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Original Investigation
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Original Investigation

Effects of Social Media on Adolescents' Willingness and Intention to Use E-Cigarettes: An Experimental Investigation

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Abstract

Introduction: This study examined the effects of experimentally manipulated social media exposure on adolescents' willingness and intention to use e-cigarettes.

Aims and Methods: Participants were 135 adolescents of age 13–18 (52.6% female, mean age = 15.3) in California. Participants viewed six social media posts online in a 2 (post source: peer or advertisement) × 2 (e-cigarette content exposure: heavy or light) between-subjects design. Analyses were weighted to population benchmarks. We examined adolescents' beliefs, willingness, and intention to use e-cigarettes in association with social media use intensity in daily life and with experimentally manipulated exposure to social media posts that varied by source (peer or advertisement) and content (e-cigarette heavy or light).

Results: Greater social media use in daily life was associated with greater willingness and intention to use e-cigarettes and more positive attitudes, greater perceived norms, and lower perceived danger of e-cigarette use (all *p*-values <.01). In tests of the experimental exposures, heavy (vs. light) e-cigarette content resulted in greater intention ($p = .049$) to use e-cigarettes and more positive attitudes ($p = .019$). Viewing advertisements (vs. peer-generated posts) resulted in greater willingness and intention (*p*-values <.01) to use e-cigarettes, more positive attitudes ($p = .003$), and greater norm perceptions ($p = .009$). The interaction effect of post source by post content was not significant for any of the outcomes (all *p*-values >.529).

Conclusions: Greater social media use and heavier exposure to advertisements and e-cigarette content in social media posts are associated with a greater risk for e-cigarette use among adolescents. Regulatory action is needed to prohibit sponsored e-cigarette content on social media platforms used by youth.

Implications: Adolescents who use social media intensely may be at higher risk for e-cigarette use. Even brief exposure to e-cigarette content on social media was associated with greater intention to use and more positive attitudes toward e-cigarettes. Regulatory action should be taken to prohibit sponsored e-cigarette content on social media used by young people, including posts by influencers who appeal to young people.

Introduction

While adolescent cigarette use in the United States has declined, e-cigarette use has risen sharply, with one in five 12th graders now reporting past-month e-cigarette use.[1] Adolescent e-cigarette use is concerning given detrimental effects of nicotine on the developing brain,[2] exposure to toxins,[3] and increased likelihood of transition to combustible cigarette use.[4] Further, recent longitudinal research raises concern that the use of e-cigarettes in adolescence can progress over time into sustained, frequent, dependent use.[5] An understanding of factors that influence adolescents' e-cigarette use is needed. Because adolescents' smoking is strongly affected by social norms,[6] the influence of social norms on adolescents' willingness to use e-cigarettes is worthy of study.

Increasingly, social norms are conveyed via social media, with use among US adolescents nearly ubiquitous.[7] Both e-cigarette users and nonusers report receiving, sharing, and searching for information on e-cigarettes on social media.[8] Seeing peers using e-cigarettes on social media suggests that e-cigarette use is normal and socially approved. Consequently, young people who experience significant exposure to e-cigarette content may be highly susceptible to future e-cigarette use. Social media also allow users to learn about the behaviors and lives of peers who are not in their immediate social circles, including "influencers" (ie, social media users with a large number of followers who are paid to promote a product).[9] Influencer marketing has been used extensively by e-cigarette companies, including JUUL, which is popular among adolescents.[10] Social media posts typically depict e-cigarette use as glamorous.[11] If adolescent social media users see other young people—friends, acquaintances, or influencers—using e-cigarettes and appearing to be happy and popular, they may see e-cigarette use as a behavior to emulate.

According to the Prototype Willingness Model,[12,13] adolescent health behavior can be triggered by willingness or behavioral intention to engage in a behavior under certain social circumstances. Seeing peers (ie, people in one's age group)[13] engage in a behavior increases willingness by making the behavior seem more normative and less risky. Adolescents create a mental "prototype" (ie, a conceptualization of a typical person who engages in the behavior), and willingness increases if the prototype is positive and similar to themselves.[12,13] The Prototype Willingness Model has contributed to the understanding of adolescent substance use, including alcohol use,[14] nonmedical prescription stimulant use,[15] and smoking.[16] Willingness predicts adolescents' behavior independently of intention.[13] In other words, adolescents may be willing to use e-cigarettes under some social circumstances (eg, when peers are using), even if they do not explicitly intend to use. Friends' approval of e-cigarettes and friends' smoking are linked to adolescents' e-cigarette use.[17] Therefore, perceptions of peers' behavior are likely to be important determinants of adolescents' willingness to use e-cigarettes.

E-cigarette posts on social media come from paid company advertisements, paid corporate influencers, and individual users' accounts. Both experimental[18–20] and correlational[21–24] studies have linked e-cigarette advertisement exposure to greater willingness and use among young people. However, social media posts generated by other young people (ie, peers) may have an even stronger influence than advertisements on adolescents' e-cigarette use. Three studies[25–27] have found associations between e-cigarette use and exposure to e-cigarette content (ie, advertisements and/or peer-generated posts) on social media; however, these studies were correlational and two[25,26] surveyed college students. College students' behavior may be less influenced by peers than adolescents' behavior, as the impact of social norms can decrease with age.[28] Observational studies of social media exposure are challenged by the reciprocal nature of social media exposure. Specifically, participants' recent use of e-cigarettes may have caused them to see more content related to e-cigarettes on the Internet, as part of targeted advertising campaigns and/or the habits of their social circles, thereby leading to an association between social media content exposure and e-cigarette use. One of the three studies examined the effects of peer-generated posts (ie, posts purportedly made by young people) and advertisements separately and found that exposure to peer-generated posts (but not advertisements) was significantly associated with e-cigarette use after adjusting for smoking.[26] Experimental research is needed to examine causality.

The present study had two purposes: (1) to assess the relationship between adolescents' social media use intensity in daily life and their thoughts and intention around e-cigarettes and (2) to experimentally test the effects of brief exposure to e-cigarette social media content on adolescents' subsequent thoughts and intention to use e-cigarettes. First, due to the popularity of positive e-cigarette content on social media,[11] we hypothesized that adolescents reporting greater social media use would report greater willingness and intention to use e-cigarettes, more positive attitudes toward e-cigarettes, greater perceived social norms, and lower risk perceptions. Second, we hypothesized that heavy (compared to light) exposure to e-cigarette content—especially peer-generated content—would result in greater willingness and intention to use e-cigarettes, more positive attitudes toward e-cigarette use, greater perceived norms, and lower risk perceptions.

METHODS

Participants, Procedure, and Design

Participant Recruitment

Adolescents (aged 13–18) living in California were recruited to participate in an online study about teenagers' thoughts and feelings after seeing posts on social media sites. Eligibility did not require social media use. Participants' households were members of the Ipsos KnowledgePanel, a nationwide probability-based online panel. KnowledgePanel uses random-digit dial and address-based sampling methodologies to invite randomly selected households to participate in the panel. Adult panelists residing in California with eligible children received a notification from KnowledgePanel about the survey. Parents provided informed consent and adolescent participants provided assent. The adolescent participants received $10 compensation through KnowledgePanel for their time in completing the survey (approximately 20 min). The entire study was completed online at home. All research activities were approved by the University of California, San Francisco Institutional Review Board.

Procedure and Design

Participants first indicated the gender of most of their friends (male or female), then viewed screenshots of Instagram-type posts matched to the gender they indicated. Participants were instructed to view each post for a few seconds and to imagine that they saw the posts while browsing Instagram. Each post was presented on its own screen. The posts differed by experimental condition. Participants were randomly assigned to an experimental condition in a 2 (post source: peer or advertisement) × 2 (e-cigarette

content exposure: heavy or light) between-subjects design. After viewing six Instagram-type posts (described in the "Measures" section), participants completed the measures described below. At the survey end, the participants were debriefed to inform them that the "peer-generated" posts were not created by real teenagers. They were informed of the risks of e-cigarette use and told that most teenagers do not use e-cigarettes.

Social Media Posts

The four experimental conditions, which determined the social media posts participants viewed, were "peer-generated" or advertisement (ie, post source) crossed by heavy or light e-cigarette content exposure. Participants randomized to the peer-generated source conditions saw six posts featuring adolescents gender-matched to their reported friend group; those randomized to the advertisement source conditions saw six gender-matched actual Instagram advertisement posts. Participants in the heavy e-cigarette content exposure conditions saw three e-cigarette posts and three unrelated posts; participants in the light exposure conditions saw one e-cigarette post and five unrelated posts. Similar strategies have been used in previous research on the Prototype Willingness Model in order to conceal the purpose of the study, avoid demand characteristics, and reflect realistic variation in social media content (eg, posts about e-cigarettes and several other topics).[29] Following the e-cigarette measures, participants also completed a brief distractor measure of willingness to eat different types of food, in order to conceal the study's purpose.

Instagram-type posts were developed based on content analyses of e-cigarette-related and general Instagram content.[30–34] E-cigarette posts depicted e-liquids, devices, and young e-cigarette users.[31–34] Unrelated posts reflected popular photo categories on Instagram: selfies, friends, travel, sports, food, fashion, or gadgets.[30] In all conditions, two posts contained images of people, with attention paid to racial and ethnic diversity, and the remainder did not contain people. In the heavy e-cigarette exposure conditions, the two posts containing people were e-cigarette posts; in the light exposure conditions, the two posts containing people were unrelated to e-cigarettes.

Posts were developed through an iterative process that included pilot testing with 12 adolescents, who saw 20 gender-matched Instagram-type posts (both related and unrelated to e-cigarettes) randomly selected from a pool of 60 posts. For each of the 20 posts, participants reported where they thought the post came from ("a company," "a teenager," or "someone else"), the age of the person/people in the photo ("<13," "13–17," "18–21," "≥22"), and the extent to which the post looked like something they would see on Instagram ("not at all," "a little," "somewhat," "a lot"). Final posts for the present study were selected based on the correct identification of the source, perception of the people as being aged 13–17 or 18–21, perceived realism, and racial/ethnic diversity within each condition. Of the final posts selected, an average of 91.8% (SD = 15.6%) of responses correctly identified the post source (ie, advertisement or peer), 79.3% (SD = 32%) perceived the person/people to be 13–21 years old, and 78% (SD = 20.7%) rated the post as realistic (ie, "somewhat" to "a lot"). A few additional posts depicting content unrelated to e-cigarettes (ie, food, gadgets) were created after pilot testing.

"Peer-generated" posts were created by superimposing stock photos on screenshots of actual Instagram posts. Advertisement posts were taken directly from Instagram. Usernames, except for those of companies posting advertisements, were concealed. Posts were presented to participants in random order. Examples of "peer-generated" posts are shown in Figure 1. Examples of advertisements are available from E. A. Vogel upon request.

Measures

Primary Outcome

Willingness to use e-cigarettes was measured with three items,[13] each of which started with the following prompt: "Suppose you were in the following situation: You are at a party and many of your friends are using e-cigarettes. You are offered an e-cigarette by a person you like very much." Participants indicated the likelihood that they would (1) take the e-cigarette and try it, (2) say no thanks, and (3) leave the situation. Each item was measured on a 1 (very unlikely) to 7 (very likely) Likert-type scale, and the latter two items (saying "no thanks" and "leaving the situation") were reverse-scored. Willingness is a stronger predictor of adolescents' smoking than intention and was therefore used as the primary outcome.[13]

Secondary Outcomes

A four-item measure assessed *intention to use e-cigarettes* on a 1 (definitely not) to 4 (definitely yes) Likert-type scale. Sample items

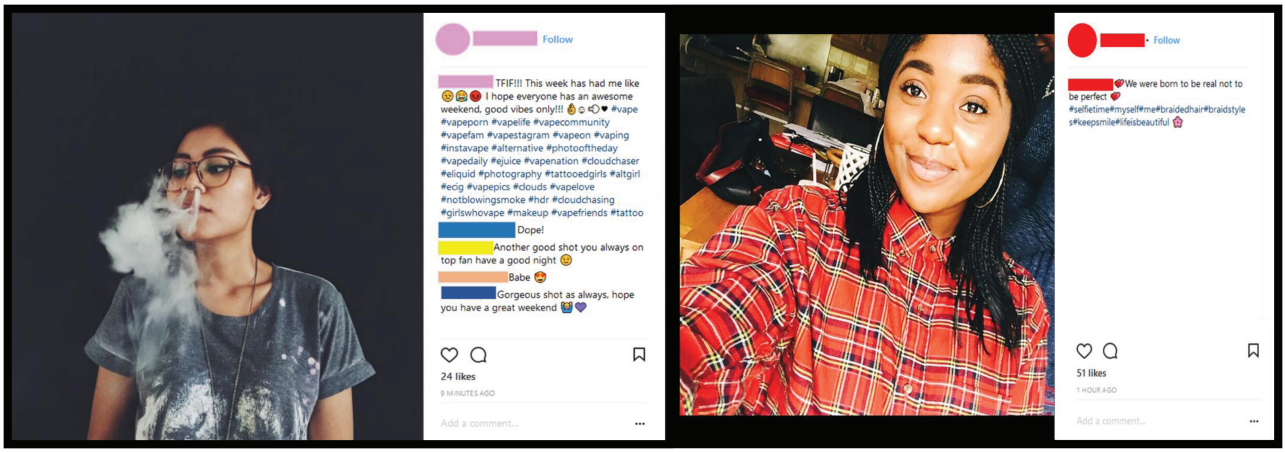

Figure 1. Examples of "peer-generated" Instagram posts: e-cigarette (left) and unrelated (right).

include, "Do you think you will try/use an e-cigarette soon?" and "Do you think you will try/use an e-cigarette anytime during the next year?".[35] A seven-item measure assessed adolescents' *attitudes about using e-cigarettes* on a continuum from 1 to 7, with scale anchors such as "unenjoyable/enjoyable" and "not attractive/attractive."[35] A six-item measure of risk perceptions assessed participants' perceived risks of e-cigarette use on a 1 (strongly disagree) to 4 (strongly agree) Likert-type scale. Sample items include, "e-cigarettes are dangerous" and "e-cigarettes aren't addictive."[36] A five-item measure of *norm perceptions* assessed participants' perceptions of what others think they should do (ie, injunctive norms) and how others behave (ie, descriptive norms). Sample items include, "My classmates think that I should use e-cigarettes" and "In my community, most people use e-cigarettes" (1 = strongly disagree; 4 = strongly agree).[37]

Social Media and Tobacco Use

The Multidimensional Facebook Intensity Scale[38] (adapted to account for all social media; 13 items, 1–5 Likert-type scales) was used to assess *intensity of social media use*. Participants also reported their prior *e-cigarette and cigarette use* ("never," "yes, but not in the past month," or "yes in the past month").[17]

Demographic Variables

Parents reported the adolescent participant's gender as part of the eligibility screening process. Data also were available on parents' race/ethnicity and household income from Ipsos KnowledgePanel.

Analyses

Sample Representativeness

To make this online sample representative of adolescents in California, all analyses were weighted to population benchmarks, using post-stratification weighting based on parents' race/ethnicity and household income. Ipsos KnowledgePanel does not collect demographic information directly from adolescent participants. Participant characteristics (weighted and unweighted) are presented in Table 1.

Data Aggregation

Composite scores were formed by computing the mean of all items for each measure. Items were reverse-scored as needed, such that higher scores reflected greater willingness, greater intention, more positive attitudes, perceptions of e-cigarette use as more normative and riskier, and more intense social media use. The willingness (Cronbach α = 0.78), intention (α = 0.94), attitudes (α = 0.92), and social media intensity (α = 0.94) measures had acceptable to excellent reliability. Because reliability was poor for the risk (α = 0.64) and norm perceptions (α = 0.55) measures, factor analyses were conducted using maximum likelihood extraction and direct oblimin rotation. The risk perceptions scale had two subscales, with three items each: one subscale reflecting the potential dangers of e-cigarette use ("danger perceptions") and one subscale reflecting perceptions of e-cigarettes as harm reducing ("reduced harm perceptions"). The norm perceptions measure did not have a clear factor structure and was reduced to a single item ("My classmates think I should use e-cigarettes") that was consistently correlated with other outcomes (eg, attitudes toward e-cigarettes, willingness to use), was approximately normally distributed, and is conceptually similar to e-cigarette norm perception measures used in other research.[39] Bivariate correlations between all measures are presented in Table 2. Most measures were significantly correlated. The high correlation (r = 0.74) between willingness and intention is consistent with the Prototype Willingness Model, and the constructs typically predict behavior independently of one another despite being highly correlated.[13]

Table 1. Participant Characteristics (N = 135)

	Weighted (analytic) sample	Unweighted sample
Gender (N/% female)	66 (48.9%)	71 (52.6%)
Age (M/SD)	15.4 (1.7)	15.3 (1.7)
E-cigarette use (N/%)		
Never	117 (86.7%)	121 (89.6%)
Yes, but not in the past month	16 (11.9%)	11 (8.1%)
Yes, in the past month	2 (1.5%)	3 (2.2%)
Combustible cigarette use (N/%)		
Never	119 (88.1%)	123 (91.1%)
Yes, but not in the past month	16 (11.9%)	11 (8.1%)
Yes, in the past month	0 (0%)	1 (0.7%)

Main Analyses

To test aim 1, social media intensity was regressed on each primary and secondary outcome in a series of linear regression analyses. To test aim 2, a series of 2 (post source: peer or advertisement) × 2 (e-cigarette content exposure: heavy or light) between-subjects analysis of variances were used to examine the effects of post source and e-cigarette content exposure on the primary and each secondary outcome, adjusting for social media intensity.

RESULTS

Social Media Use and E-Cigarette Beliefs, Willingness and Intention to Use

Intensity of social media use in daily life, with scores that can range from 1 (low intensity) to 5 (high intensity), averaged M = 2.90, SD = 0.87. Greater intensity of social media use in daily life was significantly associated with greater willingness (β = .33, t = 4.04, p < .001) and intention to use e-cigarettes (β = .40, t = 5.06, p < .001), more positive e-cigarette attitudes (β = .33, t = 4.00, p < .001), greater perceptions of e-cigarette use as normative (β = .30, t = 3.56, p = .001), and lower danger perceptions (β = −.25, t = −2.97, p = .004) and was unrelated to perceptions of reduced harm (β = .02, t = 0.24, p = .809).

Experimental Effects of Brief Exposure to Social Media Posts

Descriptive statistics for primary and secondary outcomes by the experimental condition are presented in Table 3. All analyses are adjusted for social media use intensity in daily life. There were no significant post source × e-cigarette content exposure interactions on the primary (p = .529) or secondary (ps > .642) outcomes.

Effects of E-Cigarette Content Exposure

There were significant main effects of e-cigarette content exposure (heavy vs. light) on intention to use e-cigarettes (F(1,126) = 3.94, p = .049) and attitudes (F(1,126) = 5.62, p = .019). Regardless of post source, participants with heavy exposure to e-cigarette content (compared to light exposure) expressed greater intention to use e-cigarettes (d = 0.37) and more positive attitudes toward

Table 2. Pearson Correlation Coefficients Between Key Measures in Weighted Sample ($N = 135$)

	1	2	3	4	5	6	7
1. Willingness	—	.74***	.66***	.41***	−.25**	−.19*	.33***
2. Intention	—	—	.84***	.48***	−.40***	−.17*	.40***
3. Attitudes	—	—	—	.46***	−.47***	−.25**	.33***
4. Norm perceptions	—	—	—	—	−.41***	−.16	.30**
5. Risk—Danger	—	—	—	—	—	.18*	−.25**
6. Risk—Reduced harm	—	—	—	—	—	—	.02
7. Social media intensity	—	—	—	—	—	—	—

*$p < .05$, **$p < .01$, ***$p < .001$.

Table 3. Descriptive Statistics for Primary and Secondary Outcomes by Experimental Condition in the Weighted Sample ($N = 135$)

	Willingness (1–7 scale; 3 items)			Intention (1–4 scale; 4 items)			Attitudes (1–7 scale; 7 items)		
	Heavy exposure	Light exposure	Total	Heavy exposure	Light exposure	Total	Heavy exposure	Light exposure	Total
Peer-generated	2.20 (1.08)	1.93 (1.50)	2.08 (1.27)[a]	1.42 (0.60)	1.30 (0.52)	1.37 (0.57)[a]	1.53 (1.08)	1.25 (0.53)	1.41 (0.89)[a]
Advertisement	3.21 (1.86)	2.47 (1.58)	2.90 (1.78)[a]	1.78 (0.95)	1.41 (0.64)	1.63 (0.85)[a]	1.93 (1.14)	1.47 (1.03)	1.74 (1.11)[a]
Total	2.73 (1.61)	2.20 (1.55)	2.50 (1.60)	1.61 (0.82)[b]	1.35 (0.58)[b]	1.50 (0.74)	1.74 (1.12)[b]	1.36 (0.83)[b]	1.58 (1.02)

	Norm perceptions (1–4 scale; 1 item)			Risk perceptions (danger; 1–4 scale; 3 items)			Risk perceptions (reduced harm; 1–4 scale; 3 items)		
	Heavy exposure	Light exposure	Total	Heavy exposure	Light exposure	Total	Heavy exposure	Light exposure	Total
Peer-generated	1.43 (0.58)	1.62 (0.78)	1.51 (0.68)[a]	3.48 (0.59)	3.52 (0.51)	3.50 (0.55)	3.15 (0.72)	3.13 (0.78)	3.14 (0.74)
Advertisement	1.66 (0.77)	1.78 (0.75)	1.71 (0.76)[a]	3.39 (0.53)	3.60 (0.56)	3.47 (0.55)	2.95 (0.68)	2.94 (0.72)	2.94 (0.69)
Total	1.55 (0.69)	1.70 (0.76)	1.61 (0.73)	3.43 (0.56)	3.56 (0.53)	3.49 (0.55)	3.04 (0.70)	3.04 (0.75)	3.04 (0.72)

Descriptive and inferential analyses were weighted to population benchmarks. Inferential analyses adjusted for social media use intensity in daily life.
[a]Significant difference ($p < .05$) between peer-generated and advertisement conditions, collapsing across e-cigarette content exposure.
[b]Significant difference ($p < .05$) between heavy and light e-cigarette exposure conditions, collapsing across content source.

e-cigarettes ($d = 0.39$). Associations between exposure and willingness to use e-cigarettes ($F(1,126) = 3.82$, $p = .053$, $d = 0.34$), norm perceptions ($F(1,126) = 3.59$, $p = .060$; $d = 0.21$), danger perceptions ($F(1,126) = 1.72$, $p = .192$; $d = 0.24$), and reduced harm perceptions ($F(1,126)=0.29$, $p = .590$; $d = 0$) were not statistically significant.

Effects of Post Source

There were also significant main effects of post source (peer-generated vs. advertisement) on willingness ($F(1,126) = 22.03$, $p < .001$) and intention ($F(1,126) = 12.51$, $p = .001$) to use e-cigarettes, attitudes ($F(1,126) = 9.52$, $p = .003$), and norm perceptions ($F(1,126) = 7.13$, $p = .009$). Regardless of e-cigarette content exposure, participants who viewed advertisements (compared to peer-generated posts) reported greater willingness ($d = 0.53$) and intention ($d = 0.36$) to use e-cigarettes, along with more positive attitudes toward e-cigarettes ($d = 0.33$) and greater perceptions of e-cigarettes as normative ($d = 0.28$). Danger perceptions ($F(1,126) = 1.13$, $p = .290$, $d = 0.05$) and reduced harm perceptions ($F(1,126) = 2.25$, $p = .136$, $d = 0.28$) did not significantly differ by post source.

Discussion

This study examined the association between adolescents' social media use intensity in daily life and their thoughts and intention around e-cigarettes, as well as the effects of brief exposure to social media content (both advertisements and posts purportedly made by gender-matched adolescents) on e-cigarette thoughts and intention.

First, adolescents who reported more intense social media use in their daily lives had greater willingness and intention to use e-cigarettes, more positive e-cigarette attitudes, greater perceptions of e-cigarettes as normative, and lower perceptions of e-cigarettes as dangerous. These findings are consistent with prior research demonstrating a cross-sectional association between e-cigarette use and frequent social media use among Canadian adolescents.[40] Our findings suggest that the effects of frequently viewing social media content on adolescents' susceptibility to e-cigarette use are worthy of future study. E-cigarette content is common on social media,[11,41] and repeated exposure to such content may normalize e-cigarette use. Alternatively, other factors, such as poor mental health, may be associated with both social media intensity and susceptibility to e-cigarette use. Prior research has found problematic social media use (ie, using social media more than intended, using social media despite negative consequences) to be associated with greater mental health symptoms and heavy episodic drinking.[42,43] Further research, including longitudinal designs and additional covariates, is needed to fully understand the association between social media and e-cigarette use. Nonetheless, adolescents may benefit from parental controls limiting social media use. Instagram's current policy bans paid e-cigarette advertisements and private sale or transfer of e-cigarettes facilitated by the platform; however, it allows paid influencers to post about e-cigarettes.[44] If restrictions on influencer marketing are tightened, it remains unclear whether social media platforms are equipped to enforce them.

Second, adolescents who viewed several e-cigarette posts, regardless of the posts' source, expressed greater intention to use and more positive attitudes toward e-cigarettes. The effects of viewing e-cigarette content did not depend on whether the content

appeared to come from a peer or from a company. Moreover, those who saw advertisements, regardless of content, expressed greater willingness and intention to use e-cigarettes, more positive attitudes toward e-cigarettes, and greater perceptions of e-cigarette use as normative.

Results partially supported the hypothesis that heavy exposure to e-cigarette content would result in more positive perceptions of e-cigarettes and greater willingness and intention to use. Viewing e-cigarette social media content has been associated with similar outcomes in prior research, although prior research was correlational and most studies did not involve adolescents or distinguish between peer-generated content and advertisements.[25–27] Unexpectedly, e-cigarette content exposure (heavy or light) did not interact with the content source (peer-generated or advertisement) to influence e-cigarette use outcomes. Viewing advertisements, however, did result in greater willingness, intention, attitudes, and norm perceptions. Importantly, all six posts participants viewed were matched to the source condition (peer-generated or advertisement) to which they were assigned, while content varied in both the heavy exposure and light exposure conditions. In the heavy e-cigarette content exposure conditions, half of the posts contained content unrelated to e-cigarettes (eg, food, fashion, travel). Therefore, participants received a stronger "dose" of exposure to a particular source type than a particular content type. Increasing the number of e-cigarette posts may have produced stronger main effects and interactions. In the light exposure conditions, participants still viewed one e-cigarette post, in accordance with prior research.[29] The e-cigarette advertisement may have been strong enough to temporarily impact participants' thoughts and intention around e-cigarettes, even though the remainder of the posts were unrelated. Professionally designed advertisements may have been more persuasive than "peer-generated" posts. Alternatively, seeing advertisements for popular, fun products (eg, new gadgets, trendy clothing) may have primed adolescents to view a subsequent novel product (ie, e-cigarettes) positively, as priming effects can influence subsequent unrelated judgments.[45] Although we predicted that peer-generated posts would be more impactful based on the Prototype Willingness Model, most studies of the model[12,29,46] have not directly compared peer-generated and advertising content. It seems likely that both peers and advertisements strongly influence adolescents' health behavior, including their e-cigarette use. Advertisements used in this study depicted young people. Advertisements involving older individuals may have had a weaker effect; however, many e-cigarette advertisements on social media are youth-friendly.[33]

In summary, adolescents who reported using social media intensely in their daily lives and those who were randomized to view Instagram advertisements or posts with more e-cigarette content reported more positive attitudes toward e-cigarettes and had a greater likelihood of future use. Given that the vast majority of young people use social media regularly[7] and many are exposed to e-cigarette content on social media,[26,41] findings suggest a need to enforce and expand regulation of e-cigarette content. The experimental main effects of the heaviness of e-cigarette content and post source were significant albeit weak in strength, which was anticipated given the very brief, subtle nature of the exposure conditions. Effects are likely to be cumulative, with a stronger impact with increasing exposure. Strong associations between social media use intensity in the adolescents' daily lives and their e-cigarette thoughts and intention support this supposition, although further research is needed to confirm the causal effect experimentally.

Limitations and Future Directions

First, the experimental design did not fully capture the vast array of social media content adolescents may encounter. For instance, many companies incentivize "influencers" to make product promotion posts, which may be perceived as peer-generated posts or advertisements. Examining the effects of influencer posts is an important direction for future research. Future research should also examine the effects of posts from members of one's own social network (eg, friends, acquaintances), whose social media content may be even more influential than strangers' content. Second, adolescents completed the study online, were advised to find a private place to complete the study, and were assured that their parents would not have access to their responses. Nevertheless, some youths may have underreported their use of e-cigarettes and cigarettes and/or understated their willingness and future intention. It is unlikely that an in-person survey would enhance disclosures. Third, adolescents may have different perceptions of different e-cigarette products. At the time the data were collected (February 2019), JUUL had approximately 75% of the US e-cigarette market share[47] and tended to be perceived by young people as distinct from other e-cigarettes.[48] We aimed to increase the generalizability of results by including a variety of products in each experimental condition, and instructions clarified that "e-cigarettes" included JUUL. Future research could use a similar experimental design to delve into the effects of exposure to specific product types. Finally, we had to reduce the measure of perceived norms to a single item because the full measure had poor psychometric properties in our sample. Consensus in the measurement of adolescents' norm perceptions around e-cigarettes is needed.[39] Measures of e-cigarette norm perceptions currently include characteristics of the psychosocial environment (eg, friends' use, friends' perceptions of use, living with an e-cigarette user)[49] and perceived percentage of same-age peers who use e-cigarettes.[50] Our norm perceptions measure was based on measurement guidelines that have been used successfully to predict smoking.[37] However, future research could measure the percentage of friends who use e-cigarettes and the perceptions of friends' reactions to e-cigarette use, as is now recommended.[39]

Conclusions

Exposure to more social media posts with e-cigarette content resulted in greater intention to use e-cigarettes and more positive attitudes toward e-cigarettes among adolescents. Furthermore, adolescents who used social media more intensely in their daily lives reported greater willingness and intention to use, more positive attitudes, greater norm perceptions, and lower perceptions of the danger of e-cigarettes. Findings lend credence to concerns that e-cigarette content on social media may have adverse effects on adolescents.[51] Regulatory action should be taken to prohibit sponsored e-cigarette content on social media channels used by youth, including content posted by influencers who appeal to young people.

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Declaration of Interests

EAV, KLD, SD, and CC have no conflicts of interest to disclose. DER has consulted for Carrot, Inc, which makes a tobacco cessation device. JJP has provided consultation to pharmaceutical (Pfizer, Achieve Life Sciences) and technology (Carrot, MD Revolution) companies that make medications and other treatments for quitting smoking and has served as an expert witness in lawsuits against tobacco and e-cigarette companies. MLR left UCSF on June 30, 2019 and started as an employee of JUUL Labs as of July 8, 2019. He met criteria for authorship prior to leaving UCSF and he had no role in revising the paper after leaving UCSF and joining JUUL Labs.

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