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Scot Burton

University of Arkansas - Fayetteville

J. Craig Andrews

Marquette University, craig.andrews@marquette.edu

Richard G. Netemeyer

University of Virginia - Charlottesville

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Identifying and Selecting Effective Graphic Health Warnings to Prevent Perceptual Wearout on Tobacco Packaging and in Advertising

Scot Burton

Department of Marketing, University of Arkansas, Fayetteville, Arkansas

J. Craig Andrews

Department of Marketing, Marquette University, Milwaukee, Wisconsin

Richard G. Netemeyer

McIntire School of Commerce, University of Virginia, Charlottesville, Virginia

Abstract

Graphic visual health warnings (GHWs) on cigarette packaging are used in more than 120 countries globally. Because there are concerns about the effectiveness of using the same visual warnings over many years due to

wearout, a primary issue is how to identify the most effective visual stimuli. Adolescent smokers and nonsmokers provided more than 2000 ratings of different visual warnings. Cluster analysis and follow-up analyses are used to identify a high-performing visual stimuli group from the larger group of GHWs. Subsequent analyses also show that compared to other pictorial stimuli, the high-performing group is perceived as effective in preventing adolescent smoking initiation and adolescent smokers' motivation to quit. These findings addressing the selection and evaluation of high-performing visual warnings have implications for global health and public policy communities through identification of pictorial warnings that can be most effective in impacting smoking-related outcomes for adolescents.

The Framework Convention on Tobacco Control (FCTC) requires those signing the treaty to adopt and implement large, clear, and rotating health warnings on all tobacco products within 3 years of FCTC ratification (World Health Organization [WHO], **2003**). Graphic pictorial health warnings (GHWs) are now used by more than 120 countries, and research has shown that they are effective in helping to reduce tobacco use and preventing adolescents from beginning to smoke (Tobacco Free Kids, **2020**). Because almost 90% of current U.S. adult smokers try their first cigarette before the age of 18, adolescent smoking behavior is of substantial concern to the public health community (SAMSHA, **2011**). Sadly, cigarette smoking remains the leading cause of preventable death in the United States and worldwide [Department of Health and Human Services (DHHS), **2020**].

Because tobacco control agencies in countries using GHWs need to rotate effective visuals into use to prevent wearout from repetitive exposure to static images, a critical issue is *how* to identify GHWs that will be effective in accomplishing health-related objectives. While use of GHWs has remained an ongoing issue in the United States with court cases blocking their use and continuing litigation (FDA, **2019**), many countries have used GHWs for years and need to replace and update visual stimuli. Research also indicates that using new visual stimuli helps to maintain warning effectiveness over time (Woelbert and d'Hombres, **2019**). In general, testing a limited number of GHWs, and without determining the attribute evaluations that underlie *why* a visual is effective, limits health policy decisions from maximizing desired outcomes. Because hundreds of visual images could serve as possible candidates for use, developing a concise, efficient methodology for selection of GHWs is an important goal for tobacco control and public health officials worldwide. This research proposes a methodology for selecting specific pictorial warnings and provides tests of its effectiveness. By focusing directly on the selection of the pictorial component, we make use of measures that extend beyond existing advertising-based, perceived message effectiveness items (see Davis *et al.*, **2011**).

We propose that GHW pictorial stimuli must satisfy certain criteria that will, in turn, have favorable effects on smoking related beliefs and intentions. First, as shown in prior research, GHWs should be perceived as at least moderately graphic by relevant target markets to affect downstream outcomes (Davis and Burton, **2016**; Netemeyer *et al.*, **2016**). We define graphic level as “the stimulus depiction that features a vivid pictorial representation of the consequences of smoking” (Kees *et al.*, **2010**). Prior research suggests that increasing the perceived graphic level of pictorial warnings leads to greater intentions to quit and negative attitudes toward smoking (Borland *et al.*, **2009**; Hammond, **2011**; Andrews *et al.*, **2016**; Gallopel-Morvan *et al.*, **2018**). Second, a strong fit or congruence between the warning text message and the pictorial should lead to favorable effects on downstream outcomes. Coordination of integrated marketing communications elements is important, and a lack of synergy for the intended audience can lead to discounting of the message (Andrews and Shimp, **2018**). Third, the believability of the visual warning is critical in affecting communication persuasion, and it is especially true for tobacco warnings (Beltramini, **1988**; Atkin and Beltramini, **2007**). Lastly, evidence from GHW experiments suggests a positive relationship between fear-arousing conditions and GHW effectiveness (Kees *et al.*, **2010**; Andrews *et al.*, **2016**). Although some past research has shown a negative quadratic effect in which evoked fear

can become *too high* (Henthorne *et al.*, 1993), in a meta-analysis of more than 100 articles on fear appeals, it was concluded that the stronger the level of fear aroused by an appeal, the more persuasive it will be (Witte and Allen, 2000). Similarly, prior GHW research has supported this monotonic effect for vulnerable users, such as adolescent smokers (Andrews *et al.*, 2014). These criteria have been acknowledged as important factors in enhancing the persuasive effectiveness of public health communications (Fong *et al.*, 2009; Andrews and Shimp, 2018). In sum, our objective is to offer an effective and unique methodology to demonstrate how these criteria can be integrated to select specific, high-performing pictorial warnings when compared to other pictorial stimuli.

1 METHODS

Participants and procedure

Adolescents ranging in age from 13 to 18 in the United States served as participants in this study. Participation was obtained through a professional online market research firm that maintained a large panel of adolescents and was experienced in research with teens. The firm obtained permission to participate from parents prior to obtaining consent from the adolescents following the protocol and methodology approved by a university IRB. In the main portion of the study, each adolescent participant was exposed to one of three different warning statements and then were shown nine visual stimuli that could be used in conjunction with the specific text warning. Participants responded to a selected set of evaluative questions for each of the nine pictures, and the specific text warning and picture could be seen as they responded to the questions.¹ Stimuli were drawn from pictorial images currently used throughout the world available online and those that had been proposed for use in the United States. In addition, the order of exposure to these visual stimuli was randomized. The visuals represented three diverse warning statement themes of interest globally for tobacco control: addictiveness, lung cancer, and secondhand smoke harming children (Canadian Tobacco Labelling Resource Center, 2020). In an initial pilot test, a group of 54 visuals for these themes (18 for each theme) were first discussed and ranked by six adolescents (selecting their top six visuals on graphicness and congruence with the text). They then were evaluated by four experts in the field (based on rankings of strong, moderate, or weak on graphicness and fit for all visuals). This initial vetting was used to reduce the group to 27 total visuals, with nine stimuli selected for each of the three warning themes.

For the main study, we used stratified sampling to obtain participants in three age groups (13–14, 15–16, and 17–18), gender (50% male; 50% female), and smoking status (approximately 50% smoker; 50% non-smoker). To qualify as a smoker, the adolescent respondent had to have smoked a cigarette in the past 30 days (Pierce *et al.*, 1996). A total of 229 adolescents participated in the study, and each evaluated nine pictorial stimuli.

Measures

Drawing from prior research (Kees *et al.*, 2010; WHO, 2014), we sought to develop a parsimonious set of measures that could be used by public health agencies worldwide. The four clustering measures used to form clusters were graphic level, perceived fit/congruence between the statement and picture, believability of the visual warning, and evoked fear. All were based on prior scales, and items are shown in Appendix A. Means for the multi-item measures were used in subsequent analyses.

Three measures were used as perceived effectiveness outcome variables to assess how well the clusters of pictorial stimuli predicted these effectiveness measures used for validation (Hair *et al.*, 2018). Each of these outcome measures were *not included* as part of the initial pictorial clustering analyses. Consistent with prior literature (Kees *et al.*, 2010), two items measured whether the stimuli would “help teenage smokers quit smoking” and “be effective in helping teenagers from starting to smoke” (seven-point scales with endpoints of “Strongly Disagree” to “Strongly Agree”). The final measure was specific to adolescents who currently smoked

and measured whether the visual stimuli would “help me quit smoking” (seven-point scale; “Strongly Disagree” (1) to “Strongly Agree” (7)). Such behavioral intention and effectiveness measures are important as they go beyond the specific clustering variables used.

2 RESULTS

Clustering of pictorial stimuli

A series of cluster analyses was performed on the four clustering variables shown in Appendix A. For these cluster analyses, measures were aggregated across smoker designation, age, and gender. A hierarchical clustering procedure was first performed to identify initial seed values (Hair *et al.*, 2018). We then conducted a K-means nonhierarchical cluster algorithm using those seed values determined by the hierarchical cluster procedure. We initially examined results for two through six cluster solutions. To validate these cluster results, we performed analyses of variance (ANOVAs) using the cluster membership as independent variables and the downstream outcome measures as dependent variables (Hair *et al.*, 2018).

All cluster results showed a very high performing group (i.e., pictorial stimuli rated more highly on all four clustering variables) and a low performing group emerged for each of the GHW visual stimuli. Means for each clustering variable are shown in Table 1 for the three through five cluster solutions. Table 1 shows visual warning stimuli clusters that scored high (labeled as “High Performing Visuals”) on each of the four clustering variables. The mean scores for the visuals in the high performing clusters were significantly greater than the means of the other clusters (the low performing and moderate performing clusters) for graphic level, integration with the warning message, and fear-evoking potential measures. Note results for high and low performing clusters are consistent across the three, four, and five cluster solution. Similarly, believability of the high performing visuals was higher than the means for the other clusters of visuals (Bonferroni contrasts; $p < .01$) in the three and four cluster solutions. However, in the five cluster solution, believability was similar between the high and moderate performers.

TABLE 1. Clusters of package warning visuals based on graphic level perception, picture believability, integration with text warning message, and perception of evoked fear

| | Graphic level | Integration with warning message | Picture believability | Potential perceived fear |
|--|-------------------|----------------------------------|-----------------------|--------------------------|
| 3-cluster solution | | | | |
| High performing visuals ($n = 671$ ratings) | 6.00 ^a | 6.03 ^a | 6.01 ^a | 5.92 ^a |
| Moderate performers ($n = 712$) | 3.40 | 4.45 | 4.11 | 3.42 |
| Low performers ($n = 678$) | 1.49 ^b | 2.06 ^b | 1.80 ^b | 1.49 ^b |
| <i>F</i> -value (Eta-square) | 3,288.3* (.762) | 1919.2* (.651) | 2,117.0* (.673) | 3,121.5* (.752) |
| 4-cluster solution | | | | |
| High performing visuals ($n = 576$) | 6.16 ^a | 6.33 ^a | 6.31 ^a | 6.09 ^a |
| Moderate performers ($n = 563$) | 4.41 | 5.09 | 4.77 | 4.38 |
| Believable; low graphic ($n = 287$) | 2.04 | 4.18 | 3.98 | 2.15 |
| Low performers ($n = 655$) | 1.52 ^b | 2.03 ^b | 1.68 ^b | 1.51 ^b |
| <i>F</i> -value (eta-square) | 3,085.0* (.818) | 1,598.8* (.700) | 1802.2* (.724) | 2,850.4* (.806) |
| 5-cluster solution | | | | |
| High performing visuals ($n = 671$) | 6.45 ^a | 6.50 ^a | 6.53 ^a | 6.47 ^a |
| Moderate performers ($n = 426$) | 5.00 | 5.28 | 5.20 | 4.79 |
| Believable; low graphic ($n = 252$) | 1.79 | 4.89 | 4.53 | 1.90 |

| | | | | |
|--|-------------------|-------------------|-------------------|-------------------|
| Low performers ($n = 373$) | 3.86 | 3.61 | 3.27 | 3.90 |
| Extremely low performers ($n = 589$) | 1.42 ^b | 1.91 ^b | 1.56 ^b | 1.42 ^b |
| F-value (eta-square) | 2,851.1*(.847) | 1,299.8*(.717) | 1,619.8*(.759) | 2,712.3*(.841) |

Note: Clusters are based on the ratings of visual images (2,061 total ratings of 27 unique pictures).

* $p < .001$.

^a High performing visuals are significantly higher than all other pictorial warning groupings ($p < .01$ for Bonferroni contrasts).

^b Low performing visuals are significantly lower than all other pictorial warning groupings ($p < .01$ for Bonferroni contrasts).

Examples of high performing visual stimuli that emerge from each of the cluster solutions are shown in Panel A of Figure 1. The smoker with the hole in the throat represents smoking addiction and would be associated with the text message of “Smoking is Addictive.” The “boy in bag” is associated with the warning “Tobacco smoke can harm your children.” The two pictures of the normal versus diseased lung represent the warning statement, “Cigarettes cause fatal lung disease.” It should be noted that all the pictures in panel A of Figure 1 do appear very graphic in nature while fitting well with the appropriate warning message statement.

Panel A: High Performing Visuals



Hole in Throat



Healthy Lungs vs. Smoker's Lungs



Crying Boy in Bag



Healthy vs. Diseased Lungs

Panel B: Low performing visuals.



Woman Smoking in Rain



Red Puppet



Doctor Examining Chest X-ray



Woman Coughing

FIGURE 1 Examples of high and low performing visuals. (a) High performing visuals; (b) low performing visuals. Note: In panel (a), “hole in throat” represents the addictiveness of smoking. The “crying boy with bag” represents the harmfulness of secondhand tobacco smoke to children. Both comparative lung pictures are associated with the risk of smoking causing fatal lung disease. Because of the opportunity for graphic, potentially

impactful pictures that relate to lung disease, a number of the pictures associated with this warning statement were clustered in the high performing group. In panel (b), the top two pictures were tested as potentially associated with the addictiveness of smoking. The bottom two (X-ray and woman coughing) were related to risk of smoking causing lung disease and emphysema

Examples of the lowest performing visuals are offered in panel B of Figure 1. As the means in Table 1 show, these visual stimuli performed poorly in their graphic depiction, generally were not perceived as integrated with the message, and were relatively low in believability. For instance, the picture of the woman smoking in the rain is meant to depict smoking addiction, but results suggest that it is not perceived as graphic and not a strong fit with addictiveness. Similarly, the woman coughing (to fit with smoking and lung disease) is non-graphic and could easily be associated with a person who has a cold or flu.²

Cluster validation: Effect of visual warning categorization on effectiveness measures

Because clustering algorithms maximize differences based on the levels of the clustering variables, it is important to demonstrate the usefulness of the clustering solution on measures that are *not* part of the original cluster analysis—often referred to as cluster validation. That is, for a clustering solution to be useful it should show predictive validity to some important dependent variable(s). Thus, we examined differences in three dependent measures: (1) perceived effectiveness in helping teens quit, (2) perceived effectiveness in helping teens *not* to start smoking, and (3) usefulness in helping current teen smokers to quit (measured only for those who currently smoke).

ANOVA results are shown in Table 2. All *F*-values are significant ($p < .001$) indicating differences in the dependent variables across the clusters. In each of the cluster solutions, the stimuli we classified as “high performing visuals” showed significantly higher mean scores on helping teens quit and helping teens not start versus the other clusters. Based on Bonferroni contrasts, the means for these high performing visuals were significantly greater ($p < .001$) than the means for the other cluster of visuals. In contrast, the low performing visuals clearly had lower means ($p < .001$) than the picture stimuli in the other cluster groupings.

TABLE 2. Cluster validation and prediction: Effects of picture performance categorization on perceived effectiveness in helping teens to quit, helping teens not to start, and helping current smokers to quit

| | Help teens quit | Help teens not start | Help me quit |
|-----------------------------|-------------------------|-------------------------|-------------------------|
| 3-cluster solution | | | |
| High performing visuals (a) | 5.06 ^{b,c} | 5.34 ^{b,c} | 5.06 ^{b,c} |
| Moderate performers (b) | 2.84 ^{a,c} | 3.07 ^{a,c} | 2.75 ^{a,c} |
| Low performers (c) | 1.34 ^{a,b} | 1.38 ^{a,b} | 1.27 ^{a,b} |
| <i>F</i> -values | 1,440.5* | 1,614.6* | 762.1* |
| Eta ² values | .584 | .611 | .616 |
| 4-cluster solution | | | |
| High performing visuals (a) | 5.24 ^{b,c,d} | 5.54 ^{b,c,d} | 5.28 ^{b,c,d} |
| Moderate performers (b) | 3.39 ^{a,c,d} | 3.58 ^{a,c,d} | 3.40 ^{a,c,d} |
| Believable; low graphic (c) | 2.28 ^{a,b,d} | 2.56 ^{a,b,d} | 2.06 ^{a,b,d} |
| Low performers (d) | 1.35 ^{a,b,c} | 1.41 ^{a,b,c} | 1.29 ^{a,b,c} |
| <i>F</i> -values | 944.5* | 1,045.34* | 476.0* |
| Eta ² values | .580 | .604 | .600 |
| 5-cluster solution | | | |
| High performing visuals (a) | 5.59 ^{b,c,d,e} | 5.90 ^{b,c,d,e} | 5.76 ^{b,c,d,e} |
| Moderate performers (b) | 4.09 ^{a,c,d,e} | 4.33 ^{a,c,d,e} | 4.08 ^{a,c,d,e} |

| | | | |
|------------------------------|-------------------------|-------------------------|-------------------------|
| Believable; low graphic (c) | 2.83 ^{a,b,d,e} | 2.97 ^{a,b,d,e} | 2.79 ^{a,b,d,e} |
| Low performers (d) | 2.07 ^{a,b,c,e} | 2.37 ^{a,b,c,e} | 1.90 ^{a,b,c,e} |
| Extremely low performers (e) | 1.27 ^{a,b,c,d} | 1.32 ^{a,b,c,d} | 1.24 ^{a,b,c,d} |
| <i>F</i> -values | 878.3* | 975.8* | 452.2* |
| Eta ² values | .631 | .656 | .654 |

Note: Numbers in the table are means based on seven-point scales. Superscripts indicate significant differences using Bonferroni contrasts ($p < .01$ or better). “Helping Me Quit” was asked and assessed only for current teen smokers ($n = 954$). Other dependent measures are assessed across both teen smokers and nonsmokers ($n = 2061$). The pattern for “help teens quit” and “help teens not start” was highly consistent across smokers and nonsmokers (i.e., the interactions between smoker and cluster was nonsignificant), and the means for the smokers and nonsmokers for the high performing visuals were essentially identical.

* $p < .001$.

ANOVA results for perceived effectiveness in helping current smokers quit are shown in column 3 of Table 2. Results indicate that for smokers, the high performing visuals ($M = 5.06$) would be very effective in helping them quit smoking, relative to the other cluster categories of tested visuals ($M_s = 2.75$ and 1.27 ; Bonferroni contrasts are all significant [$p < .01$]). In addition, the use of the single visual cluster independent variable explained more than 60% of the variance in the “helping adolescent smokers quit” dependent variable across each of the three alternative cluster solutions.

Further validation of the specific GHW attribute evaluations

To further validate the role of these specific clustering variables in predicting important outcomes, we also used a series of regression analyses that further support the cluster-based results. The cluster variables were used as independent variables with each of the three outcomes shown in Table 2 as dependent variables. Each of the cluster variables have a positive effect on all outcomes.³ Additional analyses also showed that smoking status, smoking frequency, and age had little moderating impact.⁴ In sum, these supplemental analyses further support the cluster-based results shown in Tables 1 and 2.⁵

3 DISCUSSION

The pattern of findings support that current adolescent smokers perceive that the group of high performing visuals (as shown in Figure 1) would be helpful in encouraging them to quit smoking, while the low performing visuals would have little impact. These results for adolescents are important because over 65% of current adult daily smokers in the United States were 18 years or younger when they began smoking daily (SAMHSA, 2011). The age at which younger consumers begin to smoke greatly influences how much they smoke per day and the number of years they smoke, and, in turn, leading to increased disease risk and premature deaths (Chassin *et al.*, 2001; Chen and Millar, 1998; DHHS, 2012; 2020). Thus, the initiation of smoking among adolescents is of great concern to the tobacco control and the public health communities (DHHS, 2020; Institute of Medicine, 2007).

For the approximately 60% of the world's population already exposed to pictorial warnings, public health officials face the practical problem of choosing from among a vast array of graphic images that may *seem* reasonable for any given warning message statement. Moreover, for countries with limited budgets using minimal testing of some limited number of visual warnings and respondents restricts the opportunity to find images that are likely to be *most* effective. Similarly, the use of between-subjects experiments is likely to restrict the number of pictorial stimuli examined due to the need to avoid having an excessive number of cells in an extremely large and costly experimental design. It also is important to rotate new warnings over time due to potential wearout (Andrews and Shimp, 2018; Woelbert and d'Hombres, 2019). Therefore, we have

demonstrated a procedure that centers on use of a simple cluster analysis with follow-up validation allowing for testing among an array of possibilities. These empirical analyses potentially could use only seven (or fewer) items for each pictorial image tested. Specifically, using measures of perceived graphic level, fit with the warning message, believability, and evoked fear yielded clusters of visuals that were strong predictors of effectiveness measures for (1) helping teens quit in general, (2) preventing teen smoking initiation, and (3) helping current teen smokers to quit. Although it is potentially useful to assess other items and pictures, because there are high correlations within each of the clustering variables, we believe that a single item for each with two to three validating outcome measures would be sufficient, enabling global public health officials with limited budgets to test a number of images at a reasonable cost. If desired, as shown here, cluster results could be complemented with a regression analysis using the four clustering variables as independent predictors. Such analyses could allow a specific rank ordering based on predicted values to help identify the most effective visuals within a high performing cluster of visuals.

To summarize, given the need to rotate pictorial warnings to prevent wearout, in Figure 2 we offer a series of steps for identifying effective GHWs for tobacco control and health agencies. Our measures of clustering variables extend beyond previous advertising-based measures of attention and believability (see Davis *et al.*, 2011), and focus on visual graphicness, believability of the visual warning, fit with the warning statement, and evoked fear from the visual warning. This methodology culminates with the use of a clustering approach for a relatively large set of pictures to identify groups (or clusters) of visual images that are likely to be optimal performers. For step 1, we suggest a *broad* search of potential visuals for specific message themes available online (see WHO, 2020). This should be followed by some vetting of the potential pictorial candidates using a qualitative pretest with the target population, backed by evaluations from research experts, to determine an initial set of visuals deemed appropriate. For the empirical data collection in steps 2 and 3, four primary evaluative measures can be used as input to a clustering algorithm available in any widely-used statistical packages (e.g., R, SPSS, SAS). Finally, clustering results are followed by ANOVAs, regressions, and other relevant analyses in steps 4–6 to identify and validate optimal performing visuals (see Figure 1).

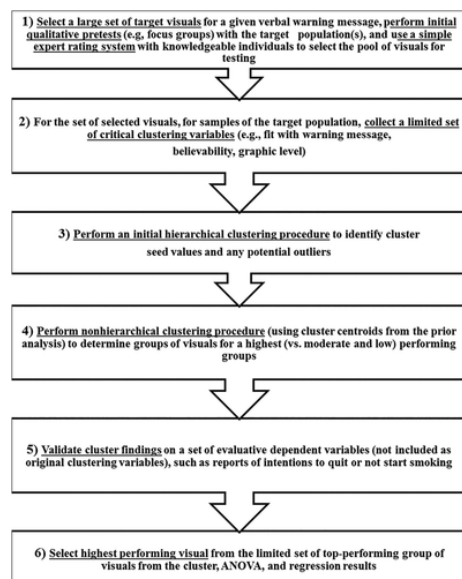


FIGURE 2 Recommended steps for testing and selecting graphic visual warnings for use on tobacco packaging

Although GHWs are used in more than 120 countries globally, in the United States only text warnings are still currently in use. While the Tobacco Control Act of 2009 required use of color graphic health warnings on tobacco packages, the industry has previously challenged the mandated graphic warnings based on first

Amendment commercial speech rights (Tobacco Free Kids, **2020**). The text-based and dated tobacco package warnings still in use in the United States are viewed as largely ineffective because they (1) often go unnoticed and (2) are perceived as weak in their ability to convey relevant information regarding risks related to smoking (FDA, **2019**; Davis and Burton, **2016**; Tobacco Free Kids, **2020**). More than a decade ago, the U.S. Institute of Medicine (**2007**) concluded that larger, graphic warnings would promote greater public knowledge of the health risks of using tobacco and would help reduce consumption, but such conclusions were not necessarily accepted by the U.S. Courts. In establishing criteria shown to be effective for GHWs, this research could be useful to countries that have not yet used pictorial warnings but will do so in the future, and perhaps in any further litigation in the United States.

There also are several limitations and opportunities for future research. First, we conducted tests only on adolescents—yet one that is extremely important and challenging (Andrews *et al.*, **2014**; Tobacco Free Kids, **2020**). However, samples of adult smokers and “social smoking” young adults also may be of interest (Netemeyer *et al.*, **2005**). In addition, while it is extremely difficult to measure effects on actual quitting behavior and smoking initiation of GHW package changes in the marketplace, it is acknowledged that how the clusters of visuals are related to long-term behavioral measures of smoking in longitudinal designs would extend these results. We tested a number of visual images for only three of the warning messages (addictiveness, lung disease, secondhand smoke harming children) common throughout the world (WHO, **2020**). Thus, we acknowledge future research should apply this approach for larger sets of image possibilities and across different cultures, and an expanded domain of warning statements.

However, our results are found to be consistent both across and within message themes for more than 2000 ratings of 27 visual warning stimuli. As such, they show significant differentiation and substantial promise for public health officials, tobacco control, and researchers interested in determining which specific visuals are likely to be most effective in communicating risk-related information. Given concerns about U.S. Court challenges, recent U.S. FDA research has focused on increased knowledge about lesser known risks as a primary outcome (DHHS, **2020**). In our study, assessing *new* knowledge was not a goal, but this could be examined more directly in future research.

Endnotes

- ¹ The specific warning statements assessed with the visual stimuli were: (1) “Cigarettes are addictive,” (2) “Tobacco smoke can harm your children,” and (3) “Cigarettes cause fatal lung disease.” To prevent any potential confounding effect of package branding, the visual stimuli and text warnings were not shown on a cigarette package.
- ² Note that the practical implications for identifying very high and very low performing visuals are consistent across the cluster solutions, and the cluster results are robust across differences in initial cluster seeds and number of clusters.
- ³ These regression analyses included the four criteria used as clustering variables (i.e., graphic level, integration with warning message, believability, and evoked fear) as independent variables and age as a control variable. Separate regressions were performed for each of the three effectiveness outcomes used for the cluster validation. Each of the clustering variables had a positive, significant effect on each of the three dependent measures. Fear had the strongest effect on helping current smokers quit, and the graphic level had the strongest effect in helping prevent teen nonsmokers from starting.
- ⁴ For both ANOVAs and correlation analyses, there was not any evidence that smoking status moderated effects of the clustering variables on the outcomes. For smokers, frequency of smoking was generally nonsignificant as a moderator, but smoking frequency did moderate the effect of graphic level on helping smokers to quit ($t = -2.78, p = .005$). However, the R^2 change (.008) was modest. Similar to the

above results, there was little evidence that the age of the participants affected the cluster results. In sum, these additional analyses further support the cluster-based results for these four key perceived attribute evaluations related to the various pictorial stimuli, and there is little evidence of moderating effects of smoking status or age.

⁵ In addition to aggregated analyses shown in Tables 1 and 2, we also performed all analyses *within* the three separate warning themes. Both the cluster analyses and the follow-up analyses on the effectiveness measures were consistent with the analyses reported in the text and tables. Thus, it is important to note that results generalize across warning themes, as shown in these tables.

APPENDIX A.

Measures of clustering variables

| |
|---|
| <i>Graphic level of the visual (Andrews et al., 2014)</i> |
| This picture is: “not graphic at all”; “very graphic” and “not intense at all” to “very intense;” $r = .95 (p < .001)$. |
| <i>Perceived fit/congruence between the statement and picture:</i> |
| “It makes sense for this warning statement to be used with the picture on a cigarette package”; endpoints of “Strongly Disagree” and “Strongly Agree” |
| “Together, this warning statement and the picture are a good fit”; endpoints of “Strongly Disagree” and “Strongly Agree;” $r = .89 (p < .001)$. |
| <i>Believability of the visual warning (Beltramini, 1988; Atkin and Beltramini, 2007):</i> |
| “This picture is” (endpoints of “not believable at all” and “very believable”) |
| <i>Evoked fear from the pictorial warning (Kees et al., 2010):</i> |
| How does this picture make you feel: (“not fearful at all” and “very fearful” and “not anxious at all” and “very anxious;” $r = .96 (p < .001)$. |

Note: All measures were seven-point scales. Given the high reliability scores (all $r \geq .89$), means for the multi-item measure were used in subsequent analyses.

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