Published in final edited form as:

Health Behav Policy Rev. ; 2(2): 154–162. doi:10.14485/HBPR.2.2.7.

Perceived Characteristics of E-cigarettes as an Innovation by Young Adults

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Abstract

Objectives—We examined channels through which information about e-cigarettes has flowed, public perception of e-cigarettes as an innovation, and how these may influence use.

Methods—An online survey of US adults aged 18–24 years (N = 874) was used. Measures included information channels, perception of e-cigarettes as an innovation, and intention to use.

Results—Television ranked first for exposure to e-cigarette information. The most positive innovation attributes were observability and relative advantage. A structural model showed that information exposure and favorable perception as an innovation predicted use.

Conclusions—The high degree of e-cigarette awareness combined with depiction of the devices as a favorable innovation may contribute to their wider adoption and may argue for regulation of e-cigarette advertising.

Keywords

E-cigarettes; information channels; Diffusion of Innovations

Since their 2007 introduction in the US electronic cigarettes (e-cigarettes) have gone from obscurity to widespread recognition. The first nationally representative survey of adults' awareness of e-cigarettes found in 2009 that 16% of respondents had heard of e-cigarettes.¹ A national survey done in spring 2013 found that 86% had heard of e-cigarettes.² One of the interesting aspects of this rapid increase of product awareness is that it has occurred in the absence of a similar trajectory in use. In 2009, *ever use* was estimated to be 0.6% among Americans.³ By 2012, 8.1% of US adults had tried an e-cigarette, with 1.4% in current use; among smokers, 32.2% had tried an e-cigarette and 6.3%, were current users.⁴ Given these observations, we sought to examine from where individuals had received e-cigarette

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Human Subjects Approval Statement

All completed questionnaires were anonymous, and no personal identifiers were used. The study was reviewed and approved as exempt by the Colorado State University Institutional Review Board.

Conflict of Interest Declaration

Neither author reports a conflict of interest in this work.

information, how they perceived the attributes of e-cigarettes, and whether these 2 factors were associated with use.

Several studies have examined the communication channels through which people have become aware of e-cigarettes.⁵⁻⁷ Communication channels are conceptualized as a mode of information delivery. These are often classified as print, such as traditional newspapers or magazines, broadcast, such as radio or television, Internet, and interpersonal. The interpersonal channel can play an important role in the flow of information and influence, especially when amplifying mediated channels. The contrasts among channels for learning about e-cigarettes has been described by Pepper et al.² In their large national survey it was found that interpersonal contacts were dominant, followed by point-of-purchase contacts (which can include an interpersonal component), television ads, online content, print ads, print news stories, and other modes. This pattern was generally consistent across current, former, and never smokers.

The information environment for e-cigarettes has been dynamic. A single advertising campaign for the product bluTM dominated the representation of e-cigarettes on television from 2011 to 2013, which has been cited as a significant factor in the increase of public awareness.^{8,9} During the same time frame product websites appeared, marketing videos took up residence on YouTube, e-cigarettes became an ongoing topic on Twitter, e-cigarettes became available in many places next to cigarettes, and store-fronts dedicated to e-cigarettes began appearing in some communities.¹⁰⁻¹⁴ Many of the marketing messages have been similar to those used successfully for cigarettes in the past.^{15,16} Moreover, many of the messages paint e-cigarettes as a new high tech device that can be used anywhere without fear of social exclusion.^{17,18} Whereas it represents only a fraction of the overall marketing expenditure on tobacco products, advertising revenue for e-cigarettes is substantial and grew markedly from \$3.7 million to \$19.9 million between 2011 and 2012.¹⁹ There are presently no restrictions on electronic cigarette advertising in the US.

An important aspect of the information surrounding e-cigarettes resides in the nature of their description as a technological innovation. For example, e-cigarettes are often described in advertising as being more environmentally friendly, more satisfying, safer, or more socially acceptable than cigarettes. Because of this we turned to the substantial body of work on the Diffusion of Innovations. This theory has been used widely to examine the manner in which new products, tools, and ideas have spread and either become widely adopted or not.²⁰ It also has been supported for its applicability in public health, including addiction prevention.²¹⁻²³

The theory conceives of an innovation as any manner of idea or product that can be seen as new by those who might adopt its use. The process of diffusion occurs over time within a defined social system, with information about the innovation being transmitted through focused communication channels, and often, in a deliberate manner. Individuals are understood to have a number of demographic and personality characteristics that make them more or less likely to adopt an innovation, or to be among the first or last to do so. More importantly with respect to the current study, diffusion also provides a description of the

characteristics of the innovation itself that individuals perceive as they consider a decision to adopt.

There are 5 characteristics of innovations that relate to its likelihood of adoption. Relative advantage refers to various ways in which the innovation can be seen as being superior to other ways of obtaining the same outcome. Relative advantage can be expressed in either economic or social terms. Compatibility is how well the innovation fits with existing values, experience, and needs. Complexity refers to how difficult an innovation appears to be to learn to use. The more complex an innovation is, the less likely it is to be adopted. Trialability depends on how well the innovation can be tested on a limited basis. When individuals can make limited trials of an innovation, it is more likely to be adopted. And finally, observability is the degree to which members of the social system may see the results of the adoption of an innovation. Observability enhances the rate of adoption.

E-cigarettes can be seen in these terms. A relative advantage might be the ability to use e-cigarettes in places where smoking is restricted. Compatibility could be seen in the delivery of nicotine. E-cigarettes might be seen as having low complexity as they are depicted as convenient and easy to use. They are easily available for purchase in person or on-line, thus high in trialability. Media-based demonstrations and the increasing number of individuals using the devices in public facilitate observability.

A few studies have offered a diffusion perspective on e-cigarettes. Choi et al²⁴ observed from a focus group study that interest in trying e-cigarettes among young adults was compatible with the diffusion model. Rook and Amos⁶ concluded from a content analysis of newspaper coverage of e-cigarettes in the UK (including Scotland) that aspects of diffusion were clearly present in the messages. Trumbo and Harper⁷ reported from a small study of students on a single college campus that positive appraisal of the innovation characteristic of e-cigarettes was predictive of their social acceptability. Pepper et al²⁵ experimentally tested the effect of diffusion-based message content, finding that comparisons to cigarettes (relative advantage) and demonstrations of product use (observability) were the most compelling messages promoting interest.

These previous findings and theoretical perspectives provided the foundation for the 2 research questions that motivated this study:

RQ1: What communication channels are associated with young adults' perception of the 5 innovation attributes of e-cigarettes?

RQ2: How are information exposure and perception of the 5 innovation attributes of e-cigarettes associated with use among young adults?

METHODS

Participants and Data Collection

This study focused on the young adult population in the US within the 18–24 age range. According to the US Census, in October 2012, 48% of the nation's 18–24 year-olds were enrolled in a college or professional school.²⁶ Therefore, the sample design provided for

proportional representation of those currently enrolled and not currently enrolled in college. Data collection was executed by GfK Custom Research through its KnowledgePanel® online survey services. GfK provides a statistically accurate sample of the US population, including non-Internet households. The survey was presented to 2032 KnowledgePanel® participants between March 21 and April 2, 2013. Item order was randomized within question sets. There were 874 complete responses, a 43% completion rate.

Measures

Descriptive demographic measures included age, sex, student status as currently enrolled or not, educational attainment as 14 levels from no formal education to completed doctorate, state of residence, and residence in a metropolitan area or not. We assessed cigarette use status using 2 items from the Behavioral Risk Factor Surveillance System.²⁷ These included having smoked 100 cigarettes in a lifetime ($1 = \text{yes}$, $0 = \text{no}$), and current use (*now smoking every day, some days, or not at all*). We then merged the items for $1 = \text{never}$, $2 = \text{former}$, $3 = \text{occasional}$, and $4 = \text{daily}$. Similarly, we assessed e-cigarette use status by asking respondents if they had ever tried an electronic cigarette ($1 = \text{yes}$, $0 = \text{no}$), and if so, what their current use was (*now using every day, some days, or not at all*). We also merged these items for $1 = \text{never}$, $2 = \text{former}$, $3 = \text{occasional}$, and $4 = \text{daily}$. We assessed use of alternate tobacco products by taking an inventory of 5 products: Hookah, pipe, cigars, snuff, and chewing tobacco. Responses were on a 1–4 scale including *Never, Tried once or twice, Some days, Every Day*. We then computed a summed index ($\alpha = .69$).

We based the items for the innovation characteristics of e-cigarettes on the measurement study by Moore and Benbasat²⁸ and the extensive work of Rogers.²⁰ Two items were used for each of the 5 elements of an innovation: Relative advantage (I think e-cigarettes are safer in terms of second-hand smoke compared to tobacco cigarettes; I think e-cigarettes are less harmful than cigarettes), Compatibility (I think e-cigarette users can easily make use of existing smoking areas; I believe using e-cigarettes would fit in well with the lifestyle of most smokers), Complexity (I believe it will not be difficult for smokers to learn how to use e-cigarettes; Overall, e-cigarettes are no more complicated to use than ordinary tobacco cigarettes), Trialability (I think it will be easy for people to purchase e-cigarettes; Smokers could easily give e-cigarettes a try to see if they like them better than tobacco), and Observability (It would be easy to tell whether a person was using an e-cigarette versus smoking tobacco; The e-cigarette has a distinctive and attractive appearance, setting it apart from tobacco cigarettes). Responses were scaled ($1 = \text{Strongly agree}$, $2 = \text{Agree}$, $3 = \text{Uncertain}$, $4 = \text{Disagree}$, $5 = \text{Strongly disagree}$). We calculated additive indices for each of the 5 components as well as an overall index of all 10 items (reliabilities reported below).

Finally, we included an assessment of information exposure. Participants were asked: “Where have you heard or seen information about e-cigarettes?” and were provided a checklist including newspapers, magazines, television, the Web, and point of purchase (on store shelves). This formed an additive measure of the 5 items ($KR-20 = .48$).

Analysis

The dataset was 99.5% complete, so we replaced the 201 missing values prior to index construction with appropriate measures of central tendency. Demographic post-stratification weights provided by GfK provided weighting to match the Knowledge-Panel® sample to current US population estimates from the current population survey. We recoded variables as needed to make all measures consistent such that higher values might predict more positive orientations toward e-cigarettes and their use.

Descriptive and exploratory analyses included appropriate measures of central tendency and dispersion, Cronbach's alpha and Kuder-Richardson-20 for index reliability, and Pearson correlations for association. We used principal components analysis with oblique rotation to assess the dimensionality of the diffusion items. We used pair-wise t-tests to evaluate differences among the information channels and among the innovation characteristics, with error bar charts to illustrate. We evaluated the first research question through a set of multiple regressions. We evaluated the second research question through a structural equation model. The logic of the model was to include cigarette use and use of alternate tobacco products as predictors of e-cigarette status, then perception of e-cigarettes as an innovation (modeled as a latent variable), with information exposure then antecedent to all components. In the final model revision, we trimmed non-significant paths and examined modification indices to consider any additional paths or covariances. We calculated model- and equation-level goodness-of-fit statistics with χ^2 and R^2 , respectively. We conducted all analyses using Stata 13.

RESULTS

Study participants were balanced on sex, with 49% being female. The average age was 21 years, 34% were full-time students, and 7% were part-time students. Of the students 34% were in a 1-to-2-year college, 66% in 2-to-4-year college, 83% in a public college and 17% in a private college. Of the non-students, 58% had completed high school, another 20% had attended some college, and 23% had completed college. Participants resided in every state except Delaware and 85% lived within a metropolitan area. Most (84%) of the participants had never smoked. Of those who had, 3% were former smokers, 8% smoked some days, and 5% smoked every day. A majority (81%) had heard of e-cigarettes, and 14% had tried e-cigarettes.

There was a strong association between smoking and e-cigarette use ($r = .53$ $p < .001$). It was seen that among the never-smokers, 4% had tried an e-cigarette; but among the current or former smokers, 45% had tried an e-cigarette ($\chi^2(1, 874) = 233$ $p < .001$). Of the 11% daily smokers in the sample ($N = 96$), 2% indicated daily e-cigarette use, 20% indicated occasional use, and 33% indicated former use; of the 7% occasional smokers in the sample ($N = 58$), 2% indicated daily use, 9% indicated occasional use, and 31% indicated former use; of the 6% ($N = 51$) former smokers in the sample, none indicated daily use, 2% indicated occasional use, and 16% indicated former use ($\chi^2(9, 874) = 274$ $p < .001$).

The 10 innovation items were entered in a principal components analysis, which yielded a single factor (Eigenvalue = 6.1, 61% of variance, component loadings range from .66 to .83,

Cronbach's $\alpha = .93$). Whereas the set is strongly unidimensional, we were interested in an evaluation of the 5 innovation characteristics. We summed each pair of items for the 5 resulting measures (advantage $r = .71$ $p < .01$ $M = 5.38$ $SD = 2.05$; compatibility $r = .59$ $p < .01$ $M = 5.1$ $SD = 1.96$; complexity $r = .56$ $p < .01$ $M = 5.25$ $SD = 1.89$; trialability $r = .69$ $p < .01$ $M = 5.05$ $SD = 1.90$; observability $r = .47$ $p < .01$ $M = 5.85$ $SD = 1.86$).

To provide further examination of the channel and innovation measures, we executed a test of means on each set using pair-wise t-tests. Figure 1 displays the means and 95% confidence intervals for the innovation characteristics. All 2-tailed, pair-wise comparisons were statistically significant at $p < .01$ except for advantage and complexity ($p < .05$), and compatibility and trialability (n.s.). Figure 2 displays the means and 95% confidence intervals for the channel items. All 2-tailed pair-wise comparisons were statistically significant at $p < .01$ except for magazine with store (n.s.) and television with in-person (n.s.).

The first research question asked how the communication channels were associated with the innovation attributes. To assess this, we ran a set of multiple regression models with the channel measures regressed on each of the innovation characteristics. Table 1 presents the results. Each of the 5 models presented significant R^2 values ranging from .06 to .12 ($p < .01$). Across the 5 innovation characteristics the strongest and most consistent effects were from magazine, in-person, and in-store (all $p < .01$). Newspaper and television information exposure had the least effect, each presenting non-significant coefficients in 4 of the 5 models. Web exposure was the next weakest overall, with significant coefficients in 3 of 5.

The second research question asked how information exposure and perception of the 5 innovation attributes might predict e-cigarette use. To assess this we tested a structural equation model in which information exposure predicted innovation and e-cigarette status. Then, innovation predicted e-cigarette status, controlling for smoking status and use of alternate tobacco products. In the final model we dropped non-significant paths and examined modification indices to consider the addition of paths, which were limited to the co-variances among the innovation error terms. The resulting model shown in Figure 3 presented acceptable goodness-of-fit, with model $R^2 = .38$, $\chi^2 (12) = 17.3$, $p = .14$.

DISCUSSION

Examination of the mean values for the channel and innovation items provides evidence for a somewhat nuanced view of the information environment and product perception surrounding e-cigarettes. We note that the channel items represent a recall measure that likely reveals as much about impression as absolute exposure. Nonetheless, previous studies have shown that television advertising has been used extensively to market e-cigarettes, with magazines and Web trailing, and newspapers last.^{9,29,30} Newspaper content on e-cigarettes also has been shaped strongly by editorial rather than advertising content.⁶ The relative role of interpersonal contact is clear, whether seeing or knowing someone using an e-cigarette or encountering a point-of-purchase display. Probably the most revealing aspect of this analysis lies in the demonstrated diversity of channels through which information on e-cigarettes has been delivered to the public.

Likewise, the means analysis for the 5 innovation characteristics reveals an informative picture and demonstrates the value of using the diffusion perspective to understand e-cigarettes. The leading factors that make e-cigarettes a favorable innovation are the observability of their use and the perception of their advantage over cigarettes. In terms of message content, the observability of e-cigarette use has been dominant from their first introduction. One of the first high-profile celebrity appearances with an e-cigarette occurred in September 2010, when actress Katherine Heigl appeared on *The Late Show with David Letterman* demonstrating an e-cigarette.³¹ Many similar examples followed on television shows, in movies, and of course, in advertisements. The message content promoting e-cigarettes as advantageous over cigarettes has been based strongly on the argument that e-cigarette users are not subject to the social exclusion that cigarette smokers receive.

These distinctions are developed further in the results for the first research question. There are differential effects on the innovation characteristics from the set of channels. For the 2 strongest innovation characteristics we see a relatively broad set of channel influences over perceiving e-cigarettes as advantageous, with in-person contact having the strongest independent effect. The manner in which advantage over cigarettes has been portrayed may be the strongest promotional aspect for the diffusion of e-cigarettes. Likewise observability has a similar profile. Across the 5 models, the in-person channel presented the most consistent effect, with an average coefficient of .21 (followed by magazines at .13 and stories at .11). This supports the idea in Diffusion Theory that although advertising and media stories may spread information about new innovations, interpersonal conversations can contribute the most to adoption.

The role of information exposure and perceived innovation characteristics in the use of e-cigarettes is important, as evaluated in the second research question. In this model the concepts of information exposure and perceived innovation are examined as unidimensional measures, considered as more of an omnibus effect from both. In this way we found that information exposure overall does predict a positive appraisal of e-cigarettes as an innovation, a finding that is consistent with the basis of Diffusion Theory and the strong marketing efforts that have been made over several years. Further, the predictive effect of positive appraisal over e-cigarette use underscores the effectiveness of the marketing messages. A key aspect of this finding lies in the relative strength of the partial coefficient from innovation to use (the zero-order association is $r = .30$ $p < .001$). Although not exceptional, the effect demonstrated in the model is above the combined effects of smoking and alternate tobacco use, which are consistently the strongest predictors of e-cigarette use.

The results of this study provide a unique view of the promotion of e-cigarettes and also present findings consistent with previous studies. Whereas Diffusion Theory has been used to evaluate a wide array of innovations, the application of this theory to e-cigarettes is novel to this investigation and a previous one involving a small sample of college students that produced similar findings.⁷ The results concerning the information channels through which the public has been exposed to e-cigarette information are also consistent with previous work showing the dominance of televised advertising and the spread of e-cigarettes in retail outlets.^{2,13}

This study also has limitations to note. All measures consisted of self-report items that carry an inherent potential for bias. Although the innovation measures were replicated from previous work, and thus, present a degree of validity, others were modifications of existing measures or ad hoc. While inclusive of young people attending and not attending college, the population for the study is limited to a narrow age range, which prevents a complete representation of e-cigarette use patterns, especially among long-term smokers. Moreover, the design was cross-sectional, eliminating the possibility of formal causal inference.

IMPLICATIONS FOR HEALTH BEHAVIOR OR POLICY

The key implication of this study lies in the domain of advertising regulation. The rapid diffusion of awareness of e-cigarettes documented in a number of studies clearly indicates that marketing efforts have been successful in getting this innovation into the first phase of new product acceptance. The evidence here also shows that key attributes of the e-cigarette as an innovation are embedded in this high level of awareness and have the capacity to persuade individuals to try or continue using e-cigarettes. In the past, the weak aspect of this product category has been compatibility, as smokers generally found they did not like the early versions of the e-cigarette. E-cigarette manufacturers have improved the product, however, and are now including enhancements such as flavors. Should perceived compatibility catch up with relative advantage and observability, the e-cigarette could achieve the 15%-25% adoption rate required for product “take off” as predicted by Diffusion of Innovations theory.²⁰ Given the unsettled nature of the evidence concerning the safety and public health impacts of these new devices, this provides further argument for regulating the marketing of e-cigarettes in the same manner as cigarettes.³²

Acknowledgments

This work was supported by the National Institutes of Health (1R03DA033578-01).

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Figure 1.
Comparison of Means for Innovation Characteristics (95% CIs)

Figure 2.
Comparison of Means for Channel Characteristics (95% CIs)

Figure 3.
Structural Model of E-Cigarette Status, Information Exposure, and Perceived Innovation
Note.

Standardized coefficients (** $p < .01$, * $p < .05$, $^\dagger p < .10$).

Table 1

Multiple Regressions of Channel Exposure on Innovation Characteristics

Advantage	b	t	p
Newspaper	.08	2.1	< .05
Magazine	.13	3.2	< .01
Television	.07	1.9	< .10
Web	.13	3.3	< .01
In-Person	.24	6.4	< .01
Store	.08	2.0	< .05
	R²	F	p
	.11	13.9	< .01

Compatibility	b	t	p
Newspaper	.04	0.9	ns
Magazine	.16	3.9	< .01
Television	.03	0.9	ns
Web	.07	1.9	< .05
In-Person	.18	4.8	< .01
Store	.14	3.6	< .01
	R²	F	p
	.09	13.2	< .01

Complexity	b	t	p
Newspaper	.07	1.7	< .10
Magazine	.10	2.3	< .05
Television	.03	.92	ns
Web	.09	2.4	< .05
In-Person	.21	5.6	< .01
Store	.10	2.8	< .01
	R²	F	p
	.08	10.5	< .01

Trialability	b	t	p
Newspaper	.03	0.8	ns
Magazine	.12	2.9	< .05
Television	.08	2.3	< .05
Web	.04	0.9	ns
In-Person	.27	7.3	< .01
Store	.14	3.9	< .01
	R²	F	p
	.12	17.5	< .01

Observability	b	t	p
Newspaper	.04	1.2	ns
Magazine	.12	2.8	<.01
Television	.04	1.1	ns
Web	.02	.44	ns
In-Person	.15	4.1	<.01
Store	.10	2.6	<.01
	R ²	F	p
	.06	6.9	<.01