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Independent or synergistic? Effects of varying size and using pictorial images in tobacco health warning labels

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ABSTRACT

Introduction: Legal challenges have blocked the implementation of large, pictorial health warning labels (HWLs) in the U.S. In light of future legal questions the U.S. Food and Drug Administration may face in proposing alternative HWLs, we examined whether less restrictive HWL versions on the front of packs—smaller HWLs and/or text-only HWLs that do not include pictorial imagery—may be sufficient to promote cognitive and affective outcomes associated with smoking cessation.

Methods: We recruited low-income smokers in two separate experiments through field-based recruitment methods (Study 1, $N = 497$) or Amazon Mechanical Turk (MTurk) (Study 2, $N = 495$). In both studies, we randomly assigned participants to a no-HWL control condition or one of four HWL conditions in a 2 (pictorial vs. text-only) × 2 (50% vs. 30% size) between-subjects design.

Results: Relative to text-only HWLs, pictorial HWLs increased negative affect but not risk belief acceptance, cognitive elaboration about smoking harms, or quit intentions. The 50% HWLs increased quit intentions relative to the control condition in both studies. The 50% HWLs also outperformed the 30% HWLs in promoting quit intentions in Study 2. Subsequent analyses revealed that this effect in Study 2 may have been driven by the 50% HWLs strengthening the relationship between risk-related thoughts and intentions, although there was no evidence for this pattern in Study 1. We found no evidence for interaction effects between the pictorial and size manipulations.

Conclusions: Our findings suggest that 50% HWLs, whether pictorial or text-only, can encourage low-income smokers to consider quitting under some conditions.

1. Introduction

Tobacco use is responsible for over 7 million deaths around the globe each year (World Health Organization, 2017). To convey the harmful effects of smoking to users and non-users, many countries have implemented large, pictorial health warning labels (HWLs) on cigarette packages (Hammond, 2011). Article 11 of the WHO Framework Convention on Tobacco Control (FCTC), ratified by 181 countries as of December 2018, requires that HWLs be large and include images to maximize their effectiveness. Ideally, they should cover 50% or more—but no less than 30%—of the product's principal display areas (World Health Organization, 2003). Large, pictorial HWLs now reach over 3.5 billion people in nearly 80 countries (World Health Organization, 2017). Although U.S. President George W. Bush signed the treaty in 2004, the U.S. Senate never gave its consent, so the treaty has not been ratified by the U.S.

Research generally supports the FCTC's requirements. For instance, pictorial HWLs increase visual attention, negative affect, cognitive elaboration, quit intentions, and quit behaviors relative to text-only HWLs (Brewer et al., 2016; Byrne et al., 2017; Noar et al., 2015). Increasing HWL size also increases visual attention, negative affect, and unfavorable pack perceptions (Bansal-Travers et al., 2011; Kotnowski et al., 2016; Les Études de Marché Créatec, 2008; Skurka et al., 2017; Wakefield et al., 2012). However, it has been difficult to isolate

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independent effects of size and pictorial changes because implementation of pictorial HWLs has typically been accompanied by HWL size increases (but see Kotnowski et al., 2016; Wakefield et al., 2012).

Litigation by the tobacco industry prevented the U.S. Food and Drug Administration (FDA) from implementing pictorial, front-of-package HWLs in the U.S. ("RJ Reynolds Tobacco Co. v. Food and Drug Admin," 2012). In 2012, five tobacco companies successfully argued that the nine FDA-proposed HWLs, which would cover 50% of the front and back of cigarette packs sold in the U.S., were unnecessarily restrictive and thus would violate the companies' commercial speech rights protected by the First Amendment. For the time being, U.S. HWLs are confined to one side of cigarette packages, are small, contain decades-old language, and do not include any imagery.

While the FDA revisits its proposed HWLs, it is worth considering whether less restrictive HWLs can still effectively convey smoking's harms and increase intentions to quit smoking because the tobacco industry will likely challenge new FDA action in court. Under the legal test applied in the 2012 case, warnings will be invalidated unless they are "narrowly tailored" to advance the government's interest in combating smoking. Graphic warnings would likely be deemed too restrictive of the tobacco companies' free speech if plain text would be equally effective; likewise, 50% coverage would be too great if a substantially smaller image (such as 30%) would do the job as well. Accordingly, we conducted two experiments in which we manipulated (a) the presence of imagery, and (b) label size, to examine any independent and synergistic (interactive) effects on key predictors of quitting—negative affect, health risk belief acceptance, cognitive elaboration about smoking's harms, and quit intentions. Previous work has examined the effects of including images (Byrne et al., 2017) and increasing size (Skurka et al., 2017) but has not used a fully crossed design to assess for interactive effects of simultaneous HWL changes.

We conducted these experiments with two samples of adult smokers. We first recruited smokers through a field-based, convenience sampling strategy. This allowed us to reach smokers of very low socioeconomic status (SES), characterized by low levels of income, education, and access to resources (e.g., food insecurity). Low-SES populations smoke at high rates in the U.S. (U.S. Department of Health and Human Services, 2014) and disproportionately suffer from smoking-related diseases (Henley et al., 2016), which makes them a key demographic group likely to benefit from implementation of new HWLs (Cantrell et al., 2013; Mead et al., 2015). In addition, to assess whether observed HWL effects can be replicated using less intensive recruitment methods, we recruited a second sample of low-income smokers through Amazon Mechanical Turk (MTurk), which researchers have used successfully in tobacco control studies (e.g., Cameron et al.,2013; Jeong et al., 2018).

2. Method

2.1. Procedures

The researchers' university IRB approved all study protocols.

2.1.1. Study 1

Field-based sample. We used U.S. census data to locate urban and rural zip codes in the Northeastern U.S. where the median household income level was ≤$35 K. We also recruited participants by contacting organizations that serve low-SES populations and agreed to support the study by assisting with advertising the study. Advertising techniques included word-of-mouth recruiting through partner organizations, in-person flyer distribution, and street-intercepts. To participate, smokers provided informed consent, and then we biochemically confirmed their smoking status with a CoVita breath test, which measures exhaled carbon monoxide and serves to distinguish between regular and casual smokers. In rare cases when requested by the participant after a failed CoVita (most often due to participants' inability to provide an extended exhalation), we administered an Alere saliva test, which instead screens for cotinine (a nicotine metabolite from combustible and non-combustible tobacco products).

Data collection in the field-based study occurred in a mobile laboratory (including eye-tracking software to collect visual gaze data, results of which we do not include in this paper). We randomly assigned participants to view images of cigarette packs in one of five conditions: one of four HWL conditions (2 × 2 design, described below) or an offset control condition (no HWLs). All participants watched a nine-image slideshow of the front of cigarette packs displayed on the computer monitor. Each image appeared for 10 s followed by a fixation cross in various locations on the screen to reset visual attention.

Participants in the control condition saw a total of nine images of branded cigarette packs without any HWLs. We selected the three most popular cigarette brands (Marlboro, Camel, Newport) for our stimuli (3 repetitions per brand for a total of 9 images). Participants assigned to the four HWL conditions saw these nine branded packs with slightly modified versions of the nine HWLs originally proposed by the FDA at the top of each pack. We modified them to (a) exclude the quitline number, "1-800-QUIT-NOW," which was deemed problematic in the courts because it is a direct statement telling consumers not to use a legal product and (b) standardize the text across warning messages. We paired each of the nine labels with one of the three cigarette brands, and we rotated the brand/HWL pairs to ensure that brands were not associated with particular HWLs. We manipulated the FDA-proposed labels to produce a 2 (imagery: present or absent) × 2 (size: covering 50% or 30% of the pack) between-subjects design (Fig. 1). For example, individuals in the 50% text-only condition saw a slideshow of the nine FDA-proposed labels that all were edited to be 50% of the top of the packs without warning imagery.

Using iPads, participants self-reported their affective and cognitive responses to the images as well as quit intentions, demographics, and covariates. We debriefed participants about the purpose of the study and paid them $20 for their time.

2.1.2. Study 2

MTurk Sample. We recruited a second sample of (not biochemically confirmed) adult smokers through MTurk about one month after collecting data for our field-based sample. Major socioeconomic disadvantage characterized the field-based sample (Table 1), so we aimed to recruit a similar pool of MTurk smokers. To do so, we utilized MTurk's premium qualifications for household income (the only marker of SES available, aside from years of education) so that most participants would be in the lowest stratifications available on MTurk (< $25,000 and $25,000-$49,999). We also required that MTurk participants reside in the U.S. and have a ≥95% approval rating on previous MTurk tasks. We employed the same experimental design and survey measures for the MTurk sample as the field-based sample. We paid MTurk participants $1.

2.2. Measures

2.2.1. Negative affect

Participants used a 5-point scale of 1 (*not at all*) to 5 (*extremely*) to report on eight emotions (e.g., *afraid*, *disturbed*, *grossed out*) using items adapted from PANAS-X (Watson and Clark, 1999). We averaged responses into a single measure (M_{field} = 2.26, SD_{field} = 1.06, Cronbach's α_{field} = .91; M_{MTurk} = 2.14, SD_{MTurk} = .98, α_{MTurk} = .90).

2.2.2. Risk belief acceptance

Participants used a 4-point scale (1 = *definitely not,* 4 = *definitely yes)* to respond to 10 items addressing their beliefs about the health effects of smoking (e.g., *Do you believe cigarette smoking causes…mouth cancer?…lung disease in people who don't smoke?*), adapted from the Population Assessment of Tobacco and Health survey (Hyland et al., 2016). Because responses were negatively skewed, we dichotomized

Fig. 1. Sample experimental stimuli.
Note: Clockwise from top left: 30% text-only, 30% pictorial, control, 50% pictorial, 50% text-only.

responses (1 = *definitely yes*, 0 = other) and created a summative risk belief acceptance index (M_{field} = 5.47, SD_{field} = 3.49, α_{field} = .91; M_{MTurk} = 4.50, SD_{MTurk} = 3.28, α_{MTurk} = .90).

2.2.3. Cognitive elaboration

Participants in all conditions used a 4-point scale (1 = *strongly disagree*, 4 = *strongly agree*) to indicate their agreement with two items (adapted from Brewer et al., 2016): *I found myself thinking about the harm my smoking might be doing* (1)…*to me* and (2) …*to other people*. We averaged responses into an elaboration scale (M_{field} = 2.94, SD_{field} = .81, r_{field} = .60; M_{MTurk} = 2.77, SD_{MTurk} = .85, r_{MTurk} = .69).

2.2.4. Quit intentions

Participants indicated whether they wanted to quit smoking for good and whether they had a time frame in mind (Centers for Disease Control and Prevention, 2016). If yes to both, participants reported when they planned to quit: *seven days*, *30 days*, *six months*, *one year*, *more than a year*. We dichotomized responses so that 1 = plan to quit in six months or sooner and 0 = no plan to quit in the next six months (quit $intention_{field}$ = 26.1%, quit $intention_{MTurk}$ = 24.8%).

2.2.5. Covariates

Participants reported on demographics, smoking covariates (e.g., recent quit attempts, cigarette dependence (Fagerström, 2012), and socioeconomic disadvantage indicators (see Table 1).

2.3. Analyses

We present means and 95% confidence intervals by condition in Table 2. For each sample, we ran three series of multivariable regressions (ordinary least squares for continuous outcomes, logistic for intentions). In the first series (Table 3), we excluded control group data, using dummy-coded predictors for the main effects of pictorial (vs. text) and 50% (vs. 30%) including demographics and covariates. The second series of regressions (Table 4) were identical to the first except we included pictorial-by-size interaction terms. The third series of regressions (Table 5) were similar to the first series except that we included data from the control groups and included a dummy variable for the 30% text-only condition. This technique allowed us to compare (a) both pictorial conditions to control and (b) both 50% conditions to control.

3. Results

3.1. Sample characteristics

Compared to the field-based sample (N = 497, Table 1), the MTurk sample (N = 495) was younger, more female and racially homogeneous, earned greater household income, and had greater educational attainment. MTurk respondents were less cigarette-dependent, made fewer quit attempts in the past year, and were less reliant on programs to address food insecurity. Demographics and covariates did not differ across conditions in either sample ($ps > .05$).

Table 1
Sample demographics.

	Field-based	MTurk
Age		
18–24	60 (12.4%)	57 (11.5%)
25–34	99 (20.5%)	196 (39.6%)
35–44	96 (19.8%)	105 (21.2%)
45–54	117 (24.2%)	82 (16.6%)
55+	112 (23.1%)	55 (11.1%)
Gender identity		
Female	195 (39.5%)	310 (62.6%)
Male	294 (59.5%)	179 (36.2%)
Transgender	3 (0.6%)	6 (1.2%)
Other	2 (0.4%)	0 (0%)
Hispanic	72 (14.8%)	35 (7.1%)
Race		
White	266 (53.5%)	425 (85.9%)
Black	186 (37.4%)	53 (10.7%)
Other, non-White race	41 (8.2%)	47 (9.5%)
Income		
< $10k	241 (49.7%)	79 (16.0%)
$10k–19k	105 (21.6%)	160 (32.3%)
$20k–29k	66 (13.6%)	155 (31.3%)
$30k–39k	24 (4.9%)	52 (10.5%)
$40k+	49 (10.1%)	49 (9.9%)
Educational attainment		
High school graduate	284 (57.6%)	482 (97.4%)
College graduate	36 (7.3%)	152 (30.7%)
Smoking variables		
FTCD (1–10)	M = 5.25 (SD = 2.45)	M = 4.10 (SD = 2 .50)
Previous quit attempt	286 (57.9%)	259 (52.3%)
Benefits program recipient		
Emergency food	320 (64.9%)	116 (23.4%)
WIC	93 (18.9%)	51 (10.3%)
SNAP	327 (66.3%)	212 (42.8%)
N	497	495

Note. Descriptive statistics based on number of complete cases with non-missing data for that variable. FTCD = Fagerström Test for Cigarette Dependence (higher scores indicate greater cigarette dependence). WIC = Women, Infants, and Children program. SNAP = Supplemental Nutrition Assistance Program.

3.2. Negative affect

There was a main effect of including a pictorial image (vs. text-only) on negative affect in models that excluded the control group (Table 3). Those exposed to pictorial HWLs reported more negative affect than those exposed to text-only HWLs. This pattern was consistent in both samples. Increasing HWL size did not influence negative affect. There was no evidence for an interaction between imagery and size on negative affect (Table 4).

Negative affect was significantly higher for participants exposed to any version of the HWLs versus those in the control group (Table 5). Coefficients were again comparable in size across the samples.

3.3. Risk belief acceptance

There were no main effects of the pictorial or the size manipulation on risk belief acceptance for either sample in models that excluded the control group (Table 3). There was no evidence for an interaction between imagery and size on risk belief acceptance (Table 4).

Results were similar when we included the control group data in our analyses (Table 5). There were no differences in risk belief acceptance for those exposed to any version of a cigarette pack with a HWL relative to control.

3.4. Cognitive elaboration

Cognitive elaboration was statistically equivalent between the pictorial and text-only conditions in the models that excluded control group data (Table 3). There were also no differences in elaboration between individuals in the 50% or 30% conditions, nor was there any evidence of a pictorial-by-size interaction (Table 4).

Pictorial HWLs did produce more cognitive elaboration than the no-HWL control packs, although 30% text-only labels also outperformed the control group on this outcome in the MTurk sample (Table 5). We observed the same general pattern in both samples, but the effect appeared to be stronger in magnitude among MTurk participants. MTurkers who saw 50% HWLs engaged in more cognitive elaboration than MTurkers exposed to the no-HWLs control packs, but as noted above so did the those exposed to the 30% text-only HWL. The effect of 50% HWLs versus control was not significant for participants in the field sample.

3.5. Quit intentions

There was no evidence of a main effect of pictorial HWLs (vs. text-only HWLs) for either sample in models excluding the control group (Table 3). Although there was no effect of increasing HWL size from 30% to 50% on participants' quit intentions in the field sample, increasing size did produce higher quit intentions in the MTurk sample. MTurkers' odds of intending to quit were twice as high in the 50% vs. 30% conditions, translating to an intention-to-quit rate that was almost 14 percentage points higher in 50% HWL conditions (31–33%) than in 30% HWL conditions (18–19%; see Table 2). There was no interaction

Table 2
Means (or percentages) and 95% confidence intervals by condition.

		Control	50% image	50% text-only	30% image	30% text-only
Negative affect	Field-based	1.47 [1.34–1.61]	2.62 [2.43–2.82]	2.27 [2.06–2.49]	2.63 [2.43–2.84]	2.30 [2.09–2.52]
	MTurk	1.39 [1.25–1.54]	2.62 [2.41–2.83]	2.15 [1.98–2.32]	2.44 [2.25–2.63]	2.07 [1.90–2.24]
Risk beliefs	Field-based	5.35 [4.69–6.01]	5.58 [4.92–6.24]	5.65 [4.94–6.37]	5.68 [4.98–6.38]	5.10 [4.35–5.85]
	MTurk	4.08 [3.40–4.76]	4.73 [4.06–5.40]	4.99 [4.40–5.58]	4.27 [3.56–4.98]	4.28 [3.66–4.90]
Elaboration	Field-based	2.70 [2.53–2.87]	3.00 [2.85–3.16]	2.97 [2.82–3.12]	3.09 [2.92–3.25]	2.92 [2.77–3.07]
	MTurk	2.37 [2.17–2.56]	2.95 [2.79–3.12]	2.87 [2.72–3.02]	2.83 [2.67–3.01]	2.77 [2.62–2.91]
Quit intentions	Field-based	14.0% [7.1%–20.9%]	27.0% [18.2%–35.9%]	35.7% [26.1%–45.4%]	26.3% [17.4%–35.1%]	27.6% [18.6%–36.6%]
	MTurk	22.2% [13.5%–31.0%]	33.0% [23.3%–42.7%]	31.1% [22.7%–39.5%]	17.7% [9.9%–25.5%]	18.8% [10.8%–26.7%]

Note. Negative affect ranged from 1 to 5, risk beliefs ranged from 0 to 10, and elaboration ranged from 1-4. Percentages indicate percentage of participants reporting that they intend to quit smoking in six months or sooner.

Table 3
Unstandardized coefficients and standard errors (or adjusted odds ratios and confidence intervals) for main effects excluding control group.

	Negative affect		Risk beliefs		Elaboration		Quit intentions [ORs, 95% CIs]	
	Field-based	MTurk	Field-based	MTurk	Field-based	MTurk	Field-based	MTurk
Condition								
Pictorial (vs. text-only)	.36 (.11)***	.42 (.09)***	.13 (.37)	−.12 (.33)	.08 (.08)	.06 (.08)	.89 [.54–1.46]	1.05 [.64–1.72]
50% (vs. 30%)	.01 (.11)	.14 (.09)	.36 (.37)	.48 (.33)	−.03 (.08)	.08 (.08)	1.32 [.81–2.15]	2.08 [1.24–3.47]**
Constant	1.67 (.35)***	2.79 (.39)***	7.77(1.22)***	5.51 (1.40)***	2.95 (.26)***	2.93 (.34)***	.08**	.42
R^2	.13	.17	.09	.11	.15	.15	–	–
N	376	405	376	405	376	405	376	405

Note. ORs = odds ratios. CIs = confidence intervals. *$p \leq 0.05$. **$p \leq 0.01$. ***$p \leq 0.001$. Models also controlled for age, gender identity, race, ethnicity, income, educational attainment, cigarette dependence, previous quit attempts, and previous receipt of federally funded programs. R^2 is non-adjusted R^2.

between the HWL size and image manipulations (Table 4).

The main effect of pictorial HWLs (vs. control) was not significant for either sample in models that included control group data (Table 5). However, there was a main effect of 50% HWLs (vs. control) in both samples. Participants were significantly more likely to intend to quit if exposed to 50% HWLs than if exposed to packs without a warning. Quit intentions were 9 to 22-percentage points higher in the 50% HWL conditions than the no-exposure control group (Table 2).

3.6. Post hoc analyses

Because the size manipulation did not influence negative affect, risk beliefs, or elaboration, we were initially uncertain about the mechanism by which a HWL size increase may have impacted intentions among MTurkers. One possibility is that rather than strengthening risk-related thoughts (i.e., risk beliefs, elaboration) directly, increased HWL size strengthens the association between risk-related thoughts and intentions (Fishbein and Cappella, 2006; Fishbein and Yzer, 2003). We ran a series of post hoc logistic regressions to explore this notion (tables not shown).

These models revealed that the pictorial manipulation did not moderate the relationship between risk beliefs and intentions in the MTurk sample (OR = .90, 95% CI = .76, 1.06), but the size manipulation did (OR = 1.27, 95% CI = 1.07, 1.50). Plotting and probing this interaction (Fig. 2) demonstrated that increasing HWL size from 30% to 50% strengthened the relationship between risk belief acceptance and quit intentions, such that there was a significant relationship between risk belief acceptance and quit intentions in the 50% HWL conditions ($p < .001$) but not the 30% conditions ($p = .46$). A similar size-by-elaboration interaction emerged among MTurk participants (OR = 2.06, 95% CI = 1.01, 4.20); that is, the relationship between elaboration and quit intentions was weak and non-significant in the 30% conditions ($p = .94$) but stronger and significant ($p = .008$) in the 50% conditions (not shown). No interaction terms were significant in the field-based sample ($ps > .05$).

4. Discussion

Across two samples of primarily low-income smokers, we found that exposure to HWLs covering 50% of a cigarette package produced greater quit intentions relative to no HWL. This finding replicates the results of a similar experiment that compared 50% HWLs to brand-only content (Skurka et al., 2017). Additionally, we found some evidence (among our MTurk sample but not the field-based sample) that increasing HWL size from 30% to 50% also led to higher quit intentions. This is noteworthy because we are not aware of other experiments that have found that enlarging HWLs, in and of itself, promotes quit intentions. Considered alongside findings from a recent randomized controlled trial that found effects of 50% HWLs on sustained cessation behavior (Brewer et al., 2016), these results offer additional evidence that 50% HWLs may be an effective and thus legally permissible policy for the FDA to implement in the U.S.

Independent of the size manipulation, including an image did not have demonstrable effects on smokers' quit intentions in either sample. Statistical power is not a plausible explanation for our results because trends in the data were not in the right direction. Proportions of participants expressing quit intentions trended lower in the pictorial conditions than the text-only conditions for both samples ($pictorial_{field} = 26.6\%$, $text\text{-}only_{field} = 31.6\%$; $pictorial_{MTurk} = 25.3\%$, $text\text{-}only_{MTurk} = 25.6\%$). Readers should interpret this null finding while bearing in mind the available evidence demonstrating the advantage of pictorial over text-only labels in promoting quit intentions and behaviors. Findings from a meta-analysis of warning label experiments indicate that pictorial warnings do increase quit intentions relative to text-only warnings (Noar et al., 2015). Further, a 4-week trial in the U.S. found that large and prominent pictorial HWLs outperformed smaller and less prominent text-only HWLs in promoting negative affect and quit behaviors (Brewer et al., 2016), which suggests that a short-term study (like ours) may underestimate the effects of pictorial HWLs in naturalistic settings that allow for greater HWL exposure and social diffusion processes (Brewer et al., 2018). Field-based, observational studies in other countries that have implemented pictorial HWLs have

Table 4
Unstandardized coefficients and standard errors (or adjusted odds ratios and confidence intervals) for main effects and interaction excluding control group.

	Negative affect		Risk beliefs		Elaboration		Quit intentions [ORs, 95% CIs]	
	Field-based	MTurk	Field-based	MTurk	Field-based	MTurk	Field-based	MTurk
Condition								
Pictorial (vs. text-only)	.34 (.15)*	.40 (.13)**	.67 (.54)	.08 (.47)	.17 (.12)	.03 (.11)	1.12 [.53–2.32]	1.10 [.50–2.43]
50% (vs. 30%)	−.02 (.15)	.13 (.13)	.88 (.52)#	.67 (.45)	.06 (.11)	.05 (.11)	1.62 [.82–3.22]	2.16 [1.06–4.40]*
Pictorial × 50%	.04 (.21)	.03 (.18)	−1.04 (.73)	−.37 (.65)	−.17 (.16)	.06 (.16)	.65 [.24–1.75]	.92 [.33–2.56]
Constant	1.68 (.36)***	2.79 (.40)***	7.51(1.23)***	5.24 (1.41)***	2.91 (.27)	2.94 (.34)***	.13	.22
R^2	.13	.17	.10	.11	.15	.15	–	–
N	376	405	376	405	376	405	376	405

Note. ORs = odds ratios. CIs = confidence intervals. *$p \leq 0.05$. **$p \leq 0.01$. ***$p \leq 0.001$. Models also controlled for age, gender identity, race, ethnicity, income, educational attainment, cigarette dependence, previous quit attempts, and previous receipt of federally funded programs. R^2 is non-adjusted R^2.

Table 5
Unstandardized coefficients and standard errors (or adjusted odds ratios and confidence intervals) for main effects including control group.

	Negative affect		Risk beliefs		Elaboration		Quit intentions [ORs, 95% CIs]	
	Field-based	MTurk	Field-based	MTurk	Field-based	MTurk	Field-based	MTurk
Condition (vs. control)								
Pictorial conditions	.74 (.10)***	.74 (.09)***	−.02 (.36)	−.10 (.33)	.21 (.08)**	.26 (.08)**	1.26 [.77–2.08]	.95 [.57–1.56]
50% conditions	.42 (.10)***	.49 (.09)***	.27 (.36)	.58 (.33)#	.15 (.08)#	.31 (.08)***	2.05 [1.23–3.42]**	1.82 [1.09–3.05]*
30% text	.62 (.13)***	.51 (.12)***	−.44 (.49)	−.05 (.45)	.20 (.11)#	.31 (.11)**	1.65 [.85–3.27]	.87 [.41–1.82]
Constant	1.16 (.29)***	2.03 (.33)***	6.61(1.06)***	5.30 (1.21)***	2.67(.24)***	2.46 (.30)***	.05***	.25
R^2	.22	.24	.07	.10	.13	.15	–	–
N	473	495	473	495	473	495	473	495

Note. ORs = odds ratios. CIs = confidence intervals. # $p \leq 0.10$. *$p \leq 0.05$. **$p \leq 0.01$. ***$p \leq 0.001$. The reference group for each predictor is the no-HWL control condition. Models also controlled for age, gender identity, race, ethnicity, income, educational attainment, cigarette dependence, previous quit attempts, and previous receipt of federally funded programs. R^2 is non-adjusted R^2.

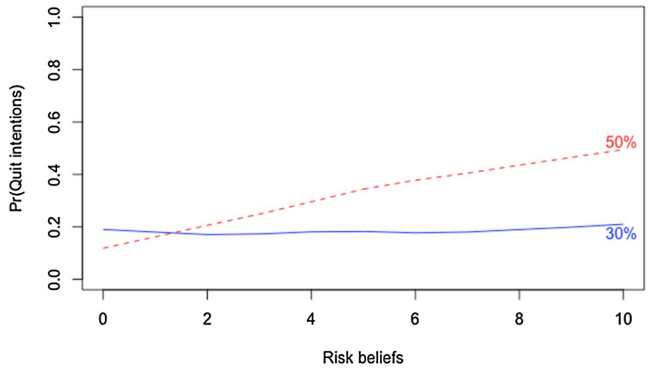

Fig. 2. Plot showing the relationship between risk belief acceptance and the probability of intending to quit smoking as a function of size condition among MTurk participants.
Note: This interaction plot shows smoothed estimates. We observed a similar interaction pattern for HWL size × cognitive elaboration among MTurk participants.

found evidence consistent with population-level effects on cessation-related behaviors, suggesting that these diffusion processes are essential and not adequately captured here (Durkin et al., 2015; Noar et al., 2016).

This raises the question of why a 50% text-only HWL promoted quit intentions in the MTurk sample, but a pictorial HWL did not. Here, it is instructive to consider two mechanisms that communication theorists have identified to explain how strategic health messages influence behavioral outcomes—persuasion and priming (Fishbein and Cappella, 2006; Fishbein and Yzer, 2003). With persuasion, message exposure changes the mean level of a mediating variable (e.g., beliefs), which results in a corresponding change in behavior. The persuasion mechanism is the more common of the two mechanisms in HWL research, yet it does not seem a fitting explanation for the present results because the observed change in MTurkers' intentions between the 30% and 50% conditions was not accompanied by parallel changes in negative affect, risk belief acceptance, or elaboration. It is possible that an unmeasured mediator accounts for the observed changes in intentions, but we measured several concepts identified to be particularly important in Noar et al.'s (2016) meta-analysis.

By contrast, the priming mechanism suggests that message exposure increases the accessibility of existing beliefs, thus enhancing their influence on behavior even if average levels of those beliefs are unchanged. We reason that this mechanism may have been at play in the MTurk sample because relatively larger warnings strengthened the link between thoughts about smoking risks (i.e., acceptance of and elaboration of those risks) and intentions. This finding is important because it speaks to a claim often made by the tobacco companies that smokers are well aware of the health risks associated with tobacco (Cummings et al., 2002)—implying that acceptance of these risks should translate to quitting behavior. Our findings show that increasing HWL size to 50% can strengthen the relationship between risk-related thoughts and quit intentions for at least some low-income smokers (those in the MTurk sample). This would be a compelling reason for implementing large HWLs in the U.S. should future research detect similar interaction patterns.

Although the 50% HWLs outperformed the control group in promoting quit intentions in both samples, the 50% HWLs only outperformed the 30% HWLs in the MTurk sample not the field-based sample. We can only speculate, but the field-based sample was characterized by a much larger degree of socioeconomic disadvantage than the MTurk sample, which may have suppressed any effects on quit intentions (a group for whom quitting may be challenging due to fewer resources or for whom smoking has greater coping value). Future research should explore such explanations in different samples and socioeconomic contexts.

Pictorial HWLs did outperform text-only HWLs in eliciting negative affect, but increasing HWL size from 30% to 50% did not influence this outcome. This pattern of findings replicates previous results (Skurka et al., 2017) and suggests that size and pictorial manipulations likely operate through different mechanisms. One speculative possibility as to why the pictorial manipulation influenced affective responses, but the size manipulation did not is that including an image adds new content (e.g., an indexical representation of the depicted health risk; Messaris and Abraham, 2001), whereas increasing size does not. Another possibility is that the added imagery helps smokers visualize the severity of tobacco-related diseases, which in turn produces greater affective responses than reading textual descriptions of the same afflictions.

Although the size manipulation moderated the association between risk-related thoughts and intentions, we found no main effects of our experimental conditions on risk beliefs. Some evidence suggests that pictorial HWLs exert their impact, at least in the short-term, by provoking an emotional response (Brewer et al., 2018; Emery et al., 2014; Evans et al., 2015; Hall et al., 2017; Romer et al., 2018). Although observational studies tend to find increases in risk acceptance after the implementation of enlarged, pictorial HWLs (Borland and Hill, 1997; Thrasher et al., 2012; White et al., 2008), randomized experiments often fail to find evidence of such an effect (Evans et al., 2015; Hall et al., 2017; Skurka et al., 2017; Wakefield et al., 2012). Perhaps longer periods of exposure are needed to move the needle on this outcome—particularly if increased warning size encourages smokers to engage in more thinking (elaboration) about these risk beliefs over time. Moreover, studies that have experimentally manipulated HWL size have measured different outcomes and compared different sizes (e.g., 20% vs. 33%, 50% vs. 75%; Klein et al., 2015; Kotnowski et al., 2016), making interpretation across studies difficult. Future research should compare a range of sizes using the FDA-proposed labels to explore these notions in greater detail.

4.1. Limitations

Given the many differences between samples, we do not know whether divergent results for our MTurk and field-based samples are attributable to demographic factors (e.g., income, educational attainment, smoking dependence) or method of data collection (e.g., online vs. in-person, demand effects, ability to verify current smoking status). We measured a limited set of smoking-related variables, so future work should explore main and interaction effects on other relevant outcomes that might mediate the effect of enlarged HWLs on intentions (e.g., visual attention, recall, label salience).

Along these lines, this study assessed the effects of HWL changes on intentions to quit, but an important, unanswered question is the extent to which these simultaneous HWL changes would influence smoking initiation among non-smokers (but see Byrne et al., 2017; Skurka et al., 2017). As previously discussed, we also recognize the limitations of our single-exposure design, the immediate measurement of smoking-related outcomes, and the contrived nature of HWL exposure in this study given that smokers may not respond to HWLs in a controlled experimental context the way they would in more naturalistic environments. These limitations underscore the importance of considering findings from tightly controlled experiments like ours alongside population-level studies that shed light on the long-term effects of HWLs in other countries like Canada, Australia, and the United Kingdom (Cappella, 2016; e.g., Hammond et al., 2007, 2003).

4.2. Policy implications

Much HWL research has focused on whether incorporating imagery into HWLs can encourage smokers to quit. Our findings suggest that increasing HWL size in and of itself may be an effective strategy to stimulate quit intentions among at least some groups of low-income smokers, in part by strengthening the relationship between thoughts about smoking risks and quit intentions. Pictorial HWLs may also be advantageous because they evoke negative affect, but these reactions may require longer periods of exposure to translate into quit behavior.

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Contributors

C. Skurka and M. Kalaji led the writing of the manuscript and data analysis. D. Kemp, J., A. G. Safi helped interpret results and contributed to the writing of the manuscript. S. Byrne, R. Avery, M. Dorf, A. Mathios, and J. Niederdeppe conceptualized the study, helped interpret results, and contributed to the writing of the manuscript. All authors read and approved the final version of the manuscript.

Conflict of interest

No conflict declared.

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