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Original investigation

Cigarette Graphic Warning Labels Are Not Created Equal: They Can Increase or Decrease Smokers' Quit Intentions Relative to Text-Only Warnings

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Abstract

Introduction: Cigarette graphic-warning labels elicit negative emotion. Research suggests negative emotion drives greater risk perceptions and quit intentions through multiple processes. The present research compares text-only warning effectiveness to that of graphic warnings eliciting more or less negative emotion.

Methods: Nationally representative online panels of 736 adult smokers and 469 teen smokers/vulnerable smokers were randomly assigned to view one of three warning types (text-only, text with low-emotion images, or text with high-emotion images) four times over 2 weeks. Participants recorded their emotional reaction to the warnings (measured as arousal), smoking risk perceptions, and quit intentions. Primary analyses used structural equation modeling.

Results: Participants in the high-emotion condition reported greater emotional reaction than text-only participants (b_{Adult} = 0.21; b_{Teen} = 0.27, p's < .004); those in the low-emotion condition reported lower emotional reaction than text-only participants (b_{Adult} = –0.18; b_{Teen} = –0.22, p's < .018). Stronger emotional reaction was associated with increased risk perceptions in both samples (b_{Adult} = 0.66; b_{Teen} = 0.85, p's < .001) and greater quit intentions among adults (b_{Adult} = 1.00, p < .001). Compared to text-only warnings, low-emotion warnings were associated with reduced risk perceptions and quit intentions whereas high-emotion warnings were associated with increased risk perceptions and quit intentions.

Conclusion: Warning labels with images that elicit more negative emotional reaction are associated with increased risk perceptions and quit intentions in adults and teens relative to text-only warnings. However, graphic warnings containing images which evoke little emotional reaction can backfire and reduce risk perceptions and quit intentions versus text-only warnings.

Implications: This research is the first to directly manipulate two emotion levels in sets of nine cigarette graphic warning images and compare them with text-only warnings. Among adult and teen smokers, high-emotion graphic warnings were associated with increased risk perceptions and quit intentions versus text-only warnings. Low-emotion graphic warnings backfired and tended to reduce risk perceptions and quit intentions versus text-only warnings. Policy makers should

be aware that merely placing images on cigarette packaging is insufficient to increase smokers' risk perceptions and quit intentions. Low-emotion graphic warnings will not necessarily produce desired population-level benefits relative to text-only or high-emotion warnings.

Introduction

The 2009 Family Smoking Prevention and Tobacco Control Act (TCA) required the US Food and Drug Administration (FDA) to create nine cigarette graphic-warning labels for placement on all domestic cigarette packages and advertisements. Warnings with graphic images plus text messages were first implemented in Canada in 2001, and are now required in at least 100 countries worldwide.[1] However, the US Court blocked the FDA from implementing their proposed graphic warnings, concluding that the warnings were "unabashed attempts to evoke emotion … and browbeat consumers into quitting" (p.1216).[2]

Experimental research aligns with the court's assertion that graphic warnings evoke more negative emotion than text-only warnings.[3,4] However, emotional reactions to graphic warnings do more than "browbeat consumers into quitting."[2] Research, in fact, suggests that these reactions underlie graphic-warning effectiveness.[4–6] Negative emotion increases smoking's perceived dangers[7] and decreases cigarettes' appeal to young people.[3] Warnings which elicit negative emotion also are more likely to be recognized than less emotional warnings.[8]

Furthermore, a recent randomized clinical trial demonstrated that the negative emotion elicited by graphic warnings influenced risk perceptions and quit intentions simultaneously through three distinct processes.[9] In it, US adult smokers who received graphic warnings on cigarette packs reported greater negative emotion toward smoking 1 week after exposure to them. Subsequently, this negative emotion served as information about risk,[10,11] increasing perceptions of smoking's health risks. The negative emotion also acted as a motivator of behavioral tendency,[12–15] influencing quit intentions. Finally, the negative emotion served as a spotlight,[16] encouraging smokers to look closely at the warnings, which led to increases in their credibility and heightened risk perceptions and quit intentions.

Some researchers have suggested that warnings eliciting negative emotion may be less effective in encouraging smokers to quit than positive or non-emotional warnings.[17] However, little empirical evidence supports this prediction. Instead, research points towards warnings that feature disturbing images like pictures of diseased organs being perceived as more effective than those featuring symbolic images[18] or testimonial warnings,[19] perhaps because the latter elicit less negative emotion. However, these studies did not explicitly test emotion's role in warning effectiveness. The current experimental research was designed to examine emotion's role in determining the efficacy of a graphic-warning-label set by manipulating how much graphic warnings elicit negative emotion.

Although the ability to evoke negative emotion is an important component of effective warning labels,[4–9] little consensus exists on how emotional reactions should be measured. Some researchers focus on discrete emotions such as fear or sadness[20]; others focus on the valence of emotional reaction.[4,7] Recent advances in psychology and neuroscience highlight the importance of dimensional approaches for characterizing emotional states.[21] One popular approach, the circumplex model of affect, proposes that emotions arise from two neurophysiological systems, related to valence (pleasure–displeasure) and arousal (aka and alertness).[22] The model conceptualizes emotional states as arising from patterns of activation within these systems. Because negative arousal drives people to prepare for action,[23] which may allow them to avoid health and other hazards, we chose only negative-valence warnings and focused on arousal (called emotion or emotional reaction from hereon) and its relation with risk perceptions and quit intentions.

We hypothesized that warnings eliciting negative emotion would increase smokers' risk perceptions and quit intentions relative to text-only warnings. However, the possible effectiveness of low-emotion images was unclear. Although emotional reaction to graphic warnings may drive their effectiveness,[3–9] such reaction could simply be a byproduct of images making warnings more noticeable and harder to ignore.[24,25] Thus, although high-emotion warnings have been shown superior to text-only warnings, it remains possible that low-emotion images could also be effective. We examine this possibility by comparing text-only versus high-emotion warnings and text-only versus low-emotion warnings.

Adult smokers and teen smokers/vulnerable smokers were randomly assigned to one of three label-type warning conditions: text-only, low-emotion, or high-emotion. Consistent with past research,[9] we predicted that emotional reaction would mediate the warnings' impact on risk perceptions and quit intentions. In particular, negative emotion would motivate action and increase quit intentions directly; it would also serve as a source of information, increasing perceptions that smoking is risky, which would, in turn, influence quit intentions.

Methods

Participants and Design

Sample sizes were determined by power analysis (see Supplementary Materials). Two US nationally representative samples were recruited through an internet survey company (YouGov; see Supplementary Materials). The adult-smoker sampling frame was constructed from the 2014 National Health Interview Survey. Panelists were 19–64 years old, had smoked ≥100 lifetime cigarettes, and currently smoked "every day" or "some days."

The sampling frame for teen smokers/vulnerable smokers was constructed from the 2011–2012 National Health and Nutrition Examination Survey. Eligible participants (14–18 years old) answered "yes" to "Have you ever tried or experimented with cigarette smoking, even a few puffs?"

Participants were randomly assigned to one cell of a between-participants design: 3 (Warning label: Text-only, low-emotion, and high-emotion) × 2 (Measures delay: Immediate, 6 weeks). All participants self-reported smoking-history, completed a baseline quit-intentions measure, and then viewed the same nine cigarette warnings from their experimental condition four times over a 2-week period. They viewed all nine warnings once at baseline, twice 1 week later, and once 2 weeks after baseline. Participants were randomly assigned to complete post-exposure measures of risk perceptions and quit intentions either immediately or 6 weeks after the last exposure (for a procedure timeline, see Supplementary Materials. A complete list of dependent measures is available from the corresponding author).

Materials and Procedure

At each time point, participants viewed all nine TCA-mandated text warnings one at a time on their computer screen. Warnings were shown on a white background, without cigarette packages. The text warnings were formatted to mimic black-and-white text warnings on cigarette packages; text was sized comparably across conditions (approximately 375 × 120 pixels). Participants in the low- versus high-emotion condition viewed the text warnings paired with images pretested to elicit little versus strong negative emotional reaction (see Supplementary Materials for pretesting details). Graphic warnings appeared at approximately 375 × 368 pixels on participants' monitors. (see Figure 1 for examples of each condition; All materials are available from the corresponding author.)

Emotional Reactions

On their first and fourth exposures, participants rated each warning on the well-validated single arousal item from the Self-Assessment-Manikin.[26] Specifically, they viewed five stick figures depicting emotions ranging from calm to excited and were asked to "Select one character to describe how the warning makes you feel from calm, drowsy, and peaceful on the left to excited, energized, and alert on the right." Reactions were coded from 1 = "Calm" to 5 = "Excited."

Smoking Outcome Measures

Smoking Risk Perceptions

Participants were asked "If I continue to smoke, I think my chances of getting a life-threatening illness because of smoking are": (0 "Almost zero"/6 "Almost certain"), "If I don't stop smoking, I would feel very vulnerable to dying at a younger age because of smoking." (−3 "Strongly disagree"/+3 "Strongly agree"), and "Compared to the average nonsmoker your age, gender, and race, how would you rate your chances of getting lung cancer?" (−3 "Much lower"/+3 "Much higher"). Measures were adapted from past research.[27]

Quit Intentions

Participants responded to a quit-contemplation ladder[28] at baseline and at the study's conclusion by choosing the number that indicated their current thinking about smoking on a 11-point scale (0 = taking action to quit [eg, cutting down, enrolling in a program]; 10 = no thought of quitting). At the study's conclusion, participants responded to items asking "Thinking about the next week, do you expect your tobacco use to ... ?" (−3 "Decrease a lot"/+3 "Increase a lot") and "How likely do you think it is that you will try to quit smoking within the next 30 days?" (−3 "Very unlikely"/+3 "Very likely").[29]

Preliminary Analyses and Analysis Strategy

Preliminary analyses were conducted using STATA.[30] We first examined the consistency of emotional reactions across exposures. Generalized estimating equations revealed that emotional reaction to the warnings did not differ significantly between the first and fourth exposures (see "Emotional reactions" in Supplementary Materials). Thus, we used indices of participants' average emotional reaction to the nine warning labels at exposure 1 (α_{adult} = 0.95, M_{Adult} = 3.12, SD = 1.06; α_{teen} = 0.93, M_{Teen} = 3.26, SD = 1.01) and exposure 4 (α_{adult} = 0.95, M_{Adult} = 3.13, SD = 1.02; α_{teen} = 0.96, M_{Teen} = 3.34, SD = 1.03) as indicators on a latent emotional-reaction variable.

We also used generalized estimating equations to investigate the impact of measurement timing for risk perceptions and quit intentions. The effects of warning condition on risk perceptions and quit intentions did not vary as a function of delay condition (see "Measurement timing" in Supplementary Materials). Thus, we controlled for measurement timing in structural equation models (SEMs) by including it as a covariate in regressions involving risk perceptions and quit intentions, but did not stratify the models by delay condition.

The SEM we tested was developed from past research demonstrating that negative emotional reaction is an important mediator of graphic-warning labels' impact on smokers' risk perceptions and quit intentions.[9] To directly compare the impact of experimental conditions, we created two dummy variables as planned comparisons. One variable compared text-only warnings (coded −1) to low-emotion warnings (coded as 1), coding high-emotion warnings as 0. The second variable compared text-only warnings (coded −1) to high-emotion warnings (coded as 1), coding low-emotion warnings as 0. In SEMs, these variables simultaneously predicted emotional reaction, and we assessed their indirect effects on risk perceptions and quit intentions via emotional reaction.

SEM was carried out in MPlus.[31] Because emotional reaction, risk perceptions, and quit intentions were non-normally distributed, maximum-likelihood parameter estimates with standard errors and a chi-square test robust to non-normality were used. This approach handles missing data on dependent measures by using all available data and selecting the set of values of model parameters that maximizes the likelihood function. Cases with missing data on independent and control variables are deleted list-wise. All analyses

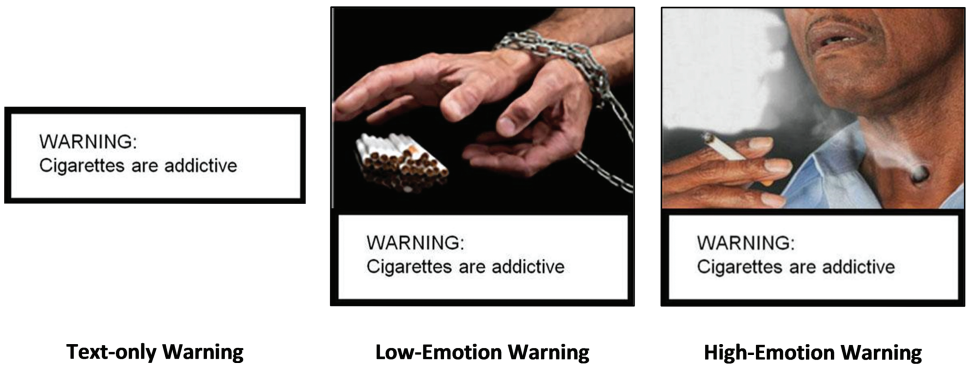

Figure 1. Example warning labels by experimental condition. Note that, although the size of the text was comparable across experimental conditions, the total size of warnings viewed by participants in the text-only condition was smaller than that of participants in the graphic image conditions. Center image purchased via iStockphoto.com/Dmytro Sobko; Right image courtesy of FDA Center for Tobacco Products.

incorporated survey weights, allowing for conclusions generalizable to specified populations.

We used logistic regressions to identify the impact of demographic characteristics on attrition. Preliminary SEM models controlled for all demographic variables associated with attrition. Variables non-predictive of risk perceptions or quit intentions were removed one at a time; the model was rerun after each deletion. Race/ethnicity (non-Hispanic white vs. other) remained a significant predictor of quit intentions (b = 0.67, p = .021) and was retained as a control variable in our final adult model. In the teen model, no demographic variables were retained (see "Attrition" in Supplementary Materials).

To evaluate model fit, we used multiple fit indices with recommended cutoff values[32] (Root Mean Square Error of Approximation [RMSEA] ≤ 0.05 with 90% Confidence Intervals of the RMSEA = 0.00–0.08, Comparative Fit Index [CFI] ≥ 0.95, and Standardized Root Mean Square Residual [SRMR] ≤ 0.08). Because Bayesian Information Criterion (BIC) more frequently selects the correct model as sample sizes increase, we also report the BIC[33]; smaller BIC values indicate that the model provides a better fit. We used BIC differences to compare model fit. We used Raftery's[34] rules-of-thumb for interpreting BIC differences between two models: Weak evidence: BIC diff 0–2; Positive evidence: 2–6; Strong evidence: 6–10; and Very strong evidence: >10. Estimated indirect effects were calculated using robust standard errors; their significance was evaluated by examining associated p-values. Simulations show that estimates using robust standard errors yield accurate estimates of sampling variability when the distribution of model parameters is non-normal.[35] Although bootstrapping is generally preferred for evaluating the significance of indirect effects,[36] no software is available which can estimate bootstrap confidence intervals in models requiring adjustment for non-normality in latent variables.

Results

Demographics

Seven hundred thirty six adults and 469 teens completed the study. For participant demographics, see Table 1. Adults were on average 46.49 (SD = 12.39) years old, 43.34% male, 73.23% white; 48.51% had a college education or higher. They smoked 13.94 (SD = 9.14) cigarettes per day, with 89.81% smoking daily; 42.24% made at least one past-year quit attempt. Teens were on average 16.42 (SD = 1.29) years old, 45.92% male, and 63.30% white. 32.41% of teens smoked daily, somedays, or occasionally and smoked an average of 1.81 (SD = 3.13) cigarettes per day on days they smoked. Across all levels of smoking behavior, including teens who smoked "rarely" or "not at all," 43.92% of teens reported at least one past-year quit attempt.

Regression and chi-square tests revealed that participant characteristics (age, gender, race, smoking status, history of quit attempts, and education in the adult sample) and baseline quit intentions did not differ by experimental condition in adult or teen samples. Model results were not substantively different when we controlled for baseline quit intentions in the adult or teen samples (see Supplementary Figure S2). Our primary predictions concerned indirect effects; for completeness, however, separate weighted regressions were used to investigate the total effects of warning-label exposure on key

Table 1. Self-Reported Participant Demographics and Smoking Behaviors by Sample

	Adult sample		Teen sample	
	Unweighted	Weighted	Unweighted	Weighted
Age	46.49 (SD = 12.39)	41.71 (SD = 12.30)	16.42 (SD = 1.29)	16.68 (SD = 1.21)
Gender				
Male	43.34%	53.01%	45.92%	52.62%
Female	56.66%	46.99%	54.08%	47.38%
Race				
White	78.67%	72.53%	63.30%	63.48%
Black	11.14%	12.69%	17.17%	9.90%
Hispanic	5.57%	9.82%	8.80%	20.27%
Other	4.62%	4.95%	10.73%	6.34%
Smoking status				
Every day	89.81%	91.89%	8.32%	8.52%
Some days	10.19%	8.11%	10.87%	11.8%
Occasionally			13.22%	15.76%
Rarely			29.85%	28.1%
Not at all			37.74%	35.81%
Cigarettes smoked daily	13.94 (SD = 9.14)	13.40 (SD = 9.14)	1.81 (SD = 3.13)	2.17 (SD = 4.00)
Baseline contemplation ladder	5.86 (SD = 3.02)	5.59 (SD = 3.06)	5.70 (SD = 4.04)	5.65 (SD = 4.04)
Past year quit history				
No quit attempts	57.76%	56.62%	56.08%	56.98%
One or more quit attempts	42.24%	43.38%	43.92%	43.02%
Education				
High school or less	21.47%	52.26%		
Some college	30.03%	24.66%		
Bachelor's degree or higher	48.51%	23.08%		

SD = standard deviation. Demographics did not differ by warning-label condition. Weighted data are used in all analyses.

outcome variables (see "Total effects" in Supplementary Materials). Variable means by condition are available in Table 2.

Measurement Models

To assess the fit of our measurement models (emotional reaction, risk perceptions, and quit intentions), we conducted confirmatory factor analyses. Our hypothesized three-factor structure fit the data well in both samples (adults: $\chi^2[17] = 25.69$, $p = .08$; RMSEA = 0.03 [CI 90%: 0.00–0.05]; CFI = 0.99; SRMR = 0.03; teens: $\chi^2[17] = 25.96$, $p = .075$; RMSEA = 0.03 [CI 90%: 0.00–0.06]; CFI = 0.98; SRMR = 0.03).

Structural Equation Model

Adult Sample

Our theory-based model (see Figure 2) provided an excellent fit to the adult data ($\chi^2[43] = 54.93$, $p = .105$; RMSEA = 0.02 [CI 90%: 0.00–0.03]; CFI = 0.99; SRMR = 0.04, BIC = 19 201.40). Participants in the low-emotion warnings condition reported significantly less emotional reaction than those in the text-only condition ($b = -0.18$, $p = .019$) whereas participants in the high-emotion condition reported significantly more emotional reaction versus text-only participants ($b = 0.21$, $p = .003$). As hypothesized, participants who experienced more emotional reaction to the warning labels perceived smoking as more risky ($b = 0.66$, $p < .001$) and were more likely to express interest in quitting ($b = 0.94$, $p < .001$). Greater risk perceptions also predicted higher quit intentions ($b = 0.79$, $p < .001$).

All indirect effects in the adult sample were statistically significant. The indirect effects of the contrast comparing participants in the low-emotion versus text-only warnings conditions on risk perceptions (Estimated Indirect Effect [IE] = −0.12, $p = .023$) and quit intentions (IE = −0.17, $p = .028$) through emotional reaction were both significant and negative. The indirect effect from this same contrast to quit intentions via emotional reactions and risk perceptions was also significant and negative (IE = −0.09, $p = .031$). Thus, reduced emotional reaction among participants in the low-emotion condition was associated with perceiving smoking as "less" risky and having "lower" quit intentions than text-only participants. Conversely, the indirect effects of the contrast comparing participants in the high-emotion versus text-only conditions on risk perceptions (IE = 0.14, $p = .004$) and quit intentions (IE = 0.19, $p = .009$) through emotional reaction were both significant and positive, as was the indirect effect of this contrast on quit intentions via emotional reaction and risk perceptions (IE = 0.11, $p = .012$). Thus, the emotional reaction that participants experienced in the high-emotion warnings condition was associated with "increased" perceptions that smoking is risky and "greater" quit intentions relative to the text-only condition.

Table 2. Variable Means And Standard Deviations by Experimental Condition in the Weighted Adult and Teen Samples

	Range	Text-only condition	Low-emotion graphic condition	High-emotion graphic condition
Adult sample				
Baseline contemplation ladder	0 to 10	5.05 (3.07)	5.45 (3.18)	5.84 (2.89)
Emotional reaction				
Exposure 1 emotion	1 to 5	3.10 (1.10)	2.92 (.95)	3.34 (1.09)
Exposure 4 emotion	1 to 5	3.08 (.98)	2.96 (.98)	3.34 (1.06)
Risk perceptions				
Risk 1	1 to 6	4.32 (1.52)	4.19 (1.43)	4.31 (1.39)
Risk 2	−3 to +3	1.19 (1.55)	1.10 (1.60)	1.06 (1.50)
Risk 3	−3 to +3	1.50 (1.43)	1.35 (1.28)	1.40 (1.29)
Quit intentions				
Contemplation ladder	0 to 10	6.06 (3.00)	5.74 (3.05)	6.40 (2.92)
Next week tobacco use intentions?	−3 to +3	−0.54 (1.13)	−0.48 (1.10)	−0.41 (1.16)
30-day quit intentions	−3 to +3	−0.74 (2.04)	−0.66 (2.05)	−0.62 (1.89)
Teen sample				
Baseline contemplation ladder	0 to 10	5.95 (4.01)	5.27 (4.08)	5.75 (4.02)
Emotional reaction				
Exposure 1 emotion	1 to 5	3.11 (1.02)	3.01 (.98)	3.69 (.90)
Exposure 4 emotion	1 to 5	3.30 (1.02)	3.02 (1.04)	3.72 (.88)
Risk perceptions				
Risk 1	1 to 6	4.40 (1.79)	4.59 (1.50)	4.28 (1.67)
Risk 2	−3 to +3	1.15 (1.72)	1.28 (1.60)	1.31 (1.51)
Risk 3	−3 to +3	0.91 (1.86)	0.97 (1.74)	0.92 (1.64)
Quit intentions				
Contemplation ladder	0 to 10	5.52 (4.04)	6.41 (3.89)	6.40 (3.71)
Next week tobacco use intentions?	−3 to +3	−1.31 (1.47)	−1.18 (1.63)	1.08 (1.45)
30-day quit intentions	−3 to +3	0.56 (1.97)	0.75 (2.07)	0.98 (1.93)

Baseline contemplation ladder = Contemplation ladder measure ("0 taking action to quit/10 no thought of quitting"); Exposure 1 emotion = Average arousal at exposure 1 (0 = low, 5= high); Exposure 4 emotion = Average arousal at exposure 4 (0 = low, 5= high); Risk 1 = "If I continue to smoke, I think my chances of getting a life-threatening illness because of smoking are: (0 Almost zero/6 Almost certain)"; Risk 2 = "If I don't stop smoking, I would feel very vulnerable to dying at a younger age because of smoking. (−3 Strongly disagree/+3 Strongly agree)"; Risk 3 = "Compared to the average nonsmoker your age, gender, and race, how would you rate your chances of getting lung cancer? (−3 Much lower/+3 Much higher)"; Contemplation ladder = Contemplation ladder measure ("0 taking action to quit/10 no thought of quitting"); Next week tobacco use intentions = "Thinking about the next week, do you expect your tobacco use to...? (−3 Decrease a lot/+3 Increase a lot)"; 30-day quit intentions = "How likely do you think it is that you will try to quit smoking within the next 30 days? (−3 Very unlikely/3 Very likely)".

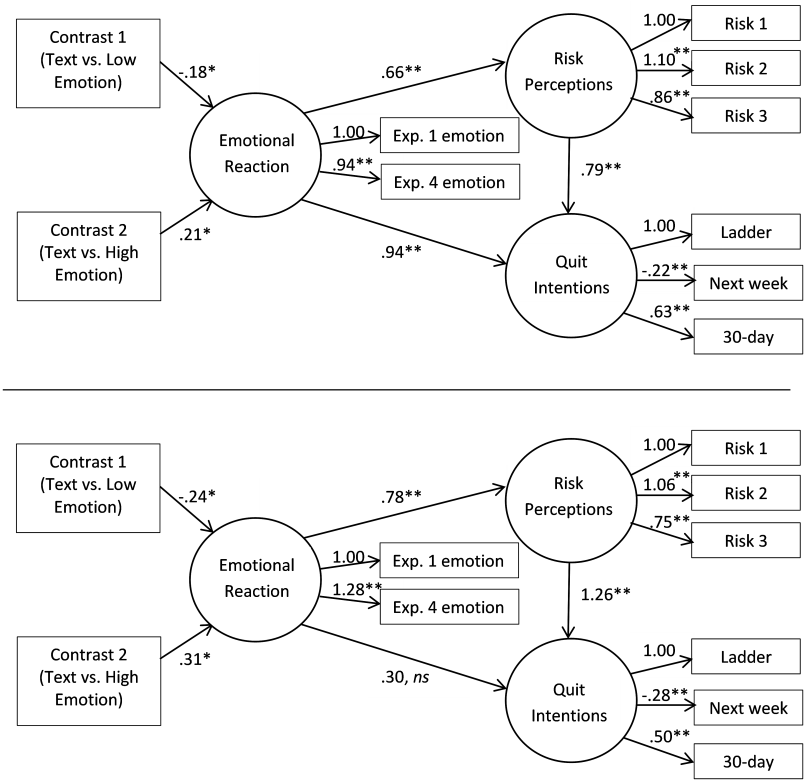

Figure 2. Final models for adult smokers (top) and teen smokers/vulnerable smokers (bottom). All coefficients are unstandardized. Models included 736 adults and 469 teens. Exp. 1 emotion = Average arousal at exposure 1 (0 = low, 5 = high); Exp. 4 emotion = Average arousal at exposure 4 (0 = low, 5 = high); Risk 1 = "If I continue to smoke, I think my chances of getting a life-threatening illness because of smoking are: (0 Almost zero/6 Almost certain)"; Risk 2 = "If I don't stop smoking, I would feel very vulnerable to dying at a younger age because of smoking. (–3 Strongly disagree/+3 Strongly agree)"; Risk 3 = "Compared to the average nonsmoker your age, gender, and race, how would you rate your chances of getting lung cancer? (–3 Much lower/+3 Much higher)"; Ladder = Contemplation ladder measure ("0 taking action to quit/10 no thought of quitting"), Next week = "Thinking about the next week, do you expect your tobacco use to ... ? (–3 Decrease a lot/+3 Increase a lot)"; 30-day = "How likely do you think it is that you will try to quit smoking within the next 30 days? (–3 Very unlikely/3 Very likely)". Exp. 1 emotion, Risk 1, and Ladder are scaling indicators.

To investigate an alternative model in which image presence increases risk perceptions and quit intentions beyond the effects of emotional reaction, paths were added from each contrast to each outcome variable (see Supplementary Figure S3). The resulting model provided very strong evidence of a worse fit to the data ($BIC_{Difference}$ = 18.92, BIC = 19 219.69; $\chi^2[39]$ = 50.91, p = .096; RMSEA = 0.02 [CI 90%: 0.00–0.04]; CFI = 0.99; SRMR = 0.04).

Teen Sample

Our theory-based model also fit the teen data well ($\chi^2[37]$ = 56.08, p = .023; RMSEA = 0.03 [CI 90%: 0.01–0.05]; CFI = 0.97; SRMR = 0.04, BIC = 13 411.04). Teens in the low-emotion condition experienced less emotional reaction upon viewing their warning labels than those in the text-only condition (b = –0.22, p = .002) whereas teens in the high-emotion condition experienced more emotional reaction than those in the text-only condition (b = 0.27, p = .001). Greater emotional reaction led to increased risk perceptions (b = 1.21, p < .001); however, it was not a significant predictor of quit intentions in the teen sample (b = 0.46, p = .128). Removing this path had little effect on fit ($\chi^2[38]$ = 58.62, p = .017; RMSEA = 0.03 [CI 90%: 0.02–0.05]; CFI = 0.97; SRMR = 0.04, BIC = 13 409.20, $BIC_{Difference}$ = 1.84); therefore, we retained it. Participants who perceived smoking as riskier expressed more interest in quitting (b = 0.21, p < .001).

Consistent with the adult sample, the indirect effect of the contrast comparing low-emotion versus text-only participants on risk perceptions was significant and negative (IE = –0.12, p = .023), as was the indirect effect of this contrast on quit intentions through emotional reaction and risk perceptions (IE = –0.23, p = .004). Thus, the reduced emotional reaction experienced by participants in the low-emotion condition was associated with "lower" risk perceptions and "reduced" quit intentions relative to those in the text-only condition. In addition and similar to the adult sample, the indirect effects of the contrast comparing participants in the high-emotion versus text-only warning conditions on risk perceptions via emotional reaction (IE = 0.23, p < .001) and on quit intentions via emotional reaction and risk perceptions (IE = 0.27, p = .002) were both significant and positive. In other words, the emotional reaction experienced by participants in the high-emotion versus text-only warnings condition was associated with "heightened" risk perceptions and "increased" quit intentions. Neither indirect effect from the contrasts to quit intentions via emotional reaction alone was significant ($IE_{Low\ Arousal\ versus\ text}$ = –0.10, p = .160; $IE_{High\ Arousal\ versus\ text}$ = 0.12, p = .159).

As in the adult sample, we investigated an alternative model in which image presence leads to increased risk perceptions and quit intentions by controlling for the effect of emotional reaction; paths were added from each contrast to each outcome variable (see Supplementary Figure S3). The resulting model provided positive

evidence of a worse fit to the data ($BIC_{Difference}$ = 5, BIC = 13 416.04; χ^2[33] = 42.93, p = .116; RMSEA = 0.03 [CI 90%: 0.00–0.05]; CFI = 0.98; SRMR = 0.03).

Discussion

The current research presents the first known evidence that graphic warnings can be less effective than text-only warnings. In adult and teen smoker/vulnerable smoker samples, this finding appears due to warnings with images that elicited less emotional reaction than text-only warnings also reducing risk perceptions and quit intentions. Conversely, warnings with images that elicited more emotional reaction led to increased smoking risk perceptions and quit intentions in both samples. Models with direct paths from emotional reaction to risk perceptions and quit intentions did not fit the data as well as our final model, suggesting that emotional reaction is the primary driver of their impact on these important outcomes. These results provide further evidence that the ability to evoke emotion is a crucial component of effective warnings. They also suggest that images which fail to elicit more emotional reaction from smokers than text alone may not produce desired population-level benefits.

In addition to the novel finding that graphic warnings with less emotional images may do more harm than good, this research is consistent with past investigations showing that emotional reaction to graphic-warning labels influences quit intentions through more than one pathway[9] and (for the first known time) in nationally representative adult and teen smoker samples. Emotional reaction served as information about risk for both adults and teens.[10,11] For adults, emotional reaction also served as a behavioral motivator,[12–15] leading directly to increased quit intentions. Curiously, this latter effect did not emerge for teens. This may be because many teens in our sample were not regular smokers. Although emotional reaction to the warnings led teens to believe that smoking harmed their health, these reactions did not directly motivate quit intentions as we measured them (It is possible that our quit-intention items may have been less relevant to teens who smoked infrequently). Additionally, 43.02% of our teen sample reported at least one past-year quit attempt and only 36.08% were regular or occasional smokers. Thus, many of our teens may believe that they have already quit. It is possible that emotional reaction to the warnings may have had stronger effects on quit intentions in a heavier smoking teen sample.

This investigation has implications for US tobacco-control policy. In blocking the FDA from implementing graphic-warning labels, the judge wrote that the government can mandate informational warnings, but "the emotional response [the graphic-warning labels] were crafted to induce is … an objective wholly apart from disseminating purely factual and uncontroversial information" (p.1216).[2] Thus, FDA could create warning labels which include images that do not evoke emotional reaction. However, the present research suggests that images eliciting less emotional reaction than text-only warnings are unlikely to be more effective than text-only warnings in encouraging cessation. Our results suggest that such warnings could even have deleterious effects on population-level health relative to text-only warnings.

It is also important to note that, although graphic warnings can elicit emotional reaction, smokers also experience emotional reaction to text-only warnings.[37] The ability to evoke emotion is not a unique property of images; rather, images can enhance text's ability to elicit reaction. A fruitful approach to designing effective US warning labels may be to pair text with images that elicit emotion and are responsive to other concerns the courts raised. For example, emotional warnings could be created using images unmodified by computer software and/or which depict the literal dangers described in the text.

One limitation of this research is that participants viewed warning labels only four times over 2 weeks. Although participants viewed these warnings more often than the single-exposure paradigm used in most experimental studies,[38] regular smokers viewed the warnings significantly less than they likely would in naturalistic exposure. Thus, it is unclear how smokers' emotional reactions to the warnings might change over a longer time period.

Another limitation of this research is that the warning labels were presented on computer screens without the context of cigarette packages. In the real world, smokers would simultaneously experience emotional reactions to the warnings and their cigarette package. Positive emotional reaction to cigarette packaging may undermine the ability of warning labels to elicit a negative emotional reaction. It is also possible that, if smokers self-associate with brand features on their cigarette packaging, cigarette packaging could increase the warnings' perceived relevance, augmenting the warnings' effects. Future research should investigate these possibilities.

Current participants also saw a single set of nine warning labels. Based on pretesting, we chose images that varied in how much emotional response they elicited. However, only warnings with negative valence were selected. Warning labels with positive valence exist (eg, Canada's "funny" image of drooping cigarette ash to convey that smoking causes impotence); inclusion of more positive labels may lead to valence and arousal mattering in predicting smokers' emotional and other responses. It is also possible that the warnings used in the high- versus low-emotion conditions differ in some important way. These other differences may have undermined the effectiveness of low-emotion warnings or enhanced the effectiveness of high-emotion warnings. For example, the low-emotion warnings contained more symbolic images than the high-emotion warnings. Symbolic images have been rated as less effective than images of diseased organs in past research.[18,19] It is also possible that low-emotion images were perceived as less relevant to the text, undermining their effectiveness.[39] Future research should replicate this study using different images to rule out possible stimulus-sampling effects.

The current research adds to existing research on the role of emotional reaction in determining the impact of graphic-warning labels. Understanding the processes by which graphic warnings influence risk perceptions and quit intentions in adult and adolescent smokers is crucial to policy makers' ability to design effective future warning labels.

Supplementary Material

Supplementary data are available at *Nicotine & Tobacco Research* online.

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Declaration of Interests

None declared.

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