Original investigation

Optimizing Warnings on E-Cigarette Advertisements

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Abstract

Introduction: We examined the effect of visual optimizations on warning text recall.
Methods: We used Amazon's Mechanical Turk to recruit 1854 young adult (18–34 years) electronic cigarette (e-cigarette) users or susceptible nonusers. We conducted a between-subjects 3 × 2 × 2 experiment to examine the influence of color (black text on white background [BW] vs. black on yellow [BY] vs. yellow on black [YB]), shape (rectangle vs. novel), and signal word (presence vs. absence of the word "warning"). We randomized participants to view one of 12 warnings on a fictional e-cigarette advertisement. We coded open-ended recall responses into three categories: (1) recalled nothing, (2) recalled something, (3) recalled the concept. We examined main effects on warning text recall using multinomial regression. We examined differences in attention, perceived message effectiveness, and appeal.
Results: Those exposed to BW or BY warnings were more likely than those exposed to YB to recall *something* (AOR = 1.6, AOR = 1.5, respectively) or the *concept* (OR = 1.4, BW). Those exposed to novel shape (44.7% novel vs. 37.9% rectangle; *p* = .003) or color (44.5% BY vs. 41.9% YB vs. 37.5% BW; *p* = .04) warnings were more likely to report attention to the warning. In aided recall, those exposed to the signal word were more likely than those not exposed to select the correct response (64.0% vs. 31.3%; *p* < .0001). We did not find differences for message effectiveness or appeal.
Conclusions: Visual optimizations such as color may influence warning text recall and should be considered for new warnings. Research should continue exploring variations for advertisement warnings to maximize attention to warning text.
Implications: This study examines the impact of visual optimizations on recall of the US Food and Drug Administration-mandated e-cigarette advertisement warning text. We found that color might influence warning text recall, but we did not find effects for shape or signal word. It is possible the newly mandated e-cigarette advertisement warnings, which are required to occupy at least 20% of the advertisement, are currently novel enough to attract attention. Future research should examine optimizations following implementation of the new advertisement warnings.

Introduction

The US Food and Drug Administration (FDA) educates the public about the risk of tobacco products through warnings on tobacco packaging and advertisements.[1] Warnings have been on cigarette advertisements since the 1970s, and have remained visually similar. With the standard Surgeon General's warning design in place for

decades, individuals attune to the familiar rectangle shape, with black text on a white background (BW), and ignore the message content, directing attention toward the more visually appealing portion of the advertisement.[2,3]

As of August 2018, electronic cigarette (e-cigarette) advertisements are required to include a warning.[4] The FDA-mandated warning label for e-cigarette advertisements is a rectangle with either a white background with black text and border or a black background with white text and border, placed on the upper 20% of the advertisement, with the following text: "WARNING: This product contains nicotine. Nicotine is an addictive chemical." The mandated warning is substantially larger than previous cigarette advertisement warnings and may be more effective at attracting attention.

However, e-cigarette companies have already begun to distract consumers from the FDA-mandated warning for e-cigarettes. Blu, a popular e-cigarette brand, released an advertisement campaign in 2017, which included a large rectangle at the top of the advertisement that contained text such as "IMPORTANT: Contains flavor" and "IMPORTANT: No ashtrays needed."[5] It is possible e-cigarette consumers will overlook the FDA-mandated warnings because they are conditioned to think it is part of the advertisement.

Changing the design of advertisement warnings may increase their effectiveness. Studies of cigarettes and smokeless tobacco consistently show that novel color, placement, and size, increase attention to and recall of advertisement warnings.[2,3,6,7] Color has been shown to increase warning readability and risk perceptions.[8,9] Visual communication research has shown that yellow increases harm perceptions and is more effective at attracting attention compared to other colors and black and white.[8–10] In addition, tobacco industry research suggests yellow is most effective for capturing consumer attention and signaling danger.[11] However, it is unclear whether color must be in the background to attract attention, or whether it can be within the text. Thus, it is important to test both variations. To date, only one e-cigarette advertisement experiment has tested color, finding that changing the background color to red increased warning attention among young adults.[12]

The format or shape of the warning may also influence its impact. Visual design theories and warnings research suggest several shapes are potentially more effective than the mandated rectangle for increasing attention and warning recall.[13,14] For example, Riley et al.[14], tested 19 shapes for warnings and identified an inverted triangle as most preferable, whereas Pieters et al.[13], found visually complex features (eg, sharp angles and asymmetrical design) increased attention.

Furthermore, text-based cues within the warning may influence consumers' attention to and interpretation of the warning. Warnings research not specific to tobacco identified differences in meaning conveyed with various signal words (ie, the word that precedes warning text) such as "caution," "warning," or "danger." Some research suggests that the word "warning" conveys serious injury whereas "caution" implies less severe injuries.[15] Some suggest a signal word is necessary for clarity and understanding, whereas others posit a signal word encourages individuals to overlook the remaining text.[2,10,15,16] However, no research has addressed the impact of *eliminating* the signal word.

We sought to determine whether visual optimizations would increase warning recall. Recall is an important precursor to emotional and cognitive reactions, and changes in knowledge, beliefs, intentions, and behavior.[17] Our primary aim was to determine whether variations in color (mandated black text on white background vs. black text on yellow background [BY] vs. yellow text on black background [YB]), shape (mandated rectangle vs. novel shape), or signal word (present vs. absent) influence open-ended recall. Our secondary aims were to examine whether optimizations influenced aided recall, attention, warning appeal, advertisement appeal, and product appeal. We hypothesized those who viewed optimized warnings (BY, YB, novel shape, or absent signal word) would have greater recall, greater attention, greater warning appeal, reduced advertisement appeal, and reduced product appeal than those within the FDA-mandated conditions. We focused exclusively on young adults, who are increasingly likely to use e-cigarettes and report high exposure to e-cigarette advertisements.[18] Further, receptivity to e-cigarette advertising in young adults is associated with later cigarette smoking,[18] and evidence indicates e-cigarette advertisements have targeted this age group.[19] Thus, this is an important population for understanding the implications.

Methods

Sample

Between April and May 2018, we used Amazon's Mechanical Turk (MTurk) to recruit young adults (18–34 years) who reported ever using e-cigarettes or were susceptible to e-cigarette use (defined in the measures section). MTurk (www.mturk.com) is an online marketplace commonly used for data collection in social science and tobacco control research.[20,21] MTurk samples yield high-quality data,[21,22] are demographically more diverse than typical college populations often used to obtain young adult samples,[21] and produce experimental results similar to those of nationally representative studies.[20,23] After reviewing a description of the study, interested MTurk workers were directed to Qualtrics to complete informed consent and a screener survey. Interested MTurk workers were screened to ensure they (1) were between ages 18 and 34 years, and (2) either used e-cigarettes or were susceptible to using e-cigarettes. To increase data quality, we restricted participation to MTurk workers with high approval ratings (ie, >85%), and included attention checks.[22] Participants received approximately $1.00 via MTurk for completing the survey.

Procedure

We conducted a between-subjects 3 × 2 × 2 factorial experiment to examine the influence of color (mandated BW vs. BW vs. YB), shape (mandated rectangle vs. novel shape), and signal word (presence vs. absence of the word "warning") on warning text recall.

Preexperiment

To create warnings for the main experiment, in February 2018, we conducted a pretest to select the novel shape and color. To test seven warning shapes and three shades of yellow, we surveyed 285 young adults who reported ever using e-cigarettes or susceptibility to e-cigarette use via MTurk. We randomized participants to view one of seven warning shapes, developed using visual communication theory principles, on our fictional e-cigarette advertisement. We did not find significant differences for warning text recall across the seven shapes. At the end of the survey, we presented all seven warnings to participants and asked which best attracted their attention, a potential predictor of recall (Supplementary Material).[6,17] The warning with a triangle and exclamation point was selected as the most attention getting (44%). To determine the shade of yellow,

we exposed participants to three shades of yellow (true yellow, dark yellow, and light yellow), for both BY and YB and asked about readability and attention for each. True yellow (cyan: 0, magenta: 0, yellow: 100, black: 0) was selected in both BY and YB as most attention getting (77%) and easiest to read (55%; Supplementary Material). Those who completed the pretest were not eligible to complete the full survey.

Main Experiment

All warnings in the main experiment were shown on a fictional e-cigarette brand advertisement created by our team to mimic existing e-cigarette brands and advertisements (Supplementary Material). We used the same advertisement across all experimental conditions. To reduce the likelihood participants would become aware the study was on e-cigarettes, we created two fictional decoy advertisements (ie, soft drink and cough syrup), each of which contained a warning visually similar to the FDA-mandated warning. We randomized participants to one of 12 warning conditions for our e-cigarette advertisement, each containing the FDA-mandated nicotine warning text (Figure 1). Participants were shown this advertisement in a random order with the two decoy advertisements. After viewing each of the three advertisements, participants responded to items about the advertisement (ad appeal, product appeal, likelihood of purchase). After viewing all three advertisements, we displayed the e-cigarette advertisement again, with the warning text covered, and measured open-ended recall. We then showed the e-cigarette advertisement again with the warning exposed, and asked participants to respond to items about the e-cigarette advertisement warning (perceived message effectiveness, brand trustworthiness). Finally, we asked participants about their attention to the e-cigarette advertisement.

Measures

Recall

Our primary outcome was warning text recall. Participants were shown the advertisement with the warning masked in red and asked to respond to the following open-ended item: "The red area at the top of this advertisement contained a text warning. Please type the text you remember, as accurately as possible, in the space below."

Following open-ended recall, we asked participants to select from a list which warning text they saw on the e-cigarette advertisement (aided recall). Response options were *Warning: This product contains nicotine. Nicotine is an addictive chemical* (correct for those in the "signal word" conditions); *This product contains nicotine. Nicotine is an addictive chemical.* (correct for those in the "no signal word" conditions); *E-cigarette use while pregnant can harm you and your baby* (incorrect); *Warning: E-cigarettes contain nicotine, an addictive chemical* (incorrect); and *None of the above* (incorrect). For analyses, we dichotomized responses into correct or incorrect.

Attention

We asked participants to select the area on the advertisement that best attracted their attention. Using the hot spot feature in Qualtrics, we identified, a priori, seven locations on the advertisement (warning, woman holding device, vapor imagery, ad slogan, brand logo, e-cigarette device, or elsewhere). Participants selected an area by clicking on the advertisement displayed on the screen. For analyses, we dichotomized responses into selecting the warning (yes) or not (no).

Warning Perceptions

We asked participants items specific to the advertisement warning, including perceived message effectiveness[24] (*makes e-cigarette or*
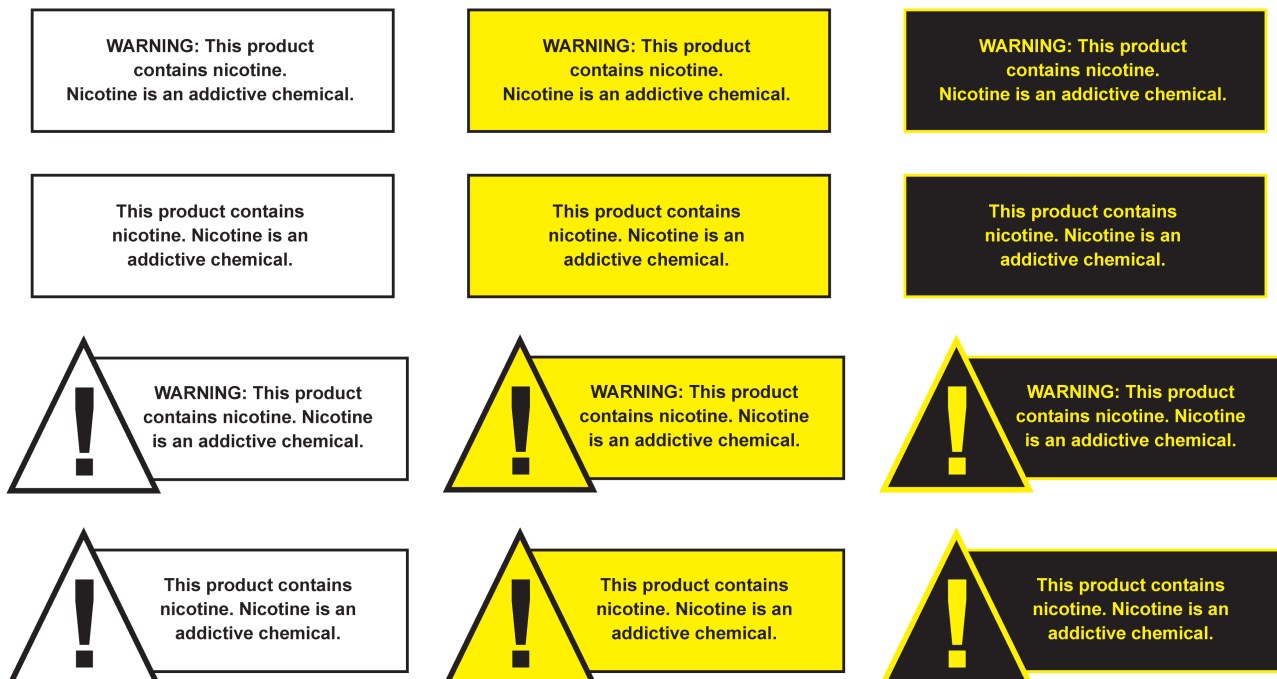

Figure 1. Twelve warning conditions from full experiment.

vaping use seem unpleasant to me; makes me concerned about the health effects of e-cigarette use or vaping; discourages me from wanting to use e-cigarettes or other vaping devices) and whether the warning increased the trustworthiness of the ad.[25] Each item included 5-point Likert response options ranging from strongly disagree (1) to strongly agree (5).

Advertisement and Product Appeal

To ensure warnings did not have unintended effects, we assessed reactions to the advertisement with items for advertisement appeal (How appealing is this advertisement to you?), product appeal (How appealing is this product to you?), and likelihood of purchasing the product (How likely are you to buy this product?).[26] Each item included 5-point Likert response options.

E-Cigarette Use

We assessed e-cigarette use as part of the screener for participant inclusion. Susceptible users were defined as those who answered "definitely yes," "probably yes," or "probably no" to any of the following five items shown to predict cigarette smoking experimentation: (1) Do you think that you will use e-cigarettes or other vaping devices soon?; (2) Do you think that in the future you might experiment with e-cigarettes or other vaping devices?; (3) At any time during the next year do you think you will use e-cigarettes or other vaping devices?; (4) If your best friend were to offer you an e-cigarette or other vaping device, would you use it?; or (5) Have you ever been curious about using e-cigarettes or other vaping devices?[27,28] Ever e-cigarette users reported ever trying e-cigarettes or other vaping devices, even one or two puffs, but did not report past 30-day use. Current users reported past 30-day use of e-cigarettes or other vaping devices.

Demographic Variables

We measured age (continuous variable), sex (male or female), race (white alone, black alone, or other), ethnicity (Hispanic or not Hispanic), income (<$50 000 or ≥$50 000), and sexual orientation (heterosexual, LGB+) as potential covariates.

Analyses

Descriptive statistics for demographic and design factors are presented. Multinomial logistic regression models were used to examine the main effects of color, shape, and signal word on a three-category warning text recall response detailed below. We first examined effects of advertisement display order, which were not statistically significant. We then fit models adjusted for age, gender, race, sexual orientation, income, and e-cigarette use status. Next, we tested interactions between the three design factors. Finally, we examined differences in perceived message effectiveness and attention by color, shape, and marker word using analysis of variance and pairwise *z*-tests of least square means. For aided recall, we performed chi-square tests of independence.

Coding

On the basis of previous research on cigarette advertisement warnings,[29,30] we coded responses to the open-ended warning recall item using the following three categories: (1) recalled nothing correct from the warning, (2) recalled something from the warning (eg, this contains nicotine), (3) recalled the warning concept (eg, linked the product to nicotine and addiction) or the exact text. Participants' responses that included partial warning information (eg, the words

nicotine and/or addiction), but not the complete warning concept (eg, product has nicotine which is addictive), were coded as 2. Responses coded as 2 included both factually correct (eg, tobacco is addictive) and incorrect (eg, nicotine causes cancer) statements. Responses that contained the warning text verbatim, with grammatical differences, or with the full concept were coded as 3. Thus, a higher score indicates greater recall. Two coders independently coded all responses (κ = 0.87), with all discrepancies decided upon by a third coder or resolved by the full study team.

Results

Sample Characteristics

Between April and May 2018, 5485 participants completed the screener survey. Of those, 2080 (37.9%) were eligible to complete the full survey. After deleting surveys with duplicate MTurk IDs (*n* = 19, 0.9%), or incorrect attention checks (*n* = 206, 9.9%), our final sample was 1854. Participants were 52.7% male, 76.0% white, 14.1% Hispanic, 81.9% heterosexual, and 54.4% with household income greater than $50 000 (Table 1). Most (74.8%) reported ever using e-cigarettes. Of those, 26.0% reported past 30-day e-cigarette use, the majority of whom reported daily or almost daily (46.9%) or weekly (33.0%) use. Approximately 40% of the sample reported other tobacco use, which is common among e-cigarette users.[31] In sensitivity analyses, recall, condition, and outcomes did not differ among those who used other tobacco products compared to those who did not use other products. Therefore, this was not included in additional analyses.

Recall

Most respondents recalled the concept (43.2%; coded as 3) or recalled something (37.5%; coded as 2) from the warning text, though 19.3% recalled nothing correct (coded as 1; Table 2). We found main effects for color but not shape or signal word (Table 3). Participants exposed to BW or BY were more likely than those exposed to YB to

Table 1. Sample Characteristics

	Sample characteristics (*N* = 1854)
Age (*n* = 1854)	27.7 (4.1)
Sex (*n* = 1852)	
Male	976 (52.7%)
Female	876 (47.3%)
Race (*n* = 1845)	
White	1403 (76.0%)
Black	189 (10.2%)
Other	253 (13.7%)
Ethnicity (*n* = 1842)	
Not Hispanic	1583 (85.9%)
Hispanic	259 (14.1%)
Income (*n* = 1839)	
<$50 000	1000 (54.4%)
≥$50 000	839 (45.6%)
Sexual orientation (*n* = 1839)	
Heterosexual	1507 (81.9%)
LGB+	332 (18.1%)
E-cigarette user status (*n* = 1854)	
Susceptible never user	467 (25.2%)
Ever user	905 (48.8%)
Current user	482 (26.0%)

Table 2. Recall Scores by Factors and Demographic Characteristics

	Recall score 1 *n* (%) or mean (SD)	Recall score 2 *n* (%) or mean (SD)	Recall score 3 *n* (%) or mean (SD)
Full sample	358 (19.3%)	695 (37.5%)	801 (43.2%)
Color			
Black on white	102 (16.6%)	238 (38.7%)	275 (44.7%)
Black on yellow	117 (18.8%)	254 (40.8%)	252 (40.4%)
Yellow on black	139 (22.6%)	203 (33.0%)	274 (44.5%)
Shape			
Rectangle	170 (18.4%)	351 (38.0%)	402 (43.6%)
Novel	188 (20.2%)	344 (36.9%)	399 (42.9%)
Signal word			
Present	184 (19.7%)	344 (36.9%)	404 (43.3%)
Absent	174 (18.9%)	351 (38.1%)	397 (43.1%)
Age	27.9 (4.0)	27.7 (4.1)	27.6 (4.1)
Sex			
Male	197 (20.2%)	360 (36.9%)	419 (42.9%)
Female	161 (18.4%)	333 (38.0%)	382 (43.6%)
Race			
White	253 (18.0%)	527 (37.6%)	623 (44.4%)
Black	55 (29.1%)	69 (36.5%)	65 (34.4%)
Other	47 (18.6%)	95 (37.4%)	111 (43.9%)
Ethnicity			
Not Hispanic	291 (18.4%)	601 (38.0%)	691 (43.7%)
Hispanic	66 (25.5%)	86 (33.2%)	107 (41.3%)
Income			
<$50,000	184 (18.4%)	365 (36.5%)	451 (45.1%)
≥$50,000	171 (20.4%)	326 (38.9%)	342 (40.8%)
Sexual orientation			
Heterosexual	295 (19.6%)	572 (38.0%)	640 (42.5%)
LGB+	61 (18.4%)	114 (34.3%)	157 (47.3%)
E-cigarette user status			
Susceptible never user	97 (20.8%)	145 (31.0%)	225 (48.2%)
Ever user	163 (18.0%)	360 (39.8%)	382 (42.2%)
Current user	98 (20.3%)	190 (39.4%)	194 (40.2%)

Recall score 1 = recalled nothing correct from the warning; recall score 2 = recalled something from the warning; recall score 3 = recalled the warning concept.

recall something (coded as 2) from the warning (AOR = 1.6, 95% CI = 1.2 to 2.2; AOR = 1.5, 95% CI =1.1 to 2.1). In addition, those exposed to BW were more likely than those exposed to YB to recall the correct concept compared to recalling nothing (OR = 1.4, 95% CI = 1.0 to 1.9); this finding was no longer significant in adjusted models. We also found an interaction effect for signal word on color. Specifically, participants exposed to BW or BY were more likely than those exposed to YB to recall something (coded as 2) from the warning when the signal word was present (AOR = 2.5, 95% CI = 1.6 to 3.9; AOR = 2.2, 95% CI = 1.4 to 3.4), but not when it was absent (AOR = 1.0, 95% CI = 0.6 to 1.6 and AOR = 1.0, 95% CI = 0.6 to 1.6).

While coding the open-ended recall responses, we identified several unanticipated responses. Several (*n* = 312, 16.8%) participants identified a health effect not specified within the warning text within their response, including 146 (7.9%) who used the word "cancer" (eg, nicotine causes cancer); 147 participants (7.9%) who replaced "this product" with other tobacco-related terminology, including "e-cigarettes" or "smoking" or "vaping"; and 32 (1.7%) who included the word "additive." These unanticipated responses did not vary by color, shape, or signal word.

For aided recall, those exposed to rectangle warnings were more likely than those exposed to novel shape warnings to correctly identify the warning text (50.5% vs. 45.0%; *p* = .017). Those exposed

to warnings with the signal word were more likely than those exposed to warnings without the signal word to correctly identify the warning text (64.0% vs. 31.3%; *p* < .0001). Notably, 77.2% of those in the no signal word condition incorrectly selected the response option: "WARNING: This product contains nicotine. Nicotine is an addictive chemical." We did not find differences in aided recall by color conditions (48.9% BW vs. 48.3% BY vs. 45.9% YB; *p* = .54).

Attention

When asked to select the area of the advertisement which most attracted their attention, those exposed to BY warnings were more likely than those exposed to other warning color conditions to select the warning as attracting their attention (44.5% of BY vs. 41.9% of YB vs. 37.5% of BW; *p* = .04). In addition, those exposed to novel shape warnings were more likely than those exposed to rectangle warnings to select the warning as attracting attention (44.7% novel vs. 37.9% rectangle; *p* = .003). We did not find differences in reported attention to the warning between those exposed to the signal word and those not exposed to the signal word (40.5% vs. 42.2%, *p* = .43).

Warning and Advertisement Perceptions

The warning styles did not impact perceived message effectiveness of the warning. Overall, the warnings were all perceived as moderately

Table 3. Unadjusted and Adjusted Odds for Warning Text Recall by Factor

	Unadjusted odds for recall score 2 vs. 1 OR (95% CI)	Adjusted odds for recall score 2 vs. 1 AOR (95% CI)	Unadjusted odds for recall score 3 vs. 1 OR (95% CI)	Adjusted odds for recall score 3 vs. 1 AOR (95% CI)
Color				
BW vs. BY[a]	1.07 (0.78 to 1.48)	1.07 (0.78 to 1.48)	1.25 (0.91 to 1.72)	1.26 (0.92 to 1.74)
BW vs. YB[a]	**1.59 (1.16 to 2.19)**	**1.61 (1.17 to 2.23)**	**1.36 (1.01 to 1.85)**	1.35 (0.99 to 1.84)
BY vs. YB[a]	**1.48 (1.09 to 2.02)**	**1.50 (1.10 to 2.06)**	1.09 (0.81 to 1.47)	1.07 (0.79 to 1.45)
Shape				
Rectangle vs. novel[a]	1.12 (0.87 to 1.45)	1.14 (0.87 to 1.47)	1.11 (0.86 to 1.43)	1.15 (0.89 to 1.49)
Signal word				
Present vs. absent[a]	0.93 (0.72 to 1.20)	0.90 (0.69 to 1.17)	0.96 (0.75 to 1.24)	0.94 (0.73 to 1.21)

Bold indicates *p* < .05. Adjusted analyses control for age, sex, race, income, sexual orientation, and e-cigarette user status. AOR = adjusted odds ratio; BW = black text on white background; BY = black text on yellow background; CI = confidence interval; OR = odds ratio; YB = yellow text on black background.
[a]Reference group.

effective (*M* = 3.5, SD = 1.3). Across variations in color, shape, and signal word, we did not find significant differences in ad appeal (*M* = 2.9, SD = 1.3), product appeal (*M* = 2.8, SD = 1.3), likelihood of purchasing the product (*M* = 2.3, SD = 1.3), or brand trustworthiness (*M* = 3.3, SD = 1.2).

Discussion

E-cigarette marketing targets and reaches millions of young adults annually.[32,33] Exposure to e-cigarette advertising influences perceptions and increases the likelihood for experimentation and use.[18,34] FDA-mandated warnings on e-cigarette advertisement may help educate young adults about the risks of e-cigarette use, however, the warnings must be attended to and remembered to have an impact. We modified the FDA-mandated e-cigarette advertisement warning in three areas: color, shape, and signal word. Color of the warning significantly influenced recall of the warning text. Specifically, among those exposed to the signal word, those exposed to the black text on white or yellow backgrounds had greater warning text recall than those exposed to the yellow on black warnings. Although our study suggests warning color plays a role in recall, we could not tease out the unique influence of having a signal word before the warning.

More than 40% of participants correctly recalled the concept of the FDA-mandated warning text—the product has nicotine, and nicotine is addictive—when shown on an e-cigarette advertisement designed to appeal to young adults. An additional one-third of participants were able to recall at least some of the warning. These findings indicate that most participants were attending to, reading, and perhaps understanding the warning, regardless of the warning format. Warning recall rates in this study were slightly higher than those previously reported for cigarette advertisements,[30,35] possibly because of the novelty of the warning and its context. The warnings in this study were shown at the newly mandated larger size (20%) and placement (at the top), which may have contributed to higher recall.[36]

Although many were able to recall the warning wholly or in part, we had several introductions of *new* information within our open-ended recall. Some respondents generalized the text "this product" to other tobacco or vape products, some generalized the warning to other health effects such as cancer, and some included the word additive either in addition to or instead of the word addictive. Extending or generalizing the warning text to other tobacco products could

mean that users view a warning for one tobacco product and make assumptions that it applies to other tobacco products, unable to distinguish between harms for one tobacco product versus another. This suggests it may be important to examine warnings that use specific terms such as "e-cigarettes" rather than "this product" to reduce generalizing across tobacco products.

In addition, more than 16% of participants included health effects not listed within the warning text (eg, cancer, pregnancy complications) when openly recalling the advertisement warning. Past research has identified misperceptions surrounding nicotine (eg, it is the nicotine in cigarettes that cause cancer).[37–40] It is possible participants heuristically recalled previously held misperceptions when trying to remember the warning; these responses were perhaps the most mentally accessible harms.[41,42] Following this same logic, participants may have transferred to other health claims because of their familiarity with other warnings (eg, cigarette warnings about pregnancy or general health harm). An alternate explanation for the not-listed, but recalled, health effects is that they were the result of negative health "halos"—when consumers transfer salient claims to general holistic impressions or beliefs about unrelated attributes or effects (eg, claim of addiction translated into cancer risk).[43–45]

Moreover, there were a number of instances of participants using "additive" when openly recalling the warning. We are not aware of other literature that mentions additive instead of or in addition to addictive (eg, addictive additive) when participants recall tobacco warnings or anti-tobacco advertising. If even a small portion of users and susceptible nonusers misinterpret this warning to mean "additive," instead of nicotine being addictive, this has serious implications, as this is the only FDA-mandated warning for multiple tobacco products. Future research should explore whether this is an isolated finding or whether these were simply misspellings.

We found some differences among those exposed to the signal word compared to those not exposed to the signal word for aided recall. Regardless of whether the signal word was present, participants selected the text with the word "warning." This may suggest that the word "warning" is implied when attending to the warning text, even if it is not present. More research is necessary to distill this finding, including testing other signal words such as "caution" or "danger"; however, the implications for removing the signal word on tobacco warnings may lead to additional space for important warning content.

Advertisement attention varied in ways we expected: reported attention to the warning was more common among those exposed to BY warnings than those exposed to BW warnings, and among those exposed to novel shape warnings—with the addition of a commonly used signal icon to indicated danger (triangle with exclamation)—compared to rectangle warnings without the icon. Following hierarchy of effects models, increasing attention is the first step for influencing perceptions and behavior necessary for increasing public health.[46,47] Thus, changing the background color of warnings shows promise as a technique to increase the likelihood the public will attend to important risk information, though it might not be the specific color, rather the presence of color that garners attention through implied risk.[9] Specific to e-cigarette advertisement warnings, we found yellow to increase attention; Mays et al.[6] found a similar increase in attention using a red background. Although a promising minority of participants (>37%) within our sample reported the warning attracted their attention, most devoted their focus to other areas of the advertisement (eg, female, vapor). However, even a slight increase in attention (a second or two) can, over time, have a large impact on consumer perceptions and behavior.[48,49]

We did not find significant differences for perceived message effectiveness for the warning. In general, warnings were perceived as moderately effective. In addition, ad appeal, product appeal, likelihood of purchasing, and brand trustworthiness did not vary by warning conditions. These initial findings may indicate warning variations do not affect brand or advertisement appeal, which could potentially limit legal arguments from the tobacco industry that the warnings are infringing on brand communication.

This study is not without limitations. Warning recall measured after a single exposure does not replicate the "real world," where young adults would be repeatedly exposed to this same warning on a variety of advertisements and marketing materials. In addition, although novel insights were uncovered in the open-ended recall responses, it is important to note these unanticipated responses may not be actual effects (eg, halo effects), and instead a result of not recalling the warning text and simply writing something to complete the survey item. Finally, we did not examine participants' perceptions regarding nicotine. Future studies may explore how nicotine perceptions influence recall and attitudes.

Future research may consider testing warnings on additional advertisements. Our study had one e-cigarette advertisement; it is possible the warning optimizations would have different results on a different advertisement background. Future research may also consider examining recall after the mandated warnings are in place; although blu e-cigarettes and smokeless tobacco products have had larger sized warnings or statements on advertisements for an extended period of time, overall, the larger warning size is still relatively novel. It is possible the optimizations tested here would increase effectiveness as consumers become more accustomed to larger warnings on advertisements. Finally, using more objective measures for attention, such as eye tracking, may reveal different patterns of results with important implications for exposure and downstream effects of the warnings. Given the single exposure, future studies should investigate whether repeated exposure results in greater attention and higher recall. Notwithstanding, these findings are encouraging as potential ways to optimize warnings for their public health impact.

Supplementary Material

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

Declaration of Interests

There are no conflicts of interest to report for this study.

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