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High School Youth and E-cigarettes: The Influence of Modified Risk Statements and Flavors on E-cigarette Packaging

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Abstract

Objectives: In this paper, we test variations of e-cigarette warning labels on high school youth, alone, and alongside modified risk statements (MRS) and/or flavors, to determine how perceptions of and intentions toward use of e-cigarettes are influenced by these package elements.

Methods: An experiment (N = 715 high school youth) varied the warning label participants viewed (FDA warning label/ MarkTen warning label/ abstract warning label) and whether they viewed the label alone or alongside MRS and/or flavors.

Results: Drawing upon the Heuristic Systematic Model, we found that youth who view an MRS with any of the warning labels are more likely to engage in counterarguing (compared to the FDA warning label alone), which increases risk perceptions. Additionally, the greater youth perceive the risks associated with e-cigarettes, the lower their intentions of using them, even if they have tried an e-cigarette in the past.

Conclusions: Tobacco education and public health messages should encourage youth to evaluate the tobacco industry messages they receive, as counterarguing is associated with higher risk perceptions. Furthermore, fostering increased awareness of the risks associated with e-cigarette use by youth can reduce intentions to use them.

Keywords

e-cigarettes; warning labels; modified risk statements; flavors; Heuristic Systematic Model

E-cigarettes present a challenge for health communication, as the products are potentially harm-reducing for adult smokers who completely switch from combustible products,[1,2] but

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Conflict of Interest Disclosure Statement

There are no conflicts of interest.

Human Subjects Approval Statement

The Institutional Review Board at the University of Minnesota gave permission in fall 2016 to collect data. Data collection occurred during the 2016–2017 academic year.

may be harm-elevating for nonsmoking youth because of the potential for nicotine addiction and because the vaping devices may contain other harmful substances, introduce foreign substances to the lung, and influence the brain development of adolescents.[3–6] Whether e-cigarettes are promoted as “safer” or not can have profound public health effects.

Research on e-cigarette labeling, including product warning labels, modified risk statements (MRS), and flavors has been growing in response to the Family Smoking Prevention and Tobacco Control Act of 2009 and the deeming that provided the United States Food and Drug Administration (US FDA) with the authority to regulate electronic nicotine delivery systems (ENDS), including e-cigarettes.[7,8] The FDA has proposed a plan for tobacco control that includes reducing tobacco-related morbidity and mortality by reducing the nicotine levels in traditional cigarettes, so they are not as addictive, while making non-combusted tobacco products such as e-cigarettes, a transition pathway away from cigarette smoking for those unable to quit.[9] Of course, essential to this tobacco control strategy is preventing e-cigarette uptake by nonsmoking youth.

In this paper, we test whether e-cigarette package elements influence how youth perceive e-cigarettes, including intentions to use the product. The FDA has stated that e-cigarettes sold in the US must include a warning label, no smaller than 12-point type and presented at 30% of the size of the package, that states, *This product contains nicotine. Nicotine is an addictive chemical*.[8] One concern is that e-cigarette packages sometimes include colorful flavor images, which may attract youth.[8] Another concern is that it is possible that in the future, manufacturers might request to include MRS, which are statements claiming that the products are associated with less of a risk of tobacco-related disease than traditional cigarettes, on the e-cigarette packages.[7,8] Therefore, it is essential to know how youth perceive the FDA e-cigarette warning label in relation to other label alternatives, and whether including an MRS or flavor on the package influences how youth view the product.

We use the Heuristic Systematic Model (HSM), which explains whether individuals use effortful thought or whether they use quick shortcuts to understand a message,[10] to predict the persuasive processes associated with various e-cigarette packaging elements. We present findings from an experiment with 715 high school students on their perceptions of e-cigarette warning label text, modified risk statements (MRS), and flavors. Finally, we conclude with theoretical and tobacco regulatory implications.

E-cigarette Package Elements

Whereas there has been extensive research on tobacco labeling,[11] the research on e-cigarette labeling and youth is just emerging. There have been some studies considering the influence of MRS and flavors on how youth perceive e-cigarettes and e-cigarette warning labels, as well as studies with adults.

Warning label text.

Prior research has investigated the influence of warning label text. In a study of adult smokers and nonsmokers, the warning label text shown on an e-cigarette package influenced risk perceptions.[12] Specifically, the extensive, medication-like MarkTen warning label text

and the FDA text at 30% of package yielded higher risk perceptions than an abstract warning label (ie, The long-term health risks associated with this product are unknown.).[12] Additionally, self-reported sex category and smoking status influenced how participants perceived the warning label text.[12] Lee et al[13] conducted a study of adult cigarette smokers and dual users, and found that those who viewed an e-cigarette package with the MarkTen warning label were more likely to agree that e-cigarettes contain dangerous chemicals and reported higher risk perceptions than those who viewed a package with no warning label. In a study of college students that compared the FDA warning label to the MarkTen warning label, the FDA text generated lower intentions to use e-cigarettes by increasing perceived risks, while the MarkTen label did not influence beliefs or intentions.[14] These early studies on the influence of warning label text suggest that it may make a difference who is viewing the message (ie, adults smokers vs college students), and therefore, it is important to consider how youth perceive these messages.

Modified risk statements (MRS).

Studies have tested the influence of modified risk statements. In a study of US youth, age 13–18, who had tried either e-cigarettes or traditional cigarettes, Andrews et al[15] found that modified risk claims made the warning label less effective in reducing e-cigarette susceptibility. These findings suggest that the modified risk messages may have unintended effects on youth. Similarly, among adult non-smokers including an MRS on an e-cigarette package increased ambiguity perceptions, which led to a process that increased intentions to use the product.[12,16] Berry et al[17] found similar results in a study of adults. When an MRS was included alongside an addiction warning label in an advertisement, it weakened the influence of the addiction warning label on addiction risk beliefs. However, when they compared an addiction warning to a reduced-risk claim in a study of adult smokers, e-cigarette users, dual users, and non-tobacco users, the addiction warning label was judged as more believable and easier to understand, and risk perceptions were higher than for the reduced-risk claim.[18]

Flavors.

Prior research has considered how the flavors in e-cigarettes attract youth. A discrete choice experiment with US youth age 14–17, studied the influence of flavors on product selection.[19] Among those who had tried an ENDS product, such as an e-cigarette, and those who have never tried them, participants were more likely to select flavors that were fruit/sweet/beverage rather than tobacco ones. However, warning messages also reduced the probability of selecting an ENDS product for those who had never used an ENDS device.[19] A survey of US youth in 6th, 8th, and 10th grades perceived flavored e-cigarettes as less harmful than non-flavored ones, and this finding was especially strong among ever and current e-cigarette users.[20] Similarly, in a national phone survey of US youth age 13 to 17, participants were more likely to try an e-cigarette offered by a friend if it was flavored like menthol, fruit, or candy compared to ones flavored like tobacco.[21] Furthermore, participants believed that fruit flavored e-cigarettes were less harmful to their health than tobacco flavored ones, with perceived harm mediating the relationship between flavors and interest in trying e-cigarettes.[21]

Whereas prior research has considered the influence of warning label text, MRS, and flavors on e-cigarette risk perceptions, it is essential to consider the relative and combined influence of these 3 factors on youth participants. Therefore, as research question one, we ask whether warning label text, modified risk statement, and flavor, in addition to demographic factors (age, self-reported sex category, white, school) and tobacco use status (last 30 days cigarette smoker, tried e-cigarette), influence how youth perceive e-cigarettes, in regards to risk perceptions, harm minimizing beliefs, novelty perceptions, message comprehension, and behavioral intentions.

The HSM, E-cigarettes, and Youth

In considering how messages influence outcome variables, one information processing factor that seems particularly important is how actively the message components are cognitively processed. The HSM states that individuals have 2 different ways of using information: systematically or heuristically. Systematic processing means they pay careful attention to the arguments in the message and think about them deeply; heuristic processing means they use quick decision rules to make snap judgements, without deliberative thought.[10,22] There are a number of different types of heuristic cues, and one is whether or not there is overall agreement between elements in the message, or what has been termed, “consensus implies correctness.”[10,22]

In a prior study of adult nonsmokers, adding a modified risk statement alongside the warning label led to both systematic and heuristic processing depending on the individual.[12,16] We propose that for youth, when an e-cigarette package contains conflicting text (ie, warning label and MRS), the individual will think deeply about these 2 arguments and actively debate them in relation to one another, which is indicative of systematic processing. This internal thought has been measured in prior research through counterarguing, or the extent to which an individual is generating arguments, debating, and questioning the claims in the message.[16]

However, when a flavor image is added to the package, we might expect a different process to take place because the flavor image is a visual cue, and visual cues are often processed heuristically.[10,22] Because the flavor suggests a different product perception than the warning label, the internal consensus between the elements on the package is likely to be reduced. We suggest that youth may be confused why something that looks just like a fruity box of gum or candy has a health warning. The concept of ambiguity has been developed in prior research on e-cigarettes to capture the perception that a lack of internal consensus exists and is perceived as confusing.[12,16] We propose that when an e-cigarette package contains a warning label and visual flavor cue, youth will experience this ambiguity.

Although we might expect that adding an MRS will lead to counterarguing and adding a flavor image will lead to ambiguity, as explained directly above, these relationships have not been tested in prior research with high school youth. Therefore, as research question 2, we ask whether warning label text, modified risk statement, and flavor, in addition to demographic factors (age, self-reported sex category, white, school) and tobacco use status

(last 30 days cigarette smoker, tried e-cigarette), influence whether youth experience ambiguity perceptions and/or counterarguing.

Next, we consider the influence of ambiguity perceptions and counterarguing on risk perceptions. When the HSM was considered as a persuasive mechanism with adult nonsmokers, we showed that ambiguity perceptions and ambiguity perceptions with counterarguing led to reduced risk perceptions and increased intentions to try the product.[16] However, this process may operate differently for youth, who may be particularly open to questioning claims of modified risk, having grown up with the Truth Initiative's questioning stance against tobacco industry messages. To investigate the persuasive processes for youth, we ask, as research question 3, whether ambiguity perceptions and/or counterarguing influence the relationships between the e-cigarette package factors (warning label, modified risk statement and flavor) and youth risk perceptions. It is also important to establish whether higher risk perceptions are associated with lower intentions to use e-cigarettes.

From a regulatory perspective, we test what persuasive processes occur when an MRS or flavor image is added to the FDA warning label, using the proposed HSM mechanisms mentioned above. As research question 4, we ask whether adding an MRS or flavor image to the FDA warning label influences risk perceptions and behavioral intentions, and by what process this may occur. As mentioned above, we might expect systematic processing for the MRS and heuristic processing for the flavor image.

METHODS

Participants

We conducted an experiment with 715 high school students (grades 9–11) in 4 schools that are a 10–30-minute drive from a large downtown metro area, and we observed the participants as they participated in the study using iPads. All data gathered from participants were self-reported via the iPads, and few, if any students, needed assistance or clarification when responding with the iPads. Data from 58 students were excluded from analysis because participants viewed another student's survey (N = 1), stopped in the middle of the study (N = 1), failed the honesty check (N = 3), failed the attention check (N = 50) or failed both the honesty and the attention check (N = 3).

Of the remaining 657 participants, 287 (43.7%) students self-identified as boys, and 370 (56.3%) students self-identified as girls. Students ranged in age from 14 to 18 (M = 15.91, SD = .93). Regarding race, 523 (79.6%) were white, 45 (6.8%) were black/African-American, 35 (5.3%) were Asian, 10 (1.5%) selected other racial categories, and 44 (6.7%) identified as multiple races. Additionally, 29 (4.4%) students identified as Hispanic. The schools varied in their social-economic profile, reporting between 12% and 44% of students receiving free and reduced-price meals. School 1 had 186 participants; school 2 had 201 participants; school 3 had 147 participants, and school 4 had 123 participants. The classes we visited were taught by one teacher within each school and were held throughout the day. There were some differences in the size of the classes.

Consistent with national trends,[3,4] these high school students used e-cigarettes more than traditional cigarettes. For example, 98 (14.9%) participants had tried a traditional cigarette, and 252 (38.4%) had tried an e-cigarette. In the past 30 days, 25 (3.8%) participants had smoked a traditional cigarette, and 142 (21.6%) had used an e-cigarette during this time. Additionally, 13 (2%) students had used 100 or more traditional cigarettes in their lifetime, and 54 (8.2%) had used 100 or more e-cigarette cartridges in their lifetime. To understand e-cigarette use by nonsmokers, it is important to note that 227 (34.6%) participants had not smoked a traditional cigarette in the past 30 days, but had tried an e-cigarette in their lifetime, with 121 (53.3% of the 227) of them using an e-cigarette in the past 30 days.

Stimulus Materials

The following variables were manipulated in the experimental conditions: (1) *warning label text* [The FDA approved text, the MarkTen 117-word text, or an abstract warning stating that the long-term health risks were unknown. All warning labels were sized to 30% of the package per the FDA deeming.][8] (2) *modified risk statement* (MRS, "This product presents a lower risk of tobacco-related disease than traditional cigarettes," included or no MRS) and (3) *Fruit flavors* (Strawberrylicious, Watermelon Splash, and Raspberry Rave included on the package or no fruit flavors). These variables were fully-crossed, resulting in 12 experimental conditions featuring every possible combination of the above factors. The conditions were: FDA warning/no MRS/no flavor (N = 51); FDA/MRS/no flavor (N = 52); FDA/no MRS/flavor (N = 52); FDA/MRS/Flavor (N = 50); MarkTen/noMRS/no flavor (N = 50); MarkTen/MRS/no flavor (N = 51); Markten/no MRS/flavor (N = 50); MarkTen/MRS/flavor (N = 52); Abstract/no MRS/no flavor (N = 49); Abstract/MRS/no flavor (N = 48); Abstract/no MRS/flavor (N = 49); and Abstract/MRS/flavor (N = 53). A control condition (N = 50) also viewed just the package fronts with no warning label, no MRS and no flavors. We use the control condition as a comparison for the manipulation check for label condition, as not all of our measures are informative when there is no warning statement text, MRS, or flavor shown. The e-cigarette brands used were the ones launched by major tobacco companies at the time of the study, R.J. Reynolds's Vuse, Imperial's Blu, and Altria's MarkTen. The box size, font, and style of the labels were standardized across conditions. Figure 1 includes a close up of a few of the packages.

Each participant viewed 9 successive images of these e-cigarette packages in their assigned condition with each package being held on screen for 10 seconds before the participant was given the option to advance to the next screen. Participants viewed all 3 brands, and each image was viewed 3 times, for a total of 9 images.

Procedure

All participants completed the study during health class, with the cooperation of the superintendents, principals, administrators and teachers. In advance of our arrival to the school, students had secured parental permission on an IRB-approved form. During our visit, they were told we were interested in what they thought about e-cigarettes and that there were no right or wrong answers. They provided assent, were informed that their responses would not be connected with their identity, were randomly assigned (stratification by school) to one of 13 experimental conditions, and received an iPad set to their assigned condition.

As mentioned above, the study was self-administered, while the research team observed. After responding to demographic and tobacco use questions, they viewed the 9 images in their assigned condition, responded to dependent measures, and answered an honesty check question. They were debriefed with an IRB approved debriefing that included a list of health risks associated with e-cigarettes from the CDC's website. A research assistant read the debriefing to them, and they were given a paper copy to take home. As requested by the school districts, participants did not receive compensation for participating, however, we recommended that the health teachers provide extra credit or homework credit for the students who returned their parental permission forms, regardless of whether or not the parents approved participation in the study. To the best of our knowledge, this was done in all classrooms.

Measures

Several of the measures used in this study were part of a pilot project on the perceptions of e-cigarette package elements.[12,16] One of our partner school districts worked with us to make sure the study materials were at the appropriate reading level for high school youth. All of the school districts approved the study materials, including the measures.

Risk perceptions.—To measure risk perceptions, we developed a scale by adapting questions that have been used in prior tobacco research:[12,23] *how much do you think people harm themselves when they use electronic cigarettes (e-cigarettes*), 1 = *No harm*, 2 = *A little harm*, 3 = *Some harm*, 4 = *A lot of harm*; *In your opinion, is using electronic cigarettes (e-cigarettes) risky for one's health?*, 1 = *Not at all*, 2 = *Maybe*, 3 = *Yes*; and *How risky are e-cigarettes?*, 1 = *Not at all risky* through 5 = *Very risky*. Because these questions were all on different scales, it was necessary to multiply responses by 15, 20, and 12, respectively before adding the values together and dividing by 60 to provide a weighted average (possible range 0.78 to 3.0). A *post hoc* factor analysis shows the questions forming this scale load on one component (N = 607, *Possible* and *Actual Range* = .78–3.00, M = 2.25, SD = .53, α = .85)

Harm minimizing beliefs.—One of the concerns about youth and e-cigarettes is that youth might minimize the risks. Conceptually, we drew upon research on the comparative risk perceptions that youth and young adults have about e-cigarettes and cigarettes to develop the questions that were used in our harm minimizing beliefs scale.[24] To measure harm minimizing beliefs, participants responded on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*) to the following statements: *Electronic cigarettes (e-cigarettes) are safe*; *Electronic cigarettes (e-cigarettes) are safer than traditional cigarettes*; and *Electronic cigarettes (e-cigarettes) must be safe because cigarette smokers use them to quit using cigarettes*. A *post hoc* factor analysis shows the questions forming this scale load on one component (N = 607, Possible Range = 1.00–5.00, Actual Range = 1.00–4.67, M = 2.60, SD = .78, α = .74).

Novelty perceptions.—When we developed this project, the concept of novelty perceptions had not been measured quantitatively in tobacco research, to our knowledge. However, some elements of this concept, such as 'cool' had been utilized. As a result, we drew conceptually from existing research on tobacco and youth to identify 'novelty factors'

associated with e-cigarettes,[25–27] and we developed the scale used in this study. We measured novelty perceptions by asking participants to indicate on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*) whether they thought e-cigarettes are (5 questions): *cool, fun to try, refreshing, interesting* and *like candy*. We ran a *post hoc* factor analysis on these measures to establish that they loaded on one component (N = 607, Possible and Actual Range = 1.00–5.00, M = 2.24, SD = 1.00, α = .90).

Comprehension.—Prior research has highlighted the role of message comprehension, or understanding of a message, as an important measure of message effectiveness.[28] To measure comprehension, participants responded on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*) to indicate whether they agreed with the statement: *The packages I just viewed gave me a better understanding of electronic cigarettes (e-cigarettes)* (N = 607, Possible and Actual Range = 1.00–5.00, M = 2.89, SD = 1.04).

Ambiguity.—Prior research has conceptualized the concept of perceived ambiguity as an assessment that contradictory information exists,[29] and a measure as to whether one finds contradictory recommendations to be confusing.[30] The ambiguity scale used in this study was developed in prior work, and we use that same measure.[12,16] We asked participants to respond to 4 statements on a 7-point scale (1 = *not at all*, 7 = *very much)*. The items were: *the packages were confusing*,[31] *the packages were contradictory, the packages were ambiguous*, and *I was confused by the packages I viewed*. A *post hoc* factor analysis reflects these questions load on one component (N = 607, Possible and Actual Range = 1.00–7.00, M = 2.87, SD = 1.32, α = .79).

Counterarguing.—Counterarguing refers to active cognitive thought that is counter to the message.[32] For example, an individual may question the claims in the message, express skepticism, or think of ideas that are in opposition to the message. We used a 3-item scale from Silvia[32] that is well-established in the literature to measure counterarguing.[32] Participants responded to 3 statements on a 7-point scale (1 = *not at all*, 7 = *very much*) that capture active engagement with the message: *were you criticizing the packages while reading them*; *were you thinking of points that went against them*; and *while reading the packages, were you skeptical of the arguments in them*. Next, we averaged the responses to these questions to calculate the counterarguing scale (N = 607, Possible and Actual Range = 1.00–7.00, M = 4.05, SD = 1.71, α = .77). A *post hoc* factor analysis reflects these questions load on one component.

Behavioral intentions.—To measure whether participants intended to use e-cigarettes, we asked: *Do you think you will use an e-cigarette soon?*[33] This question was selected from the NIH/FDA PATH Survey because it captured both susceptibility to uptake and continued use among our high school participants.[34] Participants could answer: 1 = *definitely not*, 2 = *probably not*, 3 = *probably yes*, or 4 = *definitely yes* (N = 607, Possible and Actual Range = 1.00–4.00, M = 1.74, SD = .92).

Data Analysis

Using SPSS version 22, we investigated the first 2 research questions with linear regression using ordinary least squares (OLS). The predictors included age, self-reported sex category (boys = 0, girls = 1), race (not white = 0, white = 1), dummy variables for school (school 4 = reference), cigarette smoking status (non-smoker = 0, past 30 days = 1), e-cigarette use (have not tried e-cigarette = 0, tried e-cigarette = 1), and dummy variables for our package conditions (reference category = FDA label, no MRS, no flavor). For research question 3, we investigated indirect effects using Hayes's PROCESS macro.[34] The Hayes' PROCESS macro is a statistical approach to calculating indirect effects. It is an OLS and logistic regression path analysis modeling tool used for measured variables that can be used in SPSS and SAS.[34] The PROCESS approach provides point estimates for *a, b, c'*, and *indirect* relationships. The *a* point estimate is the regression coefficient between the independent variable and the mediator; *b* is the coefficient between the mediator and the dependent variable; c' is the direct effect between the independent variable and the dependent variable when the mediator is included in the model. The indirect relationship is the relative effect of the independent variable on the dependent variable, that is attributed to the change in the value of the mediator. To test for an association between risk perceptions and behavioral intentions, we used linear regression with OLS, and for research question 4, we conducted structural equation modeling using AMOS version 23.[35]

RESULTS

Manipulation Checks

We conducted manipulation checks for label conditions and MRS conditions, and the manipulations were effective. The manipulation checks are available in supplemental materials or through correspondence with the author. Whereas the control condition is only used to illustrate manipulation checks, we do report the overall means and standard deviations for this control group on Table 1 for the measures that ask about e-cigarette perceptions.

Research Questions

E-cigarette package elements.—Research question one asked whether warning label text, MRS, and flavor, in addition to demographic factors and tobacco use, influenced how youth perceived e-cigarettes on the dependent measures of risk perceptions, harm minimizing beliefs, novelty perceptions, message comprehension, and behavioral intentions (see Table 1 for means). As the regressions illustrate (Table 2), participants who identified themselves as girls had higher risk perceptions and lower harm minimizing beliefs than those who identified themselves as boys. Participants in school 2 reported higher risk perceptions and lower harm minimizing beliefs than participants in school 4, and school 3 reported lower harm minimizing beliefs and lower novelty perceptions. Prior e-cigarette experience predicted lower risk perceptions, higher harm minimizing beliefs, higher novelty perceptions, and higher intentions to use an e-cigarette soon. Interestingly, those who had smoked a traditional cigarette in the past 30 days had higher novelty perceptions and higher behavioral intentions. In the case of label conditions, the lengthy MarkTen label generated higher message comprehension when the package did not include an MRS.

The HSM: ambiguity or counterarguing?—Next, as research question 2, we asked whether warning label text, MRS, and flavor, as well as demographic factors and tobacco use status, influence whether youth experience ambiguity perceptions and/or counterarguing. Table 1 includes the means and standard deviations for these variables, and Table 2 includes the regression table. Girls were more likely to experience both ambiguity and counterarguing, and prior e-cigarette experience reduced counterarguing. Participants in school 1 had lower ambiguity perceptions than participants in school 4. Although the 4 MarkTen labels (with and without MRS and with and without flavors) increased both ambiguity and counterarguing, the FDA and abstract labels that included the MRS also increased counterarguing. In other words, when the package included either an MRS and/or a MarkTen label, counterarguing was greater than for the reference category of the FDA warning statement alone.

The HSM: connections between ambiguity, counterarguing, risk perceptions and behavioral intentions.—Next, as research question 3, we asked whether ambiguity perceptions and/or counterarguing helped to explain the relationship between e-cigarette package factors and risk perceptions. As mentioned above, we used PROCESS to test for indirect effects, and Figure 2 reports the results.[34] We compare each of the experimental conditions to the reference condition to determine the *a* relationships, ie, the relationships between the dummy variable associated with the particular condition and the mediator being considered. Because of the large number of *a* relationships, the coefficients are reported on Figure 2, but not in the text, and, a key is provided on the figure to define each condition. Both the text and the figure include the indirect effect point estimate, as well as the *b* (relationship between mediator and dependent variable) and *c'* (direct effect when the mediator is in the model) coefficients. As Figure 2 illustrates, there was an indirect effect on the relationship between e-cigarette package elements and risk perceptions for counterarguing as a mediator, (indirect: .11, CI = .05 to .19, a = *reported on* Figure 2, b = .10***, c' = −.12*ns*, full mediation), but not for ambiguity perceptions, (indirect: −.00, CI = −.02 to .01, a = *reported on* Figure 2, b = −.01 ns, c' = −.12 ns). Specifically, whenever the package contained the MarkTen warning text or an MRS, counterarguing increased, which led to greater risk perceptions. Additionally, the more risky youth perceive e-cigarettes, the lower their intentions to use them, $F(1, 605) = 205.84$, $p < .001$, $R^2_{adj} = .25$ ($B_{undst} = -.87$, SE = .06) This is true for both those who have tried an e-cigarette in the past, $F(1, 230) = 26.95$, $p < .001$, $R^2_{adj} = .10$, ($B_{undst} = -.57$, SE = .11) and for those who have not, $F(1, 373) = 86.86$, $p < .001$, $R^2_{adj} = .19$, ($B_{undst} = -.45$, SE = .05).

Next, as research question 4, we focused on the influence of adding the MRS or flavor image to the package with the FDA warning label. As explained above, we proposed that the MRS might lead to systematic processing and that the flavor might lead to heuristic processing. Figure 3 illustrates the structural equation models testing the influence of adding an MRS or a flavor to the FDA warning label text. Consistent with systematic processing, adding an MRS to the package with the FDA warning label text increased counterarguing, which increased risk perceptions, which decreased behavioral intentions. Youth actively processed the conflicting text, which led them to ultimately have lower intentions of using

the product. In the case of the other tested models, either the fit statistics were not sound or key relationships in the path were not statistically significant.

DISCUSSION

Review of Findings

Whereas we did not find many differences between conditions on our dependent measures, with the exception of message comprehension, our study illustrates 2 important findings. First, factors associated with the person themselves, such as self-reported sex category and prior experience with e-cigarettes, are important in regards to how the e-cigarettes are perceived. It seems likely that by high school these participants already have formulated tobacco viewpoints based on their prior use. Additionally, girls are more likely to report higher risk perceptions and lower harm minimizing beliefs, and they are more likely to experience ambiguity perceptions and engage in counterarguing.

Second, the way that package elements are psychologically processed, particularly with respect to counterarguing, influences how risky youth perceive them to be. For example, whenever the package contains an MRS alongside any of the warning labels, or the MarkTen warning text, counterarguing is higher (compared to the reference condition), which leads to higher risk perceptions. Overall, we also established that the more risky youth perceive e-cigarettes to be, the less likely they are to use them, both for those who have tried e-cigarettes in the past and those who have not. Finally, we demonstrated that adding the MRS to the FDA warning label leads to lower intentions to use the product, through increased counterarguing and risk perceptions. This result may seem counter-intuitive, as adding a message claiming the product leads to *lower tobacco-related disease* increases risk perceptions. However, this finding is theoretically consistent with the HSM,[10,22] as the presence of conflicting information on the package (warning label text and MRS) leads to more active engagement with the arguments in the message, and for youth, who have grown up with the Truth Initiative's questioning stance toward tobacco products, the active cognitive thought leads to increased risk perceptions. Additionally, the mention of *tobacco-related disease* in the MRS may remind them of tobacco.

Although ambiguity is a big factor for adults in explaining how they process the MRS,[16] it was not explanatory for youth in the case of an MRS or flavors. One explanation for this is that the flavors may be so intrinsically connected to how youth think about e-cigarettes, that adding them does not introduce additional conflicting information into the message environment. Support for this logic can be found in the fact that adding a fun, fruity flavor to the package did not increase novelty perceptions.

One point that it is important to clarify is that we used both the PROCESS macro[34] and SEM in our analyses. PROCESS focuses on whether one variable has an indirect effect on the relationship between 2 others, and SEM fits the variables together distributing error throughout the entire pathway. We chose to show both of these approaches to accurately respond to each of our research questions using the approach that best matched the inquiry. For example, when connecting package condition, counterarguing, risk perceptions, and behavioral intentions, we selected to use structural equation modeling rather than successive

PROCESS analyses to account simultaneously for all 4 variables in the model. Interestingly, both PROCCESS and SEM demonstrate the same cognitive pathway in regards to adding an MRS to the FDA warning label, which fosters confidence in these results.

Limitations

Although we made every effort to be thoughtful in our approach, there are some limitations to clarify. First, we reached a hard-to-study sample of youth and had procedures in place, such as an attention check and an honesty question, to make sure they took the study seriously. Still, we are subject to the limitations of research with youth, including variable levels of understanding as to the meaning of our questions. Additionally, the parents who said *yes* to the study and the youth who remembered to bring back the parental consent form might introduce some sampling bias. For example, based on a comparison between the enrollment statistics for the school districts and our data, under-represented minorities were less likely to participate in the study. Accordingly, we included a variable for race in our regressions to address this. Whereas we made an effort to reach youth in multiple schools, across different semesters, and in different classes, some schools and classes yielded more participation than others. To address this, we included dummy variables for the schools in our regressions. It is also important to acknowledge that the classes we visited were held at different times throughout the day, and there were some differences in the size of the classes.

Our measures are consistent with the pilot research done on this topic, in that we associate systematic processing with counterarguing and heuristic processing with ambiguity.[12,16] However, one might argue these concepts can be measured in different ways. Additionally, we did not measure the influence of need for cognition, focal attention, or recall. We also utilized single item measures for message comprehension and behavioral intentions and developed scales for harm minimizing perceptions and novelty perceptions based on prior conceptual work. We recognize the limitations of this approach. When we began this study, the literature did not have established scales for e-cigarettes on these concepts. We have conducted factor analyses to confirm the items for our measure each load on one factor, and we have included alphas to demonstrate internal reliability among items.

Our stimuli materials were designed using actual package photographs and isolating key package elements. Whereas all warning label statements are positioned at 30% of package to be consistent with the deeming, the MarkTen label featured smaller and more crowded text, and the other statements featured bigger text because they were shorter. Additionally, our stimuli were shown to participants on an iPad screen in the fixed confines of the study for a relatively short amount of time (90 seconds). This length of exposure is a relatively short period of exposure compared to the lifetime of messaging that individuals are exposed to, and we did not study any long-term or lasting impacts of this exposure.

Suggestions for Future Research

In the future, researchers should seek to determine how middle school youth perceive e-cigarette package elements. As having “tried an e-cigarette” was a strong predictor in this study, it would be informative to test the influence of package elements on a population with a lower percentage of prior use. Although we considered the role of fruit flavors on the

packages, future researchers should consider how different types of flavor categories (ie, tobacco, menthol, fruit, candy, and gothic flavors) influence risk perceptions associated with e-cigarettes. Furthermore, as usage practices are continually changing, it is essential to conduct focus groups with youth on an ongoing basis to learn about current practices. Additionally, future researchers also should consider the relationship between the use of cartoon logos and e-cigarette warning labels on teen perceptions of and susceptibility toward use of vaping products.[36]

Theoretical Implications

Prior research on the HSM has provided mixed findings on whether or not persuasive processes are fostered or disrupted.[37] From this study, we do not have any evidence that the conflicting information is disruptive, as an MRS leads to more thoughtful processing and ultimately beneficial outcomes among youth (youth have increased risk perceptions and lower behavioral intentions to use e-cigarettes). From the perspective of the HSM, our findings suggest that the 2 text arguments generate cognitive debate that is consistent with systematic processing. One point worth considering is that individual difference factors, such as how deeply an individual prefers to think and interest level, may explain whether or not those exposed to conflicting information engage in this active approach. In the case of flavors, we predicted a heuristic processing model, with ambiguity as the explanatory mechanism, and we did not find support for this model.

From the perspective of tobacco regulatory science, there is a particular concern about how youth are perceiving and using e-cigarettes, as usage rates have been exponentially increasing in recent years and the health impact of this usage is incalculable at this time.[5] This study suggests that comprehension may increase when a lengthy label is used, but that there is otherwise no direct impact of package features on risk perceptions, harm minimizing beliefs, novelty perceptions, or behavioral intentions. However, there is an impact on how the package is cognitively processed and for those who engage in counterarguing as a result of questioning the MRS, we see a pathway wherein the counterarguing increases risk perceptions. Because higher risk perceptions are associated with reduced intentions to use the product, tobacco education for high school students should focus on increasing risk perceptions. One way to do this is to encourage youth to evaluate tobacco industry messages critically, through educational media campaigns and school-based initiatives. At the same time, youth who have difficulty thinking critically might need additional support in resisting tobacco, and this issue presents a challenge for parents, educators, community partners, and regulatory efforts.

Although we assumed that adding a fruity flavor to the package would increase ambiguity perceptions and novelty perceptions for youth, this was not the case. One explanation for this is that prior research shows that e-cigarettes are already perceived as fun and less risky, [38] and perhaps the fruit flavors are so intrinsically tied to how youth are viewing e-cigarettes that their addition does not constitute any new or conflicting information. Perhaps the fruit flavors do not increase ambiguity perceptions because they are not at all confusing in regards to how youth are already viewing e-cigarettes.

In this experiment with 715 high school youth, we compared different e-cigarette package elements, including warning label text, MRS and flavor image. Youth who viewed an MRS alongside any of the warning labels engaged in higher levels of counterarguing (compared to those who viewed the FDA warning label with no MRS and no flavor), which led to higher risk perceptions. We also established that the riskier youth viewed e-cigarettes, the lower their intentions to use them, both for those who have tried e-cigarettes in the past and for those who have not. In the case of the FDA warning label, adding an MRS to the package increased counterarguing, which led to higher risk perceptions and lower intentions to use the product. As usage rates increase among youth, a key challenge is to understand the influence of package elements on youth.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Sample Stimuli Materials - All Participants Viewed All 3 Brands in Their Assigned Warning Label Text/ Modified Risk Statement/ Flavor Condition (Manipulation Checks Available by Request)

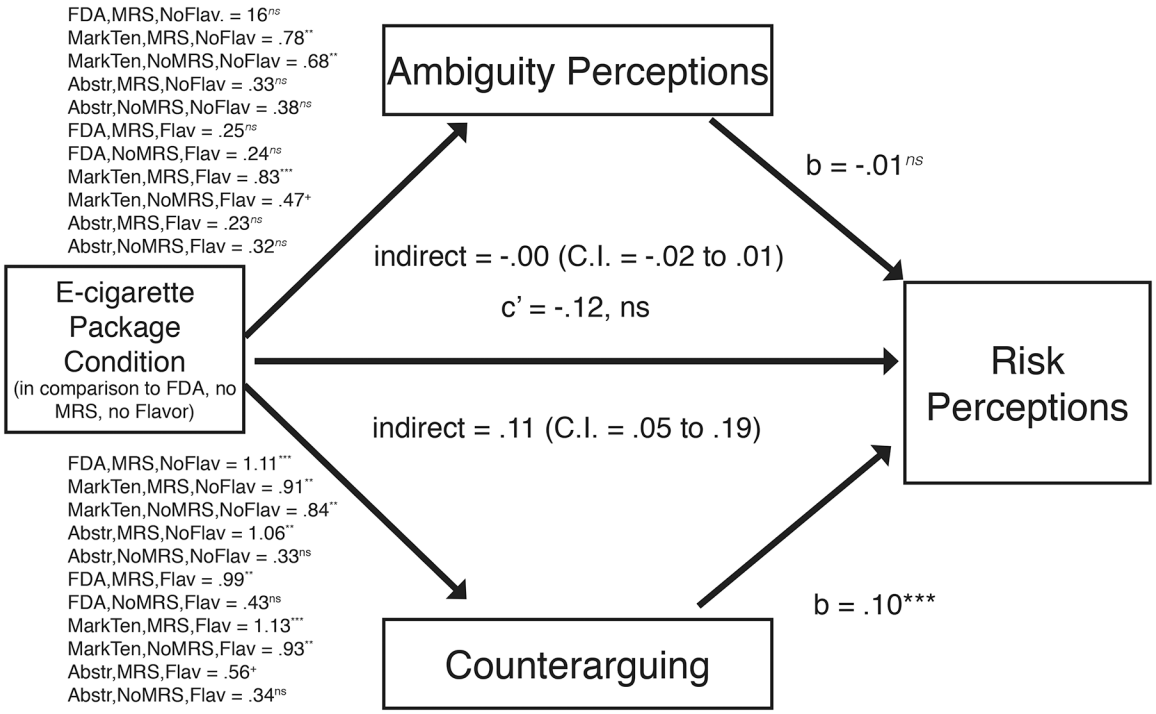

Figure 2.

Testing the Influence of Ambiguity Perceptions and Counterarguing on the Relationship between E-cigarette Package Condition and Risk Perceptions

+p ≤ .10, *p ≤ .05, **p ≤ .01, ***p ≤ .001

Note.

The reference category is FDA,noMRS,noFlav. The IV was entered as FDA,MRS,NoFlav with the other dummy variables listed as covariates. Model 4 was selected in PROCESS. The warning label conditions were: FDA = FDA warning label; MarkTen = MarkTen warning label; Abstr = Abstract warning label. MRS means the package contained a modified risk statement, and noMRS means that the package did not contain a modified risk statement. Flav means the package contained a fruit flavor image, and noFlav means the package did not contain a fruit flavor image. The content of the warning labels and modified risk statements, as well as examples of the fruit flavors, can be seen in Figure 1.

This figure illustrates that when an MRS is on the package or when the MarkTen warning label is viewed, youth engage in more counterarguing than when they view the FDA warning label alone, and this counterarguing fully explains an increase in risk perceptions. There is no indirect effect for ambiguity perceptions.

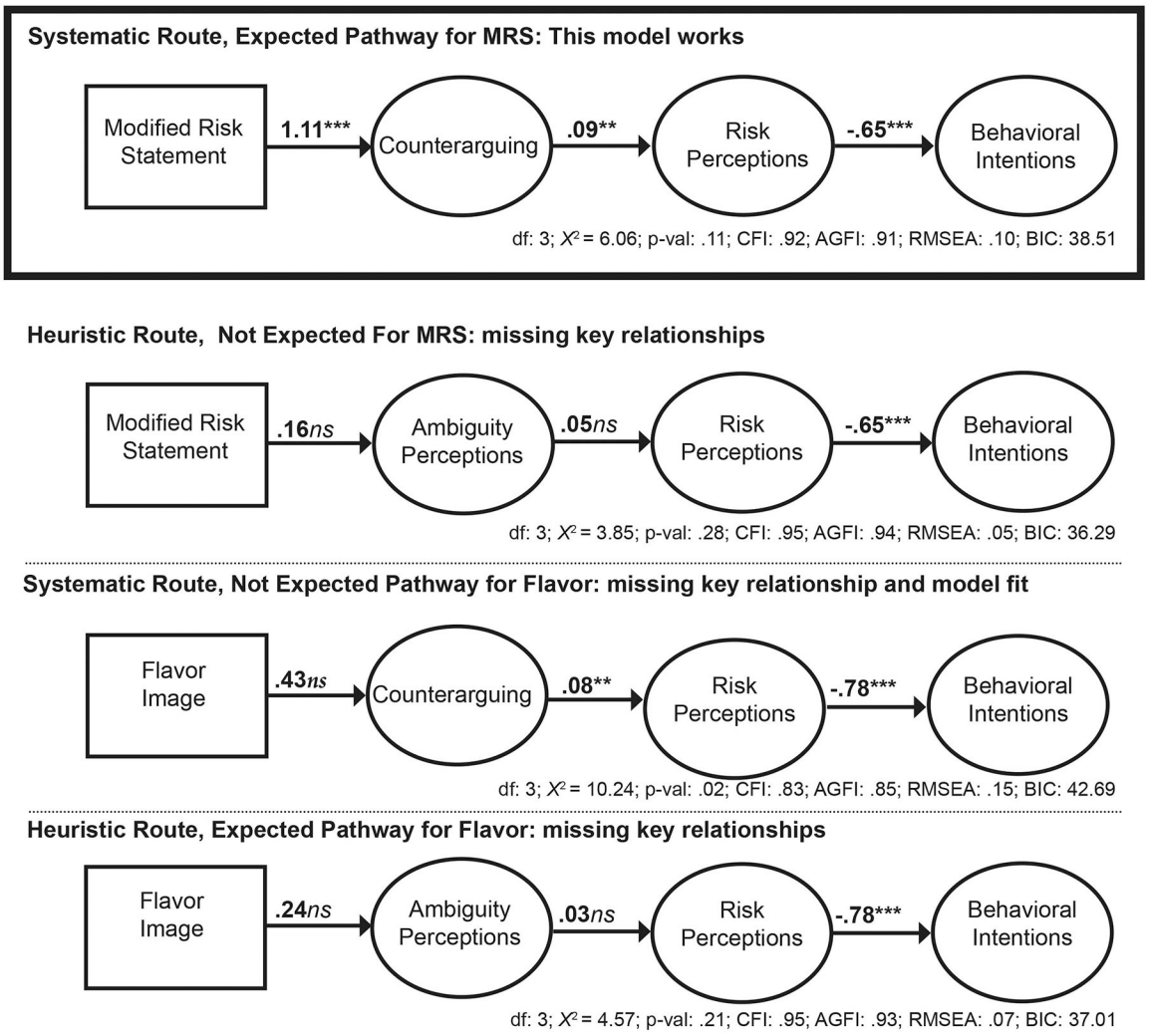

Figure 3.

Testing the Influence of Adding a Modified Risk Statement or a Flavor Image to the FDA Warning Label, through the Theoretical Perspective of the Heuristic Systematic Model

+p ≤ .10, *p ≤ .05, **p ≤ .01, ***p ≤ .001

Note.

These analyses used only those participants who viewed the FDA warning label. The first 2 models use only those participants who viewed the FDA warning label alone or with the MRS (no flavor), and the second 2 models use only those participants who viewed the FDA warning label alone or with the flavor (no MRS).

Table 1

Means and SDs for Warning Label Text x Modified Risk Statement x Flavor for Dependent Variables (RQ1, RQ2)

Warning Label Text	Modified Risk Statement	Flavor	Risk Perceptions	Harm Minimizing Beliefs	Novelty Perceptions	Message Comprehension	Behavioral Intentions	Ambiguity	Counterarguing
			M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
No Label	No MRS	No Flavor (a)	2.19 (.57)	2.54 (.71)	2.25 (1.06)	--	1.72 (.93)		
FDA Label	No MRS	No Flavor (b)	2.28 (.58)	2.58 (.82)	2.22 (.84)	2.78 (1.01)	1.55 (.70)	2.49 (.99)	3.33 (1.47)[di]
		Flavor (c)	2.23 (.50)	2.76 (.67)	2.26 (1.03)	2.67 (1.00)[f]	1.73 (.97)	2.72 (1.33)	3.76 (1.86)
	MRS	No Flavor (d)	2.28 (.51)	2.69 (.83)	2.15 (1.12)	2.87 (.89)	1.83 (.99)	2.64 (1.29)	4.44 (1.49)[b]
		Flavor (e)	2.27 (.52)	2.49 (.79)	2.21 (1.05)	2.90 (1.04)	1.80 (.99)	2.74 (1.23)	4.32 (1.62)
MarkTen Label	No MRS	No Flavor (f)	2.26 (.50)	2.60 (.83)	2.28 (1.09)	3.44 (.81)[cjkm]	1.80 (.99)	3.17 (1.39)	4.17 (1.67)
		Flavor (g)	2.30 (.56)	2.50 (.85)	2.06 (.99)	3.18 (1.06)[k]	1.60 (.90)	2.96 (1.35)	4.26 (1.64)
	MRS	No Flavor (h)	2.22 (.56)	2.53 (.82)	2.27 (1.10)	3.12 (1.11)	1.78 (.97)	3.27 (1.39)	4.24 (1.62)
		Flavor (i)	2.35 (.50)	2.49 (.72)	2.32 (.94)	2.81 (1.03)	1.60 (.82)	3.32 (1.34)	4.47 (1.65)[b]
Abstract Label	No MRS	No Flavor (j)	2.24 (.55)	2.62 (.87)	2.36 (1.07)	2.71 (.98)[f]	1.90 (1.09)	2.86 (1.46)	3.67 (1.77)
		Flavor (k)	2.12 (.58)	2.65 (.76)	2.33 (.96)	2.49 (1.12)[fg]	1.84 (.92)	2.80 (1.47)	3.67 (1.83)
	MRS	No Flavor (l)	2.24 (.46)	2.72 (.62)	2.33 (.94)	3.00 (1.03)	1.69 (.75)	2.82 (1.15)	4.40 (1.75)
		Flavor (m)	2.25 (.53)	2.61 (.74)	2.15 (.93)	2.75 (1.07)[f]	1.75 (.85)	2.72 (1.23)	3.89 (1.87)

Note.

Tukey's correction was used for post hoc analyses.

The superscripts illustrate which items are significantly different from one another. The comparisons are defined in the flavor column.

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Table 2

Regression Models Predicting Dependent Variables

	Risk Perceptions	Harm Minimizing	Novelty Perceptions	Message Comprehension	Behavioral Intentions	Ambiguity	Counterarguing
Age	.03 (.02)	−.04 (.03)	.04 (.04)	.02 (.05)	.03 (.03)	.06 (.06)	.09 (.07)
Self-reported sex category	.15 (.04)***	−.23 (.06)***	−.12 (.07)+	−.01 (.08)	−.10 (.06)+	.56 (.11)***	.66 (.13)***
White	−.07 (.05)	.07 (.07)	−.08 (.09)	−.14 (.11)	.12 (.07)+	−.01 (.13)	.16 (.17)
School1	−.05 (.06)	.06 (.09)	−.03 (.10)	−.02 (.13)	.00 (.09)	−.33 (.16)*	−.09 (.20)
School2	.16 (.06)**	−.25 (.08)**	−.10 (.10)	.05 (.12)	−.02 (.08)	.12 (.16)	.07 (.20)
School3	.09 (.06)	−.19 (.09)*	−.23 (.11)*	.12 (.13)	.02 (.09)	−.22 (.16)	.14 (.21)
Cigarette smoking status	−.08 (.11)	.02 (.15)	.57 (.18)**	−.40 (.23)+	.51 (.15)***	−.33 (.28)	−.33 (.36)
E-cigarette use	−.40 (.04)***	.73 (.06)***	1.08 (.07)***	−.02 (.09)	1.19 (.06)***	−.06 (.12)	−.85 (.15)***
FDA/no MRS/Flavor condition	−.04 (.10)	.17 (.13)	−.02 (.16)	−.11 (.20)	.10 (.13)	.17 (.25)	.42 (.32)
FDA/MRS/no Flavor condition	.03 (.09)	.06 (.13)	−.16 (.16)	.10 (.20)	.19 (.13)	.20 (.25)	1.19 (.32)***
FDA/MRS/Flavor condition	.05 (.10)	−.17 (.13)	−.09 (.16)	.13 (.20)	.17 (.14)	.37 (.25)	1.14 (.32)***
MarkTen/no MRS/no Flavor condition	.02 (.10)	−.05 (.13)	−.03 (.16)	.65 (.20)**	.17 (.14)	.73 (.25)**	.97 (.32)**
MarkTen/no MRS/Flavor condition	.04 (.10)	−.11 (.13)	−.19 (.16)	.40 (.20)*	.03 (.14)	.51 (.25)*	1.00 (.32)**
MarkTen/MRS/no Flavor condition	−.04 (.10)	−.08 (.13)	−.02 (.16)	.34 (.20)+	.16 (.14)	.80 (.25)**	.95 (.32)**
MarkTen/MRS/Flavor condition	.05 (.09)	−.05 (.13)	.12 (.16)	.01 (.20)	.09 (.13)	.81 (.25)***	1.12 (.32)***
Abstract/no MRS/no Flavor condition	.01 (.10)	−.05 (.14)	.01 (.17)	−.05 (.20)	.20 (.14)	.42 (.26)+	.44 (.32)
Abstract/no MRS/Flavor condition	−.09 (.10)	−.04 (.14)	−.05 (.17)	−.29 (.20)	.12 (.14)	.42 (.26)+	.55 (.32)+
Abstract/MRS/no Flavor condition	−.02 (.10)	.11 (.14)	.06 (.17)	.21 (.21)	.12 (.14)	.35 (.26)	1.14 (.32)***
Abstract/MRS/Flavor condition	.01 (.09)	−.04 (.13)	−.16 (.16)	−.02 (.20)	.09 (.13)	.21 (.25)	.62 (.32)*
Adjusted R^2	.18	.26	.33	.04	.45	.07	.12
F	7.90***	11.98***	16.78***	2.22**	27.16***	3.54***	5.53***
df	19	19	19	19	19	19	19
Residual df	587	587	587	587	587	587	587

+ $p \leq .10$,

*
p ≤ .05,

**
p ≤ .01,

***
p ≤ .001

Note.

Cells represent unstandardized regression coefficients and standard errors of ordinary least square (OLS) regressions. Predictors: age, self-reported sex category (male = 0, female = 1), race (not White = 0, White = 1), dummy variables for school (reference category = school4), cigarette smoking status (non-smoker = 0, past 30 days = 1), e-cigarette use (have not tried e-cigarette = 0, tried e-cigarette = 1), and dummy variables for our package conditions (reference category = FDA label, no MRS, no flavor).