Cigarette Constituent Health Communications for Smokers: Impact of Chemical, Imagery, and Source

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Abstract

Introduction: Communication campaigns are incorporating tobacco constituent messaging to reach smokers, yet there is a dearth of research on how such messages should be constructed or will be received by smokers.

Methods: In a 2 × 2 × 2 experiment, we manipulated three cigarette constituent message components: (1) the toxic constituent of tobacco (arsenic vs. lead) with a corresponding health effect, (2) the presence or absence of an evocative image, and (3) the source of the message (FDA vs. no source). We recruited smokers (N = 1669, 55.4% women) via an online platform and randomized them to one of the eight message conditions. Participants viewed the message and rated its believability and perceived effectiveness, the credibility of the message source, and action expectancies (ie, likelihood of seeking additional information and help with quitting as a result of seeing the message).

Results: We found significant main effects of image, constituent, and source on outcomes. The use of arsenic as the constituent, the presence of an evocative image, and the FDA as the source increased the believability, source credibility, and perceived effectiveness of the tobacco constituent health message.

Conclusions: Multiple elements of a constituent message, including type of constituent, imagery, and message source, impact their reception among smokers. Specifically, communication campaigns targeting smokers that utilize arsenic as the tobacco constituent, visual imagery, and the FDA logo may be particularly effective in changing key outcomes that are associated with subsequent attitude and behavioral changes.

Implications: This article describes how components of communication campaigns about cigarette constituents are perceived. Multiple elements of a tobacco constituent message, including type of constituent, image, and message source may influence the reception of messages among current smokers. Communication campaigns targeting smokers that utilize arsenic as the tobacco constituent, visual imagery, and the FDA logo may be particularly effective in changing key outcomes among smokers. The effects of such campaigns should be examined, as well as the mechanisms through which such campaigns affect change.

Introduction

Tobacco use is the leading cause of preventable death in the United States.[1] Much of the harm from smoking comes from chemicals (ie, constituents) present in cigarettes and cigarette smoke. Of the 5000 constituents in a single cigarette, at least 70 are recognized carcinogens.[2] The US Food and Drug Administration (FDA) has recently required manufacturers to report harmful and potentially harmful constituents (HPHCs) in tobacco products.[3] Upon receiving reports from tobacco manufacturers, the FDA is required to communicate this information to the public in a "format that is understandable and not misleading to lay persons."[3] Within the context of the *The Real Cost* campaign (a media campaign that seeks to educate at-risk teens about the harmful effects of tobacco use), the FDA has begun communicating information about tobacco constituents. For instance, in one advertisement ("Science Class"), the harmful effects of cigarette constituents (specifically, formaldehyde, acrolein, and nitrobenzene) are represented as a dangerous creature. This type of messaging, where descriptive statements about chemical constituents in cigarettes and their health effects are used, represents a shift from previous quantitative disclosures on cigarette packs about constituents and emissions (tar, nicotine, and carbon monoxide), which may mislead consumers to believe brands with lower yields are less harmful.[4,5]

Few studies have examined the effectiveness of tobacco communication campaigns where constituents are part or all of the messaging. Evidence indicates that consumers are often unaware of constituents in tobacco products or smoke and their harm[6] and that some types of constituent messaging can increase consumer's knowledge of constituents, knowledge about the health risks of smoking, and cognitive elaboration.[4,5,7] However, more research examining *characteristics of health messages* that only focus on cigarette constituents may be helpful in understanding effective constituent messages. Therefore, our study sought to examine characteristics of cigarette constituent messages among smokers by manipulating: the nature of the cigarette constituent (arsenic vs. lead), the use of visual imagery (image of a skull formed of cigarette smoke vs. no image), and the source of the message (FDA vs. no source). We chose these three manipulations based on previous research documenting the effectiveness of visual imagery in general tobacco communication campaigns,[8] the importance of source credibility on attitudes and behavioral intentions,[9] and evidence suggesting constituents such as lead and arsenic may discourage smokers from wanting to smoke cigarettes.[6,10] We intended to develop communication messages that evoked the serious consequences of cigarette smoking and hypothesized that messages that included visual imagery and a credible source would be more persuasive than messages without such components.

Methods

Data Collection

We administered the experiment via Amazon Mechanical Turk (MTurk), a web-based platform that is frequently used for survey and behavioral research.[11] For our study, we limited inclusion to adults (18+) in the United States who reported smoking cigarettes in the past 30 days, and paid $3.50 for participation. The University of North Carolina at Chapel Hill IRB approved this study (#15–1952); all participants completed informed consent. To ensure high-quality data, we excluded participants who failed any of the three attention checks (n = 203). Our final sample included 1669 current adult smokers.

Measures

Experimental Manipulation

For this experiment, we manipulated three components of a health message on cigarette constituents in a 2 × 2 × 2 design: the message about a toxic constituent found in cigarettes (arsenic vs. lead) with a corresponding health effect, the image (the presence vs. absence of a smoky skull), and the source of the message (FDA vs. no source). The arsenic message read as: "Cigarette smoke contains arsenic. This causes lung tumors" and the lead message read as: "Cigarette smoke contains lead. This causes brain disorders." Participants were able to view the messages for as long as they wanted. An example message can be seen in Figure 1 (Supplementary Appendix A).

Outcomes

We assessed four outcomes: message believability, source credibility, perceived message effectiveness, and action expectancies. We measured believability with two items assessing whether the messages were believable and convincing (α = 0.89).[12] We measured source credibility with three items assessing whether the sponsor of the messages was credible,[13] trustworthy,[14] and an expert[13] (α = 0.94). We measured perceived effectiveness with three items assessing whether the messages discouraged participants from smoking, made smoking seem unpleasant, and made them concerned about the health effects of smoking (α = 0.83) (Baig SA, Gottfredson NC, Noar SM, Boynton MH, Ribisl KM, Brewer NT, unpublished data). We measured action expectancies with two items that assessed participants' likelihood of seeking information about chemicals in cigarettes and seeking help to quit smoking as a result of seeing the message (α = 0.83). We assessed all outcomes on a 5-point scale and averaged scores.

Background Variables

All participants provided information on sex, race, ethnicity, education, age, smoking status, and FDA's credibility as a tobacco regulator (Supplementary Appendix B). We measured smoking status with the item "Do you now smoke cigarettes every day, some days, or not at all?" and dichotomized responses as "every day smokers" and "some days smokers". Nonsmokers were screened out of the study. Because the FDA is a government agency, we also measured credibility in the FDA as a tobacco regulator using a six-item validated scale (α = 0.82).[15]

Data Analysis

We used SAS version 9.3 for analysis. We entered all variables simultaneously in one-way analyses of covariance (ANCOVA) models to compare mean differences among the three experimental factors for each of our four outcomes. Results from the ANCOVA models included F-values, p-values, and effect sizes (semi-partial eta-squared; small effect size = 0.01, medium = 0.06, large = 0.14).[16] Additionally, we conducted analyses that included two-way interactions of each of three experimental conditions and smoking status to determine if combinations of the health message characteristics affected perceptions. For source credibility as the outcome, we also examined interactions between the manipulation of the source and perceived credibility in the FDA as a tobacco regulator. We set the alpha level at $p < .05$.

Results

Descriptive Statistics

Our sample of adult smokers (n = 1669) was mostly white (82.4%), non-Latino (88.5%) and on average, 34.2 years old (Supplementary

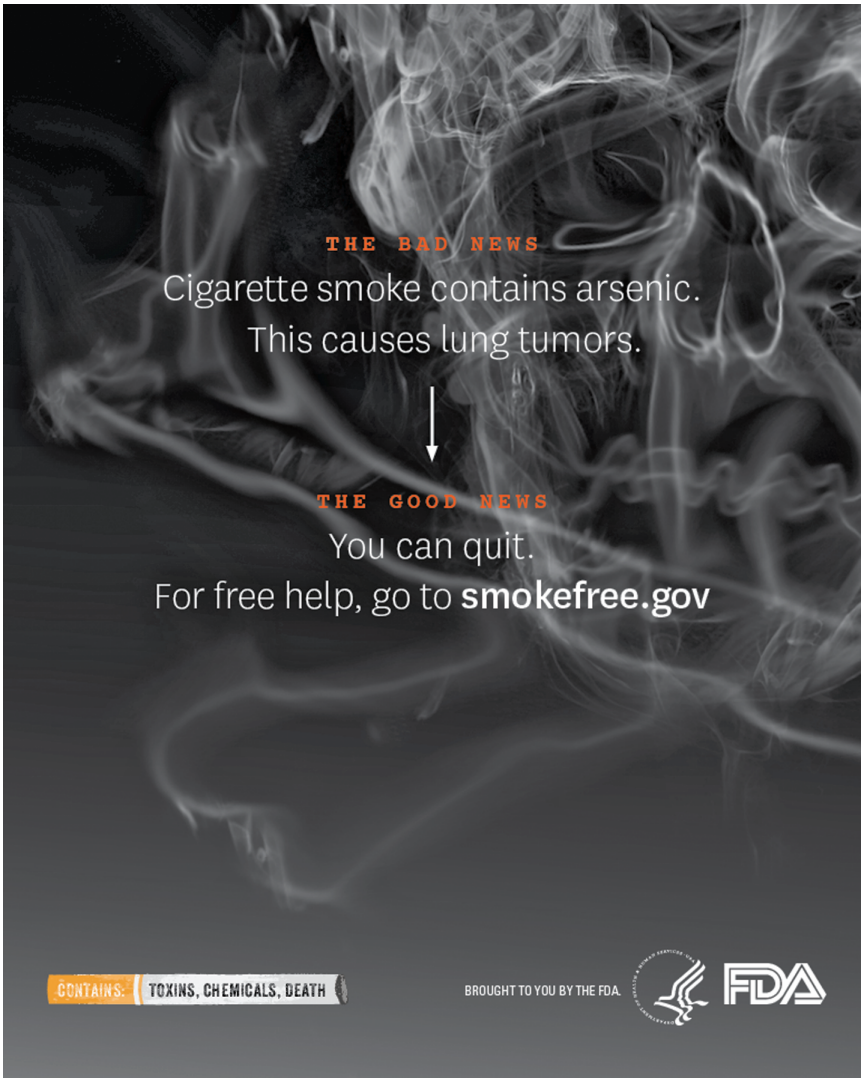

Figure 1. Example experimental condition with arsenic as the constituent, and skull image and FDA logo both present. For this experiment, we manipulated the constituent of the message (arsenic vs. lead), whether the message has an image (smoky image background vs. not) and the source of the message (FDA vs. not). For the constituent, the message could either be related to arsenic (presented in the figure) or lead (with text stated "Cigarette smoke contains lead. This causes brain disorders."). All messages had the "Contains" brand and "Ready to be tobacco free? You can quit. For free help, go to smokefree.gov."

Appendix C). Participants reported moderate credibility in the FDA as a tobacco regulator (mean, M = 3.6, standard deviation, SD = 0.8). Correlations among the four outcomes were moderate to strong (range = .41 to .78).

Main Effects and Interactions for Experimental Conditions

We found significant main effects for each of the three experimental conditions (Table 1). Participants in the arsenic condition reported the messages as more believable ($p < .001$) and the source as more credible ($p < .001$), but perceived the message as less actionable ($p = .03$) than participants in the lead condition. Participants in the evocative image condition reported the messages as more believable ($p < .001$), the source as more credible ($p = .01$), and the message as more effective ($p < .001$) than participants in the no-image condition. Participants in the FDA logo condition reported the source as more credible ($p < .001$) than participants in the no source condition (without the FDA logo). There were no significant interactions between the experimental manipulations. Effect sizes for the manipulations were small, ranging from 0.01 to 0.02.

Effects of Background Variables

Perceptions of the messages were influenced by sex, smoking status, and perceived credibility of the FDA as a tobacco regulator (ANCOVA results). Males reported the messages to be less believable ($F = 6.29$, $p = .01$) and effective ($F = 7.47$, $p = .01$) than females. Daily smokers reported the messages to be less effective ($F = 14.4$, $p = .001$) and actionable ($F = 7.6$, $p = .01$) than some-days smokers. Perceived credibility of the FDA was positively associated with message believability ($F = 208.6$, $p < .001$), source credibility ($F = 316.0$, $p < .001$), perceived effectiveness ($F = 144.8$, $p < .001$), and action expectancies ($F = 62.9$, $p < .001$). Effect sizes for the effects of background variables on the four outcomes ranged from 0 to 0.15.

There was a significant interaction between perceived credibility of the FDA and the source manipulation ($p = .01$). Specifically, for individuals who perceived the FDA to have high credibility (M +

Table 1. Effects of the Experimental Factors Manipulated

	Outcome			
Experimental factor	Believability	Source credibility	Perceived effectiveness	Action expectancies
Constituent				
Arsenic, mean (SD)	**3.81 (1.06)**	**3.74 (1.01)**	3.45 (1.12)	**2.77 (1.19)**
Lead, mean (SD)	**3.50 (1.20)**	**3.49 (1.16)**	3.43 (1.17)	**2.88 (1.21)**
	$F = 31.78$, $p < .001$, $\eta^2 = 0.02$	$F = 23.05$, $p < .001$, $\eta^2 = 0.01$	$F = .01$, $p = .92$, $\eta^2 = 0.00$	$F = 4.86$, $p = .03$, $\eta^2 = 0.003$
Image				
Present, mean (SD)	**3.79 (1.11)**	**3.70 (1.09)**	**3.54 (1.11)**	2.87 (1.21)
Absent, mean (SD)	**3.51 (1.16)**	**3.53 (1.09)**	**3.33 (1.18)**	2.78 (1.19)
	$F = 22.55$, $p < .001$, $\eta^2 = 0.02$	$F = 7.27$, $p = .01$, $\eta^2 = 0.004$	$F = 13.45$, $p < .001$ $\eta^2 = 0.01$	$F = 1.94$, $p = .16$, $\eta^2 = 0.001$
Source				
FDA, mean (SD)	3.71 (1.14)	**3.79 (1.07)**	3.48 (1.13)	2.88 (1.19)
None, mean (SD)	3.60 (1.14)	**3.44 (1.09)**	3.39 (1.17)	2.77 (1.21)
	$F = 2.76$, $p = .10$, $\eta^2 = 0.001$	$F = 45.02$, $p < .001$, $\eta^2 = 0.02$	$F = 1.72$, $p = .23$, $\eta^2 = 0.001$	$F = 3.61$, $p = .11$, $\eta^2 = 0.002$

ANCOVA controlled for age, sex, race/ethnicity, education, credibility of the FDA as a tobacco regulator, and smoking status. For each experimental factor, the DF_{model} and DF_{error} were (17, 1651). Bolded mean pairs are those that are statistically significant ($p < .05$).

1 *SD*), the presence of the FDA logo increased source credibility. However, for individuals who perceived the FDA to have low credibility (*M* – 1 *SD*), the FDA logo had no effect on source credibility. There were no significant interactions between smoking status and the experimental conditions.

Discussion

In this study, we found that messages that specified arsenic as a constituent and used the FDA logo increased message believability and/or source credibility, and the presence of the visual image increased believability, source credibility, and perceived effectiveness. The fact that participants rated messages reporting arsenic in tobacco as more believable and the source as more credible than lead is consistent with a previous study finding higher consumer awareness of arsenic as a constituent in cigarette smoke than lead.[10] However, in this same study, participants reported both lead and arsenic to be equally harmful and discouraging.[10] Given these results, it is possible that participants in our study were less aware of lead and its health effects ("brain disorder") compared to arsenic ("lung tumors") and thus more likely to want to seek out information about constituents or quit smoking (ie, heightened action expectancies). This might explain why we observed decreased message believability and source credibility, but increased action expectancies, when lead was the constituent as opposed to arsenic.

Previous research on tobacco warnings found that messages containing visual imagery were more effective and powerful than no-imagery messages.[8,17,18] For instance, in an experimental study examining pictorial warnings or text-only warnings on cigarette packs, participants who received the pictorial warnings rated the warnings as significantly more salient, credible, and impactful than participants who received the text-only warnings, regardless of race, education, or income.[8] These findings are supported by a relevant body of research on health warnings for tobacco products, including recent reviews and a meta-analysis, which documented the benefits of pictorial warnings over text-only warnings.[17,18] Our manipulation on the use of visual imagery for tobacco constituents, through the presence of a skull formed of cigarette smoke, supports and extends this research to messaging about constituents.

Source credibility affects how positively messages are received.[9] For instance, in an experiment manipulating the source of smoking cessation advertisements, researchers found that messages sponsored by a tobacco company were less credible than ads sponsored by public health agencies and that credibility was associated with perceived ad effectiveness for nonsmokers.[19] While additional research is needed regarding source credibility in tobacco communication campaigns, particularly regarding behavioral outcomes, it may be an important component of health messages that should be considered by researchers and policy makers. Although many individuals are unaware of the FDA's tobacco regulatory authority or may doubt the credibility of the FDA,[20] we found that the presence of the FDA logo enhanced the source credibility of a cigarette constituent message. Moreover, we found that these differences were most pronounced among individuals who perceived the FDA as a credible tobacco regulator. Thus, individual characteristics may interact with message characteristics to influence receptivity to tobacco communication campaigns.

Lastly, we found that certain subgroups (ie, men, everyday smokers, individuals with lower perceived credibility in FDA) were less likely to report the constituent messages as impactful—regardless of condition. Further research examining how tobacco communication campaigns about constituents are perceived among these populations is warranted.[6]

Limitations

The present study had some limitations. First, viewing the messages online differs from how participants may view the messages in real life and introduces some concerns about ecological validity. Second, we manipulated the presence or absence of a source rather than a credible source versus a not credible source; relatedly, it is possible that participants thought both ads were sponsored by the government due to the language "for free help, go to smokefree.gov." Third, effect sizes for the impacts of these manipulations on outcomes were small. Finally, there is little research examining whether manipulations of source credibility are associated with changes in smoking or other behavioral outcomes. Some research suggests that source credibility may be associated with message effectiveness, particularly when credible sources versus noncredible sources are compared,[19] but other research suggests that tobacco messages heard over the phone without a source may be just as *believable* as messages with a governmental source (ie, Surgeon General, FDA, CDC).[21–23] Given

the lack of previous research, particularly regarding behavioral outcomes, and the limitations of the present study discussed above, additional research on source credibility is warranted.

Conclusions

The present study provides some of the first evidence regarding how tobacco constituent messages are perceived by current smokers. Our findings indicate that cigarette communication campaigns about constituents that utilize arsenic as the tobacco constituent, visual imagery, and the FDA logo may be particularly effective in changing key outcomes among smokers.

Supplementary Material

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

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Declaration of Interests

None declared.

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References

1. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. *JAMA*. 2004;291(10):1238–1245.
2. Rodgman A, Perfetti TA. *The Chemical Components of Tobacco and Tobacco Smoke*. Boca Raton, FL: CRC Press; 2013.
3. Food and Drug Administration. *Reporting Harmful and Potentially Harmful Constituents in Tobacco Products and Tobacco Smoke Under Section 904(a)(3) of the Federal Food, Drug, and Cosmetic Act*. Silver Spring, MD: U.S. Department of Health and Human Services Food and Drug Administration Center for Tobacco Products (CTP); 2012.
4. Gallopel-Morvan K, Moodie C, Hammond D, Eker F, Beguinot E, Martinet Y. Consumer understanding of cigarette emission labelling. *Eur J Public Health*. 2011;21(3):373–375.
5. Hammond D, White CM. Improper disclosure: tobacco packaging and emission labelling regulations. *Public Health*. 2012;126(7):613–619.
6. Hall MG, Ribisl KM, Brewer NT. Smokers' and nonsmokers' beliefs about harmful tobacco constituents: implications for FDA communication efforts. *Nicotine Tob Res*. 2014;16(3):343–350.
7. Thrasher JF, Murukutla N, Pérez-Hernández R, et al. Linking mass media campaigns to pictorial warning labels on cigarette packages: a cross-sectional study to evaluate effects among Mexican smokers. *Tob Control*. 2013;22(e1):e57–e65.
8. Cantrell J, Vallone DM, Thrasher JF, et al. Impact of tobacco-related health warning labels across socioeconomic, race and ethnic groups: results from a randomized web-based experiment. *PLoS One*. 2013;8(1):e52206.
9. Pornpitakpan C. The persuasiveness of source credibility: a critical review of five decades' evidence. *J Appl Soc Psychol*. 2004;34(2):243–281.
10. Brewer NT, Morgan JC, Baig SA, et al. Public understanding of cigarette smoke constituents: three US surveys. *Tob Control*. 2016;26(5):592–599.
11. Crump MJ, McDonnell JV, Gureckis TM. Evaluating Amazon's Mechanical Turk as a tool for experimental behavioral research. *PLoS One*. 2013;8(3):e57410.
12. Beltramini RF, Evans KR. Perceived believability of research results information in advertising. *J Advert*. 1985;14(3):18–31.
13. McCroskey JC. Scales for the measurement of ethos. *Speech Monographs*. 1966;33:65–72.
14. Grandpre J, Alvaro EM, Burgoon M, Miller CH, Hall JR. Adolescent reactance and anti-smoking campaigns: a theoretical approach. *Health Commun*. 2003;15(3):349–366.
15. Schmidt AM, Ranney LM, Noar SM, Goldstein AO. Development of the FDA Tobacco Credibility Scale (FDA-TCS). *Tob Regul Sci*. 2017;3(1):47–55.
16. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Earlbaum Associates; 1988.
17. Noar SM, Francis DB, Bridges C, Sontag JM, Ribisl KM, Brewer NT. The impact of strengthening cigarette pack warnings: systematic review of longitudinal observational studies. *Soc Sci Med*. 2016;164:118–129.
18. Noar SM, Hall MG, Francis DB, Ribisl KM, Pepper JK, Brewer NT. Pictorial cigarette pack warnings: a meta-analysis of experimental studies. *Tob Control*. 2016;25(3):341–354.
19. Byrne S, Guillory JE, Mathios AD, Avery RJ, Hart PS. The unintended consequences of disclosure: effect of manipulating sponsor identification on the perceived credibility and effectiveness of smoking cessation advertisements. *J Health Commun*. 2012;17(10):1119–1137.
20. Jarman KL, Ranney LM, Baker HM, Vallejos QM, Goldstein AO. Perceptions of the food and drug administration as a tobacco regulator. *Tob Regul Sci*. 2017;3(2):239–247.
21. Francis DB, Noar SM, Kowitt SD, Jarman KL, Goldstein AO. Believability of new diseases reported in the 2014 Surgeon General's Report on smoking: Experimental results from a national survey of US adults. *Prev Med*. 2017;99:94–98.
22. Kowitt SD, Jarman K, Ranney LM, Goldstein AO. Believability of cigar warning labels among adolescents. *J Adolesc Health*. 2017;60(3):299–305.
23. Lazard A, Kowitt SD, Huang L-L, Noar SM, Jarman K, Goldstein AO. Believability of cigarette warnings about addiction: national experiments of adolescents and adults. *Nicotine Tob Res*. In press.