Published in final edited form as:

Drug Alcohol Depend. 2018 July 01; 188: 251–258. doi:10.1016/j.drugalcdep.2018.04.013.

Effects of Exposure to Anti-Vaping Public Service Announcements Among Current Smokers and Dual Users of Cigarettes and Electronic Nicotine Delivery Systems

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Abstract

Introduction.—Anti-vaping public service announcements (PSAs) are intended to discourage vaping or use of electronic nicotine delivery systems (ENDS). However, vaping portrayals in PSAs may have unintended effects if they increase smoking or vaping urges. This study examined benefits and unintended effects of anti-vaping PSAs with vapor portrayals on smoking and vaping-related outcomes.

Methods.—Young adult smokers (N=171) and dual users (N=122) aged 21–30 years were randomly assigned to view: 1) anti-vaping PSAs with vapor; 2) anti-vaping PSAs without vapor; 3) physical activity PSAs; or 4) anti-smoking PSAs with smoking cues. Outcomes were changes in vaping and smoking urges before and after viewing PSAs, post-test vaping and smoking intentions in the next hour, and post-test intention to purchase ENDS and traditional cigarettes.

Results.—Smokers only: Exposure to anti-vaping PSAs with vapor (vs. physical activity) was associated with lower intention to vape and to purchase ENDS ($p < 0.001$) and lower intention to smoke and purchase cigarettes ($p < 0.05$). Exposure to anti-vaping PSAs with vapor (vs. PSAs without vapor and vs. anti-smoking PSAs with smoking cues) was associated with lower intention to vape in the next hour ($p < 0.05$). Exposure to anti-vaping PSAs without vapor (vs. physical activity) was associated with lower change in vaping urge ($p < 0.05$) and intention to purchase ENDS ($p < 0.001$). Dual users: Exposure to anti-vaping PSAs without vapor (vs. anti-smoking PSAs) was associated with lower intention to purchase ENDS ($p < 0.05$).

Conclusion.—Viewing anti-vaping PSAs with vapor was not associated with unintended effects and may have benefits on reducing smoking and vaping-related outcomes.

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Competing interests: None.

Keywords

electronic nicotine delivery systems; public service announcements; smokers; dual users

1. INTRODUCTION

Finding effective strategies to reduce tobacco product use among young adults is a public health priority. Tobacco use prevalence is highest among United States (US) young adults compared to all other age groups (Kasza et al., 2017). In 2013–2014, 38% of US young adults reported current use of any tobacco product (i.e., using tobacco on some days or every day), 20% reported current use of traditional cigarettes, and 9% were current users of electronic nicotine delivery systems (ENDS) (Kasza et al., 2017). Dual use of cigarettes and ENDS is also increasing: 34% of nondaily smokers and 30% of young adult daily smokers are current users of ENDS (McMillen et al., 2014). Young adults are also the target audience of tobacco companies and ENDS manufacturers (Biener and Albers, 2004; Ling and Glantz, 2002). For instance, young adults exposure to ENDS advertisements on television increased by 321% between 2011 and 2013 (Duke et al., 2014).

Since 2014, public service announcements (PSAs) aimed at discouraging ENDS use among youth and young adults have been adopted as part of tobacco control efforts, including campaigns in Chicago and San Francisco at the local level, Alaska and California at the state level, and nationally by the US Office of the Surgeon General and Centers for Disease Control and Prevention (Alaska Department of Health and Social Services, 2014; California Department of Public Health, 2017; City of Chicago, 2015; Office of the U.S Surgeon General and U.S. Centers for Disease Control and Prevention, Office on Smoking and Health, 2017; San Francisco Department of Public Health, 2015).

Although anti-vaping PSAs are targeted at reducing vaping among young people who are vaping and those who are susceptible to vaping but have no extensive smoking history, these messages may also result in unintended effects on current smokers and dual-users. Based on a review of recent anti-vaping PSAs, we noted seven examples that include portrayals of actors exhaling visible emissions (California Department of Public Health, 2017, 2016a, 2016b, 2015, Tobacco Free Alaska, 2015a, 2015b, 2014). Such portrayals of visible ENDS emissions, frequently termed as “vapor” by ENDS users (Pearson et al., 2017), are visually similar to cigarette smoke. Prior research found that exposure to nicotine-associated cues in anti-smoking PSAs, such as when actors smoke or hold traditional cigarettes, may elicit subjective and behavioral responses that lead to more intensive smoking, undermining the intended effect of PSAs to discourage smoking (Kang et al., 2009). Others have reported that smoking cues in PSAs did not increase smoking urges or interfere with recall and persuasive effects of anti-smoking arguments (Falcone et al., 2013). In addition, recent research reported that viewing vaping cues within ENDS product advertisements resulted in cross-over effects in increasing smoking urge (King et al., 2015, 2016, 2017; Maloney and Cappella, 2016). It is plausible that vapor portrayals within anti-vaping PSAs may also promote motivationally significant responses including increased urge to smoke. To our

knowledge, the effects of viewing vapor cues within the context of anti-vaping PSAs among young adult smokers have not been investigated.

This study aimed to examine benefits and unintended effects of anti-vaping PSAs on smoking and vaping-related outcomes among young adult smokers and dual users of cigarettes and ENDS. Based on prior ENDS cue reactivity research, we test the hypotheses that exposure to anti-vaping PSAs containing vapor portrayals would influence smoking and vaping urges, intentions to smoke and vape in the short term, and intentions to purchase cigarettes and ENDS among smokers only and dual-users.

2. METHODS

2.1. Study Design

A between-subjects design was employed in which each participant was randomly assigned to one of the following four conditions: 1) anti-vaping PSAs with vapor (vapor cue), 2) identical anti-vaping PSAs with no vapor (no vapor cue), 3) physical activity PSAs (physical activity); and anti-smoking PSAs with smoking cues (anti-smoking).

2.2. Experimental and Control Stimuli

2.2.1. Anti-vaping PSAs.—The study team created eight high quality English language anti-vaping video PSAs for the study (four PSAs for the vapor condition and four PSAs for the no vapor condition). We operationalized vapor cues as one or more actors depicting the hand-to-mouth motion of using an ENDS, inhaling on the device and exhaling visible emissions. In the no vapor cue condition, although one or more actors depict handling or using the ENDS, the scenes depicting vapor were absent. The rationale for utilizing new PSAs as experimental stimuli vs. using actual anti-vaping PSAs was to ensure that the vapor cue and no vapor cue conditions were identical with the only difference being the presence or absence of visible, exhaled ENDS vapor. We first extracted anti-vaping health messages used in existing anti-vaping PSAs (e.g., ENDS lead to nicotine addiction, ENDS contain harmful chemicals) and pilot tested these messages among a separate sample of young adults (N=130) to evaluate argument strength (Zhao et al., 2011). The three arguments that were rated most highly were arguments about ENDS containing chemicals (e.g., formaldehyde), ENDS as gateway to smoking, and ENDS being addictive. We engaged an advertising agency (Harvest, Lansing MI) to utilize these top-ranked arguments to write, cast, film and edit the PSAs to ensure the production quality of the PSAs would be comparable to actual anti-vaping PSAs. The PSAs were designed to be similar to anti-smoking PSAs in terms of including human characters and scenes that show actors holding and handling tobacco products. For instance, in one anti-vaping PSA, two actors were depicted handling and sharing an ENDS device outdoors and a voice-over actor read a message on the presence of harmful chemicals within ENDS and discouraging the use of ENDS. The study team vetted and approved the final versions of the PSAs.

2.2.2. Physical activity PSAs.—We included a physical activity control condition that was similar to anti-vaping PSAs in terms of camera changes and actors to differentiate between responses to general structural features of public health PSAs that increase arousal

and responses to our anti-vaping messages in particular. We obtained four PSAs promoting physical activity through an online search of existing PSAs. For example, one of the PSAs included actors portrayed as changing from sedentary lifestyles (e.g., sitting on a couch) to various activities including swimming and weight-lifting.

2.2.3. Anti-smoking PSAs.—We included anti-smoking PSAs with visible smoking cues as a control condition because of prior research indicating that these cues may increase smoking urges and undermine the intended effects of PSAs to reduce smoking (Kang et al., 2009). We also sought to determine whether observed differences in the outcomes were due simply to exposure to anti-tobacco messaging in general or were specific to anti-vaping messages. We obtained four anti-smoking PSAs through an online search of existing PSAs containing smoking cues (i.e., depictions of an actor holding and smoking traditional cigarettes and exhaling visible cigarette smoke). For example, one of the anti-smoking PSAs depicted a parent smoking a cigarette and exposing his child to secondhand smoke at home and in a vehicle. We attempted to match the number of vaping cues in the anti-vaping PSAs and smoking cues in the anti-smoking PSAs to ensure the messages were comparable in that regard. Due to funding constraints, we did not create anti-smoking PSAs.

Across the four conditions, all PSAs were in English language, ranged from 29–32 seconds in length, had at least four camera changes, contained close-ups of faces, included emotional content, and contained at least two human characters. Video stimuli utilized in this study are available at this link (<http://bit.ly/2FMCR0W>).

2.3. Participants and Recruitment

Participants were recruited from Boston, MA (n=152) and East Lansing/Lansing, MI (n=141) metro areas using flyers, Craigslist ads, Facebook advertising, word-of-mouth via past participants, and from the Michigan State University's participant pool. E-mail and telephone screenings were used to verify that participants met the following inclusion criteria: aged 21 to 30 years old, current cigarette smoker (has smoked at least 100 lifetime cigarettes, and within the past 30 days) or current dual-user (current smokers who have used both ENDS and traditional cigarettes within the past 30 days), able to read and understand English, not currently attempting to quit smoking, not currently pregnant or breastfeeding, and no self-reported physical or psychological limitations that would preclude their participation in the study procedures. A total of 293 participants (171 were traditional cigarette smokers only and 122 were dual-users) met the inclusion criteria and completed the study.

2.4. Procedures

Participants were directed to abstain from smoking for at least six hours before coming to the laboratory. The rationale for requiring smoking abstinence prior to the experiment is to ensure that all participants have low levels of circulating blood nicotine levels at baseline and to enhance the likelihood of elicitation of smoking urges (Bedi et al., 2011). This procedure is consistent with research assessing cue reactivity to ENDS-related cues (King et al., 2015, 2017). Abstinence was verified using a carbon monoxide (CO) breath test of less than 10 ppm. Written informed consent was obtained at the laboratory. Participants were

requested to complete an online Qualtrics survey using a laboratory computer. The first section of the survey comprised questions about participants' smoking behaviors and pretest urge to smoke and vape. Next, participants were randomly assigned using the 'randomizer' element within the Qualtrics platform to view a set of four PSAs within one of the four conditions (vapor cue, no vapor cue, physical activity, or anti-smoking). Following each PSA, participants answered questions related to perceived effectiveness of the PSA. After viewing all four PSAs, participants responded to questions related to the study outcomes. To minimize the experiment demand effect, we explained to participants that the study was meant to explore young adults' responses to different types of consumer advertising prior to the experiment and they were blinded to the study's specific hypotheses. We further included non-tobacco related PSAs (physical activity) as a control condition. We did not include distraction tasks to minimize participant burden. Participants were paid up to \$50 for their participation. The Michigan State University and Harvard TH Chan School of Public Health IRB committees reviewed and approved all study procedures.

2.5. Measures

2.5.1. Smoking urge and vaping urge.—*Smoking urge* was assessed using the following two items derived from Brief Questionnaire of Smoking Urges (QSU-Brief) (Cox et al., 2001) before and after viewing the PSAs: 1) "I have an urge for a cigarette right now" and 2) "A cigarette would taste good right now". These items have strong correlations with the full, 10-item QSU-Brief in previous research and have high inter-item correlations (Lee et al., 2013; Maloney and Cappella, 2016). *Vaping urge* was assessed using two similar items: 1) "I have an urge for an e-cigarette right now" and 2) "An e-cigarette would taste good right now" before and after viewing the PSAs. Participants rated their responses to these items using a 5-point scale (1=very little to 5=very much). The two items for cigarettes were averaged to form the pretest (inter-item $r=0.78$) and posttest (inter-item $r=0.78$) smoking urge measures. Similarly, the two items for ENDS were averaged to form the pretest (inter-item $r=0.73$) and posttest (inter-item $r=0.80$) vaping urge measure. We computed changes in smoking and vaping urges by subtracting the pretest urge measure from the posttest urge measure of each behavior ($M(SD)_{\text{smoking urge}}=-0.27$ (1.79), skewness=-0.19; $M(SD)_{\text{vaping urge}}=-0.44$ (1.67), skewness=0.03), consistent with prior research assessing ENDS-related cue reactivity to changes in smoking and vaping urges (King et al., 2015, 2016, 2017).

2.5.2. Intention to smoke and intention to vape in the next hour.—*Intention to smoke in the next hour* was measured using the question "How likely is it you will smoke a cigarette in the next one hour?" *Intention to vape in the next hour* was measured using a similar question "How likely is it you will use an e-cigarette in the next one hour?" Responses to both questions were along a 4-point scale (1=definitely yes to 4=definitely not) or "I don't know" ($M(SD)_{\text{intention to smoke}}=3.23$ (1.08), skewness=-1.08; $M(SD)_{\text{intention to vape}}=1.72$ (0.95), skewness=1.25). The rationale for specifying "the next one hour" within the item was to assess short-term behavioral intentions of smoking and vaping following exposure to the PSAs. The responses were reverse-coded in the analyses such that a higher score reflects higher intentions to smoke or vape. Respondents who

indicated “I don’t know” were coded as missing (3 cases were missing on intention to smoke and 9 cases were missing on intention to vape).

2.5.3. Intention to purchase cigarettes and intention to purchase ENDS.—

Intention to purchase cigarettes was assessed using a measure adapted from the Juster Scale (Juster, 1966), a scale combining verbal and numeric description of probabilities that respondents would purchase a product. The Juster scale has been used to assess intentions of smoking-related behaviors including cessation and cigarette purchasing in previous research (Gendall et al., 2016; Hoek et al., 2011; Janet Hoek et al., 2011; Marsh et al., 2014; Sanders-Jackson et al., 2015). Respondents were asked “How probable is it that you will purchase a combustible or traditional cigarette in the next three months?” *Intention to purchase ENDS* was assessed using a similar question: “How probable is it that you will purchase an e-cigarette in the next three months?” Responses to both questions were along an 11-point scale (0=no chance, almost no chance (1 in 100) to 10=Certain, practically certain (99 in 100)) ($M(SD)_{\text{intention to purchase cigarettes}}=7.29 (3.65)$, skewness=-1.02; $M(SD)_{\text{intention to purchase ENDS}}=2.97 (3.55)$, skewness=0.92). The full set of response options for these items are available as Online Supplementary Material.

2.5.4. Covariates.—Nicotine dependence was assessed using the Fagerström Test for Nicotine Dependence (Heatherton et al., 1991) and categorized into low nicotine dependence (FTND score <5) and high nicotine dependence (FTND score ≥ 5). We also included study site (Boston vs. East Lansing).

We did not measure baseline intention to smoke and vape or intention to purchase cigarettes and ENDS to reduce the threat of retest sensitivity with asking multiple outcomes at baseline which might produce unwanted priming before viewing the PSAs and influence how participants processed the PSAs.

2.6. Data Analyses

Sociodemographic variables (age, sex, race/ethnicity, highest education level, and household income) were compared between conditions using chi-square and t-tests as a randomization check, which indicated no significant differences in these sociodemographic variables across conditions. Due to the skewness of four of the outcome variables, we fitted multiple linear regression models with robust standard errors to test whether PSA condition influenced each of the six study outcomes (three vaping-related and three smoking-related). A four-category PSA condition variable (vapor cue, no vapor cue, physical activity, and anti-smoking) was used as the main independent variable in each of the regression models. Each regression model controlled for study site to control for variations in participant characteristics and the study setting across sites. The models further controlled for level of nicotine dependence because we found a significant difference in level of nicotine dependence across the four study conditions ($p=0.034$). The regression analyses did not control for sociodemographic variables as there were no significant differences in these variables across conditions. Based on the regression coefficients, we plotted the marginal means of each outcome for each condition. We completed separate analyses among smokers only and dual-users.

3. RESULTS

3.1. Participants

Table 1 summarizes the participant characteristics stratified by smokers and dual-users. Most participants (58%) were current cigarette smokers and 42% were dual-users of cigarettes and ENDS. About half of the study participants were aged 25–30 years (56%), 63% were male, 47% were non-Hispanic White, 25% were college-educated or higher, 45% were currently enrolled in an institution of higher learning, and 48% reported an annual household income of less than \$20,000.

3.2. Regression analyses

Table 2 summarizes the multiple linear regression models predicting each study outcome with PSA condition for smokers only and dual-users. The referent condition is the vapor cue condition. Among smokers only, exposure to anti-vaping PSAs with vapor (vs. physical activity and anti-smoking PSAs) was associated with lower intention to vape in the next hour. Exposure to anti-vaping PSAs with vapor (vs. physical activity) was associated with lower intention to purchase ENDS, lower intention to smoke in the next hour, and lower intention to purchase cigarettes. Exposure to anti-vaping PSAs with vapor (vs. no vapor cue PSAs) was associated with higher intention to vape in the next hour. Among dual-users, there were no significant differences in these outcomes between the vapor cue condition and the other three conditions.

Table 3 summarizes the linear regression models with the no vapor cue condition as the referent. Among smokers only, exposure to anti-vaping PSAs with no vapor was associated with reduced vaping urge vs. physical activity PSAs; lower intention to vape vs. physical activity PSAs; and lower intention to purchase ENDS vs. physical activity PSAs. Among dual-users, exposure to anti-vaping PSAs with no vapor was associated with lower intention to purchase ENDS vs. anti-smoking PSAs.

To aid in the interpretation of the significant between-condition comparisons among smokers only, Figure 1 summarizes the predicted marginal means of vaping-related outcomes by PSA condition from the regression analyses. Similarly, Figure 2 summarizes the predicted marginal means of smoking-related outcomes by PSA condition from the regression analyses among smokers.

4. DISCUSSION

In this study, we examined the effects of brief exposures to anti-vaping PSAs on vaping and smoking-related outcomes among smokers only and dual-users. Specifically, exposure to anti-vaping PSAs (vs. control PSAs) was associated with 5 out of 6 vaping and smoking-related outcomes including lowering vaping urge, intention to vape, intention to purchase ENDS, intention to smoke, and intention to purchase cigarettes among smokers only. In contrast, among dual users, exposure to anti-vaping PSAs (vs. control PSAs) was associated only with lower intention to purchase ENDS, and not with the other vaping and smoking-related outcomes in this study. We further explored whether the effects on these outcomes of viewing PSAs that include portrayals of vapor differ from viewing PSAs that omit vapor. We

found a marginally significant difference in intentions to vape among smokers who viewed PSAs with vapor vs. PSAs with no vapor. These findings have implications for future efforts to design anti-vaping campaigns for different groups of young adult smokers, and also indicate directions for further research on the effects and mechanisms of processing anti-vaping messages.

The limited response to anti-vaping PSAs observed among dual users suggests that health arguments against using ENDS that are frequently utilized (e.g., ENDS lead to nicotine addiction, ENDS contain harmful chemicals) (Alaska Department of Health and Social Services, 2014; California Department of Public Health, 2017; City of Chicago, 2015; Office of the U.S Surgeon General and U.S. Centers for Disease Control and Prevention, Office on Smoking and Health, 2017; San Francisco Department of Public Health, 2015) may be less persuasive to dual users and would have reduced impact on vaping among this subgroup of smokers. Previous research found that smokers who use ENDS indicated quitting or reducing smoking as reasons for using ENDS, which suggest that these themes instead could be more salient for dual users (Berg et al., 2014; Biener and Hargraves, 2015; Patel et al., 2016; Richardson et al., 2014; Rutten et al., 2015; Vickerman et al., 2016). Accordingly, campaign planners could consider formative research to develop and evaluate specific messages targeted for dual users that ENDS have not been evaluated or approved for use as cessation devices and have not undergone rigorous evaluation of their safety and efficacy for helping smokers to quit using combustible cigarettes and ENDS completely.

In addition, one study found that dual users perceive lower comparative risk of using ENDS vs. traditional cigarettes when compared with smokers only (Richardson et al., 2014). Consequently, compared with smokers, dual users may have higher skepticism over anti-vaping PSAs that focus on health risks, leading to increased counterargument of these messages, which could explain the limited association between viewing anti-vaping PSAs and the study outcomes among dual users. Future research could examine the differences in motivational, attitudinal, and information processing processes across subgroups of smokers and how these variables interact with anti-vaping messages.

Based on the study findings, including vapor cues in anti-vaping PSAs did not result in unintended cross-over effects on smoking-related outcomes compared with anti-vaping PSAs with no vapor cues. This finding differs from previous research that reported cross-over effects of viewing vapor cues on smoking urge in the context of ENDS product advertising (King et al., 2016; Maloney and Cappella, 2016). Furthermore, anti-vaping PSAs with vapor cues may have an advantage over anti-vaping PSAs with no vapor cues compared with control PSAs (physical activity) in terms of lowering intentions to smoke and to purchase cigarettes among smokers. For campaign planners, the findings would suggest that vapor cues may not necessarily be deleterious and could either be included or omitted in future anti-vaping PSAs.

Including vapor cues in anti-vaping PSAs resulted in a marginally significant lower intention to vape in the next hour among smokers compared with anti-vaping PSAs with no vapor cues. This indicates that including vapor cues within anti-vaping PSAs may be beneficial for the purpose of discouraging vaping among smokers. This finding is contrary to expectations

based on prior research with anti-smoking PSAs which found that smoking cues may undermine the intended effect of PSAs to discourage smoking (Carter and Tiffany, 1999; Erlich et al., 2011; Kang et al., 2009; Shiffman et al., 2013; Watson et al., 2010) and with Falcone and colleagues (2013) who reported no adverse effects of smoking cues in anti-smoking PSAs. Although discouraging vaping among current smokers may not necessarily be viewed as a positive public health outcome due to the potential role of harm reduction with using ENDS (National Academies of Sciences, Engineering, and Medicine, 2018), we think that it would be most beneficial to encourage smokers to quit using both combustible cigarettes and ENDS entirely. From the overall picture of the findings in this study, anti-vaping PSAs reduced both vaping and smoking-related outcomes among smokers, suggesting that the anti-vaping PSAs may have a net positive health benefit for smokers.

4.1. Limitations

The study involved a single brief exposure to the PSAs (combined duration of 2 minutes). The experimental design may be associated with demand effects due to participants viewing anti-vaping PSAs and being asked questions about vaping and smoking cognitions almost immediately. We attempted to minimize this threat by including a non-tobacco related PSA condition (physical activity) and we believe the threat posed by demand effects were minimal as we observed significant differences between participants who viewed anti-vaping PSAs and those who viewed physical activity PSAs. We were also not able to assess participants' subsequent vaping and smoking behaviors outside of the laboratory setting. In future research, repeated exposures to PSAs and longitudinal follow-up of participants to obtain behavioral outcomes could be conducted. We utilized existing anti-smoking PSAs with smoking cues which had more variation in the messages. Future studies could create both anti-vaping PSAs with vaping cues and anti-smoking PSAs with smoking cues that are identical with the exception of the tobacco product being portrayed. The study was conducted at two sites and participants may not be representative of other smokers and dual users. While we asked participants to abstain from smoking prior to the experiment so they would be in a nicotine-deprived rather than in a satiated state, the majority of participants reported low nicotine dependence and may therefore have limited reactivity to the PSAs in terms of urge to smoke, intention to smoke within the next hour, and intention to purchase cigarettes compared with more nicotine-dependent smokers. Although we did not find that abstinence prior to the experiment resulted in ceiling effects for the outcomes in this study (there was room for change in all the study outcomes), this concern may be more apparent if there are more participants who had higher levels of nicotine dependence. Additional work to replicate the study findings among a larger, more geographically diverse, and more nicotine-dependent smokers would be recommended. We are unable to draw inferences of the impact of vapor cues on those who only use ENDS or former smokers. Subsequent studies could explore the effects of vapor cues in PSAs on tobacco-use outcomes across different subgroups of tobacco users.

4.2. Conclusion

Anti-vaping PSAs may be more effective in reducing vaping and smoking-related outcomes among young adult smokers only. The presence of vapor vs. omitting vapor in anti-vaping

PSAs was associated with lower intentions to vape among smokers. Future efforts to design targeted anti-vaping campaigns for different groups of smokers may be necessary.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

Research reported in this publication was supported by the National Cancer Institute of the US National Institutes of Health under award number U01CA154281 (State and Community Tobacco Control Initiative U01 Developmental Grant). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Figure 1 –. Vaping-related outcomes by experimental stimulus among smokers only (N=171)

Note. Predicted marginal means of each outcome for each condition, controlling for study site and nicotine dependence. Mean (SE) are reported. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Changes in vaping and smoking urges were computed by subtracting the pretest urge measure from the posttest urge measure of each behavior.

Figure 2 –. Smoking-related outcomes by experimental stimulus among smokers only (N=171)
 Note. Predicted marginal means of each outcome for each condition, controlling for study site and nicotine dependence. Mean (SE) are reported. * $p < 0.05$.
 Changes in vaping and smoking urges were computed by subtracting the pretest urge measure from the posttest urge measure of each behavior.

Table 1 –

Study sample characteristics stratified by smoking and vaping status

	Cigarette smokers only (N=171)	Dual users of cigarettes and ENDS (N=122)	
	N (%)	N (%)	Chi-Square test p
Site			0.945
Boston	89 (52%)	63 (52%)	
Lansing	82 (48%)	59 (48%)	
Age			0.245
21–24	71 (42%)	59 (48%)	
25–30	100 (58%)	63 (52%)	
Sex			0.424
Male	105 (62%)	77 (65%)	
Female	64 (38%)	41 (35%)	
Race/Ethnicity			0.183
Non-Hispanic White	73 (46%)	56 (49%)	
Non-Hispanic Black	43 (27%)	29 (25%)	
Hispanic/Latino	17 (11%)	20 (18%)	
Asian	16 (10%)	7 (6%)	
Other/Multi-racial	9 (6%)	2 (2%)	
Highest Education Level ^a			0.018
<High School	7 (4%)	12 (10%)	
High School	35 (21%)	16 (14%)	
Some College	78 (46%)	68 (57%)	
College Graduate	49 (29%)	23 (19%)	
Household Income			0.130
<\$20,000	80 (47%)	59 (50%)	
\$20,000-\$49,999	39 (23%)	27 (23%)	
\$50,000-\$99,999	32 (19%)	12 (10%)	
\$100,000	18 (11%)	20 (17%)	
Nicotine Dependence			0.253
Low	132 (77%)	87 (71%)	
High	39 (23%)	35 (29%)	

Notes. Among cigarette smokers only: 2 cases missing sex, 13 cases missing race/ethnicity, 2 cases missing education, and 2 cases missing household income. Among dual users: 4 cases missing sex, 8 cases missing race/ethnicity, 3 cases missing education, and 4 cases missing household income.

^aThere were 131 participants who reported they were currently enrolled in an institution of higher learning.

Regression analysis predicting study outcomes by experimental condition (with anti-vaping ads *with* vapor cues as reference group)

		Change in vaping urge (range from -6 to 6)		Intention to vape in the next hour (range from 1 to 4)		E/NDs (range from 0 to 10)		Change in smoking urge (range from -7 to 5)		Intention to smoke in the next hour (range from 1 to 4)		Intention to purchase cigarettes (range from 0 to 10)	
		β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Smokers (N=171)													
Experimental Condition													
Vapor cue (referent)													
No vapor cue		-0.45	-1.01, 0.12	0.18 [*]	0.01, 0.36	0.27	-0.47, 1.00	-0.05	-0.87, 0.77	0.33	-0.07, 0.72	1.27	-0.23, 2.76
Physical Activity		0.39	-0.17, 0.94	0.39 ^{***}	0.19, 0.59	1.90 ^{***}	0.84, 3.00	0.54	-0.32, 1.41	0.48 [*]	0.10, 0.87	1.69 [*]	0.15, 3.22
Anti-smoking		0.11	-0.47, 0.69	0.24 [*]	0.05, 0.42	0.88	-0.06, 1.82	-0.39	-1.23, 0.45	0.13	-0.27, 0.54	1.13	-0.36, 2.63
Dual-users (N=122)													
Experimental Condition													
Vapor cue (referent)													
No vapor cue		-0.83	-1.70, 0.04	-0.55	-1.16, 0.07	-0.64	-2.66, 1.38	0.01	-0.69, 0.72	-0.22	-0.77, 0.32	0.58	-1.28, 2.45
Physical Activity		-0.69	-1.58, 0.19	-0.32	-0.89, 0.26	-0.87	-2.73, 1.00	-0.07	-0.99, 0.84	-0.10	-0.63, 0.43	0.01	-1.88, 1.90
Anti-smoking		-0.84	-1.88, 0.20	-0.17	-0.83, 0.49	1.78	-0.06, 3.50	0.38	-0.54, 1.30	-0.23	-0.74, 0.28	0.88	-1.94, 2.70

Note. Multiple regression models with robust standard errors were fitted due to moderate skewness of four of the outcome measures.

* p<0.05,

** p<0.01,

*** p<0.001.

All analyses controlled for study site and nicotine dependence. Changes in vaping and smoking urges were computed by subtracting the pretest urge measure from the posttest urge measure of each behavior.

Table 3 –

Regression analysis predicting study outcomes by experimental condition (with anti-vaping ads *without* vapor cues as reference group)

	Change in vaping urge (range from -6 to 6)		Intention to vape in the next hour (range from 1 to 4)		Intention to purchase ENDS (range from 0 to 10)		Change in smoking urge (range from -7 to 5)		Intention to smoke in the next hour (range from 1 to 4)		Intention to purchase cigarettes (range from 0 to 10)	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Smokers (N=171)												
Experimental Condition												
No vapor cue (referent)												
Vapor cue	0.45	-0.12, 1.01	-0.18*	-0.36, -0.01	-0.27	-1.00, 0.47	0.05	-0.77, 0.87	-0.33	-0.72, 0.07	-1.27	-2.76, 0.23
Physical Activity	0.83*	0.18, 1.49	0.21	-0.00, 0.43	1.63***	0.60, 2.67	0.59	-0.11, 1.30	0.16	-0.21, 0.52	0.42	-1.02, 1.87
Anti-smoking	0.56	-0.11, 1.23	0.06	-0.14, 0.26	0.61	-0.30, 1.53	-0.34	-1.01, 0.34	-0.19	-0.58, 0.20	-0.13	-1.49, 1.22
Dual-users (N=122)												
Experimental Condition												
No vapor cue (referent)												
Vapor cue	0.83	-0.04, 1.70	0.55	-0.07, 1.16	0.64	-1.38, 2.66	-0.01	-0.72, 0.69	0.22	-0.32, 0.77	-0.58	-2.44, 1.28
Physical Activity	0.14	-0.78, 1.06	0.23	-0.38, 0.84	-0.23	-2.38, 1.93	-0.09	-1.01, 0.84	0.12	-0.43, 0.68	-0.58	-2.57, 1.41
Anti-smoking	-0.01	-1.08, 1.06	0.38	-0.29, 1.04	2.42*	0.44, 4.40	0.36	-0.52, 1.24	-0.01	-0.52, 0.51	0.30	-1.52, 2.11

Notes. Multiple regression models with robust standard errors were fitted due to moderate skewness of four of the outcome measures.

* p<0.05,

** p<0.01,

*** p<0.001.

All analyses controlled for study site and nicotine dependence. Changes in vaping and smoking urges were computed by subtracting the pretest urge measure from the posttest urge measure of each behavior.