48%
Education*					
High school or less	33%	26%	28%	26%	28%
Some college or university	40%	44%	18%	38%	35%
University or more	27%	29%	54%	36%	37%
Income*					
Low	23%	24%	33%	23%	26%
Middle	26%	30%	36%	36%	32%
High	51%	47%	31%	41%	42%
<b>Smoking-related characteristics</b>					
Quit intentions in next 6 months*	41%	43%	47%	40%	42%
Quit attempt in prior 4 months*	35%	38%	53%	36%	40%

\*p < 0.05 for chi-square (categorical) and F-test (continuous) to compare across countries. Tukey's post hoc test was performed to compare group means of negative emotions scale.  
<sup>a</sup> Data were collected from Jan 2013 (Wave 2) to Sep 2014 (Wave 7) in Australia, Sep 2012 (Wave 1) to Sep 2014 (Wave 7) in Canada and Mexico, and Jan 2013 (Wave 2) Jan 2014 (Wave 8) in the US. All variables were measured at time "t".

adjusting for socio-demographics, smoking-related characteristics, self-efficacy, heaviness of smoking index (HSI), and the number of survey participated (Adjusted Odds Ratio [AOR] = 1.09 to 1.17; p < 0.001).

3.3. Moderating effect of self-efficacy (H2) and nicotine dependence (H3)

Tests for the moderating effect of self-efficacy on the relationship between negative emotional responses towards cigarette pack warnings and subsequent quit attempts, indicated rejection of H2; we found no additive or multiplicative interaction between negative emotions and self-efficacy in all countries (p > 0.05). Moreover, we found that the heaviness of smoking index did not additively or multiplicatively moderate the relationship between negative emotions and subsequent quit attempts, rejecting H3.

3.4. Negative emotions and potential mediators (H4)

Table 2 shows the associations of negative emotions with cognitive

**Table 2**  
Associations of Negative Emotions with Potential Mediators and Subsequent Quit Attempts, 5439 smokers, by Country.

Country	N smokers	Attention to warnings	Risk concern	Avoiding warnings	Forgoing cigarettes due to warnings	Subsequent quit attempts <sup>a</sup>
		b (95% CI)	b (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Australia	1127	0.18 (0.16, 0.20)*	0.70 (0.66, 0.74)*	1.28 (1.22, 1.35)*	1.60 (1.50, 1.70)*	1.09 (1.04, 1.14)*
Canada	1290	0.20 (0.17, 0.22)*	0.77 (0.74, 0.81)*	1.40 (1.32, 1.47)*	1.60 (1.49, 1.70)*	1.10 (1.05, 1.15)*
Mexico	1392	0.17 (0.14, 0.20)*	0.64 (0.60, 0.68)*	1.26 (1.20, 1.33)*	1.53 (1.45, 1.62)*	1.17 (1.12, 1.23)*
US	1630	0.21 (0.19, 0.23)*	0.72 (0.68, 0.75)*	1.46 (1.38, 1.55)*	1.66 (1.60, 1.80)*	1.15 (1.10, 1.20)*

\*p < 0.001.  
<sup>a</sup> We found no multiplicative or additive interactions with self-efficacy or heaviness of smoking index.

and short-term behavioral responses to warnings. Consistent with H4, in all countries, stronger negative emotions were independently associated with greater likelihood of reporting attention to warnings (bs = 0.17 to 0.21, ps < 0.001), thinking more about risks (bs 0.64 to 0.78, ps < 0.001), avoiding warnings (AORs = 1.24 to 1.45, ps < 0.001), and forgoing planned cigarettes due to warnings (AORs = 1.54 to 1.70, ps < 0.001).

3.5. Mediating effect of cognitive and short-term behavioral responses to warnings (H5)

As shown in Table 3, the mediation analyses showed significant indirect effects of negative emotions on subsequent quit attempts mediated by attention to warnings, consistent with H5a. Parameter estimates for mediation by attention ranged from 0.02 in Mexico (bootstrap bias-corrected [BC] 95% CI = 0.0045 to 0.0436) to 0.05 in the US (BC 95% CI = 0.0233 to 0.0722). There were also significant indirect effects for risk concern in Canada (b: 0.07; BC 95% CI = 0.0196

**Table 3**  
Direct and Indirect Effect of Negative Emotions on Quit Attempts, 5439 smokers, by Country.

	Australia (N = 1127 smokers)	Canada (N = 1290 smokers)	Mexico (N = 1392 smokers)	US (N = 1630 smokers)
<b>Model 1: Mediation by Attention</b>				
Indirect effect	0.03**	0.04**	0.02*	0.05***
Direct effect	0.07*	0.06*	0.15***	0.12***
Total effect	0.10***	0.10***	0.17***	0.16***
<b>Model 2: Mediation by Risk Concern<sup>a</sup></b>				
Indirect effect	0.05	0.07**	0.03	0.07**
Direct effect	0.05	0.03	0.15***	0.09**
Total effect	0.10***	0.10***	0.17***	0.16***
<b>Model 3: Mediation by Avoiding<sup>b</sup></b>				
Indirect effect	0.03**	0.03**	0.02*	0.06***
Direct effect	0.08*	0.07*	0.16***	0.12***
Total effect	0.11***	0.11***	0.18***	0.18***
<b>Model 4: Mediation by Forgoing<sup>c</sup></b>				
Indirect effect	0.10***	0.07***	0.09***	0.07***
Direct effect	0.03	0.05	0.10***	0.12***
Total effect	0.14***	0.12***	0.19***	0.18***

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.

Note. All estimates are coefficients controlling for socio-demographics, smoking-related outcomes, self-efficacy, heaviness of smoking index, the number of survey participated, survey wave, and attention to warnings. Direct effect indicates the unmediated effect of negative emotions on quit attempts adjusting for a mediator, while indirect effect indicates the effect of negative emotions on quit attempts mediated by a mediator. Total effect is the sum of the direct effect and the indirect effect.

<sup>a</sup> Models also controlled for thinking about risks due to warnings.

<sup>b</sup> Models also controlled for avoiding warnings.

<sup>c</sup> Models also controlled for forgoing cigarettes due to warnings.

to 0.1248) and the US (*b*: 0.07; *BC* 95% *CI* = 0.0271 to 0.1111) but not in Australia and Mexico, contrary to H5b.

Consistent with H5c and H5d, there was a significant indirect effect of negative emotions on subsequent quit attempts mediated by short-term behavioral responses to warnings, i.e., avoiding warnings and forgoing planned cigarettes due to warnings, in all countries. The parameter estimates for mediation by avoiding warnings ranged from 0.02 (*BC* 95% *CI* = 0.0010 to 0.0301) in Mexico to 0.06 (*BC* 95% *CI* = 0.0369 to 0.0824) in the US and those by forgoing cigarettes due to warnings ranged from 0.07 (*BC* 95% *CI* = 0.0352 to 0.0987) in the US to 0.10 in Australia (*BC* 95% *CI* = 0.0644 to 0.1381).

Table 4 presents the results of the mediation analyses where all mediators were simultaneously introduced. There was a significant total indirect effect of negative emotions on subsequent quit attempts mediated by all four mediators, consistent with H5. The parameter estimates for the total indirect effect ranged from 0.09 in Mexico (*BC* 95% *CI* = 0.0454 to 0.1403) to 0.13 in the US (*BC* 95% *CI* = 0.077 to 0.1782). There was also an indirect effect for forgoing cigarettes due to

**Table 4**  
Direct and Indirect Effect of Negative Emotions on Quit Attempts, 5439 smokers, by Country.

	Australia (N = 1127 smokers)	Canada (N = 1290 smokers)	Mexico (N = 1392 smokers)	US (N = 1630 smokers)
Total Indirect effect	0.12***	0.12***	0.09***	0.13***
Attention	0.01	0.02	0.01	0.02
Risk concern	0.00	0.03	-0.02	0.03
Avoiding	0.02*	0.03**	0.01	0.05***
Forgoing	0.10***	0.06***	0.08***	0.04*
Direct effect	0.02	0.00	0.10**	0.06
Total effect	0.14***	0.12***	0.19***	0.19***

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.

Note: All figures are coefficients controlling for socio-demographics, smoking-related outcomes, self-efficacy, heaviness of smoking index, the number of survey participated, and survey wave. Direct effect indicates the unmediated effect of negative emotions on quit attempts adjusting for a mediator, while indirect effect indicates the effect of negative emotions on quit attempts mediated by a mediator. Total effect is the sum of the direct effect and the indirect effect.

warnings when controlling for other mediators in all countries; the parameter estimates for forgoing planned cigarettes due to warnings ranged from 0.04 in the US (*BC* 95% *CI* = 0.005 to 0.074) to 0.10 in Australia (*BC* 95% *CI* = 0.06 to 0.139).

#### 4. Discussion

Our study shows that stronger negative emotional responses to specific cigarette package warnings were associated with a higher likelihood of quit attempts in all countries, consistent with previous observational studies (Hammond et al., 2004; Yong et al., 2014), which assessed smokers' recall of negative emotional responses to all warnings in general. The consistency in results suggests that the overall affective responses emerge from reactions to the specific stimuli, as would be expected. Smokers who reported stronger negative emotions were also more likely to avoid warnings and forgo cigarettes due to warnings, compared to those who reported weaker negative emotions. The results are consistent with dual-process theories suggesting the important role of emotions in decision making and motivating behavior change (Borland, 2014; Slovic et al., 2007). Thus, warnings may serve as an "affective tag" (Slovic et al., 2007) eliciting negative attributions to tobacco products, thereby increasing the likelihood of making quit attempts. Indeed, this interpretation is consistent with recent randomized trials where smokers are provisioned with packs that have pictorial or text warnings, where negative emotional responses mediate warning effects on risk perceptions and quit intentions (Evans et al., 2015, 2016). Our observational study extends this work out further by linking negative emotions with quit attempts.

We found no support for the moderating effect of self-efficacy on the relationship between negative emotions and subsequent quit attempts. Our results are consistent with other studies (Cho et al., 2016; J. F. Thrasher et al., 2016b) that used data from the same parent project and found no evidence or moderation of warning effects by self-efficacy or reactance, whether measured as a trait or a state (i.e., affective reactance), when predicting subsequent quit attempts. This is in contrast with some single-session experimental studies that found that fear-arousing cigarette pack warnings better motivate smokers with stronger self-efficacy to quit (Mays et al., 2014; Romer et al., 2013; Witte, 1994), which is why some scholars oppose warnings with high fear-arousing

content (Ruiter and Kok, 2005). The experimental studies, however, measured momentary levels of self-efficacy, which can change over time (Herd and Borland, 2009). Hence, in longitudinal studies like ours it is plausible that smokers with low self-efficacy at baseline increased self-efficacy before attempting to quit but that change may not be captured due to the length of time between the baseline and the quit attempts.

Nicotine dependence also did not moderate the relationship between negative emotions and cessation. Therefore, warnings that elicit stronger negative emotions may promote quit attempts even among smokers who may find it difficult to quit due to their dependence on cigarettes (Vangeli et al., 2011). Our finding is consistent with the results from prior experimental research on message framing that did not consider affect (Moorman & van den Putte, 2008; Szklo and Coutinho, 2010) but found that negatively framed messages had similar effects on smokers with different levels of nicotine dependence. Schneider et al. (2012) also found that fear-arousing warnings increased motivation to quit among both heavy and light smokers. Hence, negative emotions elicited by warnings may promote cessation, independent of important factors that impede cessation, such as nicotine dependence or low self-efficacy to quit.

The introduction of graphic warnings in the US are blocked partly due to a judicial argument that they should be “factual” and avoid arousing negative emotions (Goodman, 2013; “R.J. Reynolds Tobacco Co. v. U.S. Food & Drug Administration,” 2012). Our findings, however, indicate that stronger negative emotional responses to warnings are consistently associated with greater attention to warnings and elaboration of health risks due to smoking, as in other studies (Emery et al., 2014; Evans et al., 2015). The results were no different when each emotion was analyzed separately, suggesting that the observed results came from a generalized negative reaction rather than any more nuanced emotion, in support of the psychological construction theory (Russell, 2003). Moreover, the pattern of results was similar in all countries, despite differences in warning size and content. We found US smokers who were exposed to weak, text-only warnings (that are argued to be “factual”) also reported some negative emotions, and the implications of these responses were similar to those found for pictorial warnings. This confirms that the judicial argument that warnings should not be emotional but factual is a “false dichotomy” (Popova et al., 2017). Indeed, it appears that emotions are an important pathway of effect, independent of the warning content that produces them (Borland et al., 2009b; Cho et al., 2016; Yong et al., 2014). Hence, selecting warnings that do not evoke negative emotional responses will mean selecting less effective warnings.

Our study observed that attention to warnings and short-term behavioral responses significantly mediated the relationship between negative emotions and quit attempts. A combined indirect effect of all mediators nullified the direct effect of negative emotions on quit attempts in all countries but Mexico. Specific indirect effect of negative emotions via forgoing remained significant after adjusting for other mediators in all countries. A key finding was that, in all countries but Mexico when adjusting for all mediators, smokers who reported higher negative emotions were more likely to avoid warnings, which in turn was associated with a higher likelihood of making quit attempts during the follow-up period. The positive influence of avoidant behavior on cessation behavior mirrors previous findings (Cho et al., 2016; Fathelrahman et al., 2013; J. F. Thrasher et al., 2016b; Yong et al., 2014) and the theory of “ironic processes” –wherein attempting to suppress thoughts makes them more likely to occur (Wegner, 1994). Further investigation could determine which characteristics of warnings elicit the strongest negative emotions or avoidant behaviors to inform future development of effective warnings, and whether stronger warnings continue to produce greater quitting. The evidence so far is positive; aversive Brazilian pictorial warnings (Volchan et al., 2013) increased the proportion of both heavy smokers engaging in avoidant behavior (International Tobacco Control Policy Evaluation Project

[ITC], 2014) and smokers making quit attempts (Szklo et al., 2016).

#### 4.1. Limitation

Our study has several limitations. First, missing data due to loss to follow-up and item non-response may bias the findings, although our results were adjusted for characteristics related to the missing data. Sensitivity analysis with propensity scores also produced a pattern of results consistent with those described in the main results section, tempering the concerns regarding bias due to the missing data. Second, the causal inference from negative emotions to cognitive and short-term behavioral responses to warnings is limited due to the cross-sectional analysis of those associations. We assessed negative emotional responses under forced exposure conditions assuming these responses represented reasonable approximations of participants’ responses in the month-long period leading up to the survey – which was the reference period for questions on general responses to warnings. Our sensitivity analysis showed that negative emotional responses to specific warnings predicted cognitive and short-term behavioral responses reported four months later, consistent with the results from our cross-sectional approach to assessing mediation. However, we did not conduct a mediation analysis that went from time “*t*” (negative emotions) to time “*t*+1” (general warning response) to time “*t*+2” (cessation) not only because it would result in losing too much of the sample but also because it would be less likely to capture the more immediate effects of negative emotions on behavior when quit attempts are assessed up to eight months later. Third, study participants were from an unknown sampling frame and response rates were low, so the sample may not be representative of general population in each country. As we do not have data to assess factors associated with differential response to study invites, it is unclear whether any associated bias would lead to over- or under-estimation of study effects. Nevertheless, weighting the analyses to make our sample comparable to the age, sex, and educational profile of the general population of smokers in each country produced results that were consistent with those presented here. Hence, the results presented here do not appear to be seriously biased as our primary interpretations and conclusions would be the same even with this weighting approach. Fourth, we did not assess quit success as an outcome. It is plausible that negative emotions predict quit attempts but not the success of those quit attempts, as some other motivational factors such as attitude to smoking do (Borland et al., 2010; Vangeli et al., 2011). Further investigation over a longer period can clarify whether negative emotions predict maintenance of quit attempts. Finally, we did not include any qualitative research components. Future qualitative research on the types and extent of emotional responses to warnings may help better understand the role of emotions in warning reactions.

#### 4.2. Conclusion

This study provides additional evidence that negative emotions aroused by cigarette pack warnings do not produce adverse effects; rather, the stronger negative emotions are independently associated with greater attention to warnings and cognitive elaboration of the health risks due to smoking, as well as with making subsequent quit attempts. The present findings reiterate the need for implementing warnings that arouse strong negative emotions because stronger negative emotions are more likely to stimulate quit attempts.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2017.10.003>.

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