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Passive exposure to electronic cigarette (e-cigarette) use increases desire for combustible and e-cigarettes in young adult smokers

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Abstract

Background—Passive exposure to combustible cigarette use has been shown to act as a cue to increase smoking urge. Given the resemblance of e-cigarettes and other electronic nicotine delivery systems (ENDS) to combustible cigarettes, we examined whether these devices could also act as a cue to increase smoking desire and urges in those passively exposed.

Methods—Young adult daily smokers (age 18–35 years; N=60) completed subjective ratings before and after exposure to a study confederate drinking bottled water (control cue) and then smoking either a combustible or e-cigarette (active cue). Smoking desire and urge ratings were measured with visual analogue scale items for desire for a regular and an e-cigarette and the Brief Questionnaire of Smoking Urges.

Results—Passive exposure to both the e-cigarette and combustible cigarette cue significantly increased observers' ratings of desire and urge to smoke a regular cigarette (all ps<0.05). Exposure to the e-cigarette cue but not the regular cigarette cue also increased desire to smoke an e-cigarette (p<0.01).

Conclusions—The results provide the first evidence in a controlled setting that electronic cigarette exposure may evoke smoking urges in young adult daily smokers. With replication, these findings may have relevance for ENDS regulation and policy.

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Contributors ACK conceptualised the study and led the study implementation, analysis and drafting and revising of the manuscript. LJS contributed to study design, data collection, data interpretation and revising of the manuscript. PJM contributed to study design, oversaw and provided data collection, conducted data analysis and drafting and revising manuscript. AKM and DJF contributed to study design, data interpretation and drafting and revising the manuscript.

Competing interests ACK has provided consultation to the US Food and Drug Administration. AKM has provided consultation to the US Food and Drug Administration.

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INTRODUCTION

Electronic cigarettes, also known as e-cigarettes or electronic nicotine delivery systems (ENDS), deliver nicotine to the user via inhalable vapour and therefore do not generate combustible tobacco smoke. Since ENDS have not been specifically classified as tobacco products, no systematic federal regulations have yet been applied to their manufacturing, distribution or public use.[12] Use of these products has increased substantially in recent years in the USA,[3] with one in five smokers reporting having used e-cigarettes,[4] and experimental use among youth doubling from 3.2% in 2011 to 6.8% in 2012.[5] Young adults specifically have been found to view e-cigarettes as accessible, convenient and modern,[6] and there are concerns that they are targeted in some e-cigarette advertising campaigns[578] and specialty 'vape' shops and lounges.[9]

Whether ENDS products will show promise or peril for the widespread harms related to combustible smoking is up for debate among clinical researchers, practitioners and policymakers.[310–14] As a number of e-cigarettes resemble combustible cigarettes, concerns have been raised that their increasing use could perpetuate and re-normalise smoking behaviours. While passive viewing of regular cigarette use has been shown to act as a cue to increase observers' urges to smoke,[1516] there has been no research to date to support the claim that use of an e-cigarette affects passive observers' desire to smoke. Therefore, in a controlled laboratory paradigm, we examined the effects of passive exposure to e-cigarette versus combustible cigarette use on smoking desire and urge among young adult daily smokers.

MATERIALS AND METHODS

The study included a randomised between-subjects design. Participants were randomised to either passive exposure to combustible cigarette use (n=30; 13 female) or e-cigarette use (n=30; 13 female). Study candidates were recruited by online advertisements for a 2 h study described as 'assessing mood response following exposure to common tasks and social interactions' (see online supplementary appendix for details). This general description was chosen to reduce expectancy of cigarette and e-cigarette exposure. Inclusion criteria were age between 18 and 35 years, daily smoking of 5–18 cigarettes per day, not having any major medical or psychiatric disorders excluding nicotine dependence, and not currently trying to quit smoking. Candidates (N=69) arrived between 10:00 and 15:00 h, completed informed consent and underwent screening that included interviews and surveys on background characteristics, the Fagerström Test for Nicotine Dependence (FTND)[17] and a modified non-patient version of the Structured Clinical Interview for *DSM-IV*.[18] Abstinence from alcohol and recreational drugs was required for at least 24 h prior to the study, and an alcohol breath test was used to verify current sobriety (0.000 mg%). Smoking abstinence for at least 2 h prior to arrival was also required and verified by an expired air carbon monoxide reading of ≤15 ppm.

Eligible participants (60/69; 88%) were informed that the 1 h study session would immediately follow the screening and would include completing computerised surveys before and after engaging in two randomly assigned tasks for 5 min, separated by a 10 min

break. The tasks were described as engaging with a second participant in conversation, viewing pictures, eating food, drinking a beverage or smoking. In fact, task selection at both intervals was predetermined for the study participant to engage in conversation with another participant and choose the topic from the list provided, that is, talk about the weather, pets, places to eat, movies and television, local landmarks or vacations. In addition, the other participant was a study confederate predetermined to drink water for his/her first task (ie, control cue) and then to smoke either an e-cigarette that is visually similar to a regular cigarette (NJOY King) or a combustible cigarette (American Spirit or Benson and Hedges) (ie, active cues) for the second task. After each cue, participants completed the digit symbol substitution task[19] to maintain concentration and mask the focus of the study. Upon study completion, each participant was debriefed and paid US$30. The study was approved by the University of Chicago Institutional Review Board.

Videotapes of the exchange between the confederates (one female and one male, ages 21 and 24 years, respectively) and the participants were later scored by two independent raters to ascertain the quality of the interactions using the Two-Dimensional Social Interaction Scale.[20] Results showed no differences in participant–confederate interactions in the e-cigarette versus combustible cigarette cue groups (ps≥0.16).

Measures were given at baseline (time 0), following the control cue (15 min) and following the randomised active cue (35 and 50 min). The main dependent measures were two visual analogue scale (VAS) items for *Desire to smoke an electronic cigarette* and *Desire to smoke a regular cigarette (your preferred brand)* anchored from ‘not at all’ (0) to ‘most ever’ (100)[21] and the Brief Questionnaire of Smoking Urges (BQSU)[22] with 10 items rated from 1 (strongly disagree) to 7 (strongly agree) and summed for a total score.[22] Additional VAS items were included to mask the focus on smoking (see online supplementary appendix for details). Data were analysed by 2 group (active cue type)×4 time (0, 15, 35, 50 min) analyses of variance. Significant main effects or interactions were analysed by simple effects tests.

RESULTS

The sample was racially diverse, with 40% Caucasian, 38% African-American, 17% more than one race and 5% other races. Participants’ average age was 25.2±4.3 (SD) years with 13.5 ±1.5 years of education. In the past month, they averaged smoking 8.4±3.0 cigarettes per day on 99% of days. Major background and smoking characteristics did not differ between the groups except for a lower average FTND score in the e-cigarette versus combustible exposure group (3.2±2.1 vs 4.3 ±2.0; $t(58)=-2.00$, $p<0.05$), so FTND was included as a covariate in all analyses. Approximately half the sample (52%) reported any past e-cigarette use, with 23% reporting past month use with an average frequency of 3.6±3.3 days. As expected, overall ratings for desire for electronic cigarettes were higher in the past month e-cigarette users than non-users (*group*: $F(1)=21.39$, $p<0.001$). There were no differences on smoking urge and desire responses to either the e-cigarette or combustible cigarette cue in past month e-cigarette users versus non-users (*time x group*: Fs(3)≤0.28, ps≤0.84).

Passive exposure to the confederate smoking either a combustible or an e-cigarette increased participants' desire to smoke a regular cigarette (*time*: F(3)=3.92, p=0.010) and overall smoking urge (BQSU) (*time*: F(3)=3.10, p=0.028). These effects were evident at both of the two time points after the active cues relative to the baseline and water cue (p<0.01; figure 1A). In addition, exposure to the e-cigarette but not combustible cigarette cue increased participants' desire for an electronic cigarette (*time x group*: F(3,57)=4.74, p=0.003). These effects were evident at both time points after the e-cigarette cue relative to the baseline and water cue (p<0.01; figure 1B). For the whole sample, desire ratings for a regular cigarette were higher than for an e-cigarette (see figure 1), which was not unexpected since participants were daily smokers (see online supplementary appendix for full results).

DISCUSSION

The results demonstrated that, in a laboratory paradigm, passive exposure to both e-cigarette and combustible cigarette use increased young adult smokers' urge to smoke a regular cigarette. Supporting prior studies,[1623][24] passive exposure to combustible cigarette use increased ratings of desire and urge to smoke a regular cigarette, with the novel finding of passive exposure to *e-cigarette use* increasing regular cigarette desire and urge to a similar extent. Further, passive exposure to e-cigarette use (but not combustible cigarette use) increased desire for an e-cigarette. These findings support a recent investigation purporting that passive viewing of an e-cigarette commercial advertisement elicited smoking urges and favourable beliefs of ENDS.[25] Our findings build upon these results by including baseline pre-exposure measures and a comparison control cue. If the recent study findings are replicated and extended, they may provide an empirical base for the contention that the close resemblance of ENDS products to traditional cigarettes could unintentionally increase smoking desire and urge among those passively exposed.

The strengths of the current study include examining a diverse young smoker sample, assessing pre-exposure and post-exposure ratings, and including a control cue. Expectancy was minimised by not disclosing the specific purpose of the study. In terms of limitations, it is unclear whether the results of this laboratory-based study will generalise to actual responses in the real-world context or whether they will generalise to older, heavier, former or never smokers. Additionally, as the current study targeted in vivo exposures via direct social interactions, the degree to which e-cigarette exposure affect smoking urges in other contexts could not be determined. Finally, the order of presentation of the control and active cues were fixed, so the active cue salience may have been confounded with time spent in the laboratory.[23] However, as the cues were within 15 min of each other, it is unlikely that time of nicotine deprivation played a large role in the differences in control and active cues. Future research with counterbalanced cue presentations or a multiple session designs will be important.

The impact of the increasing popularity of ENDS products is currently inconclusive.[12–14] On the one hand, e-cigarette proponents posit that these products may be effective in harm reduction, provide a viable alternative to combustible cigarette use and play a role in the 'end game' for regular cigarettes.[26] On the other hand, opponents postulate that e-cigarettes may perpetuate and re-normalise smoking to undermine tobacco control efforts, maintain

nicotine dependence and lead to dual product use.[3514] A strong evidence base is needed to fully examine both sides of this issue. With the prevalence of ENDS product use increasing and forecasted to rise sharply in the coming years,[27] passive exposures will no doubt increase. These exposures may or may not be in environments where regular smoking has been banned. While the debate about e-cigarettes has been largely focused on product consumers, the current findings underscore the importance of examining the impact among passive observers to determine whether passive exposure to e-cigarettes should factor into policy discussions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What this study adds

- E-cigarette use has increased substantially in recent years. The close resemblance of e-cigarettes and other electronic nicotine delivery systems to combustible cigarettes has been proposed as a potential cue to promote and re-normalise smoking but thus far there has been no empirical support for this supposition.
- The current study finds that when young adult smokers are exposed to someone smoking an e-cigarette, their desire for a regular cigarette and urge to smoke is increased to a similar extent as when they are exposed to someone smoking a combustible cigarette. Exposure to e-cigarette use also increased desire to smoke an e-cigarette.
- Future research should continue to examine the effects of e-cigarette use on passive observers to further elucidate the role of e-cigarettes in tobacco control policy.

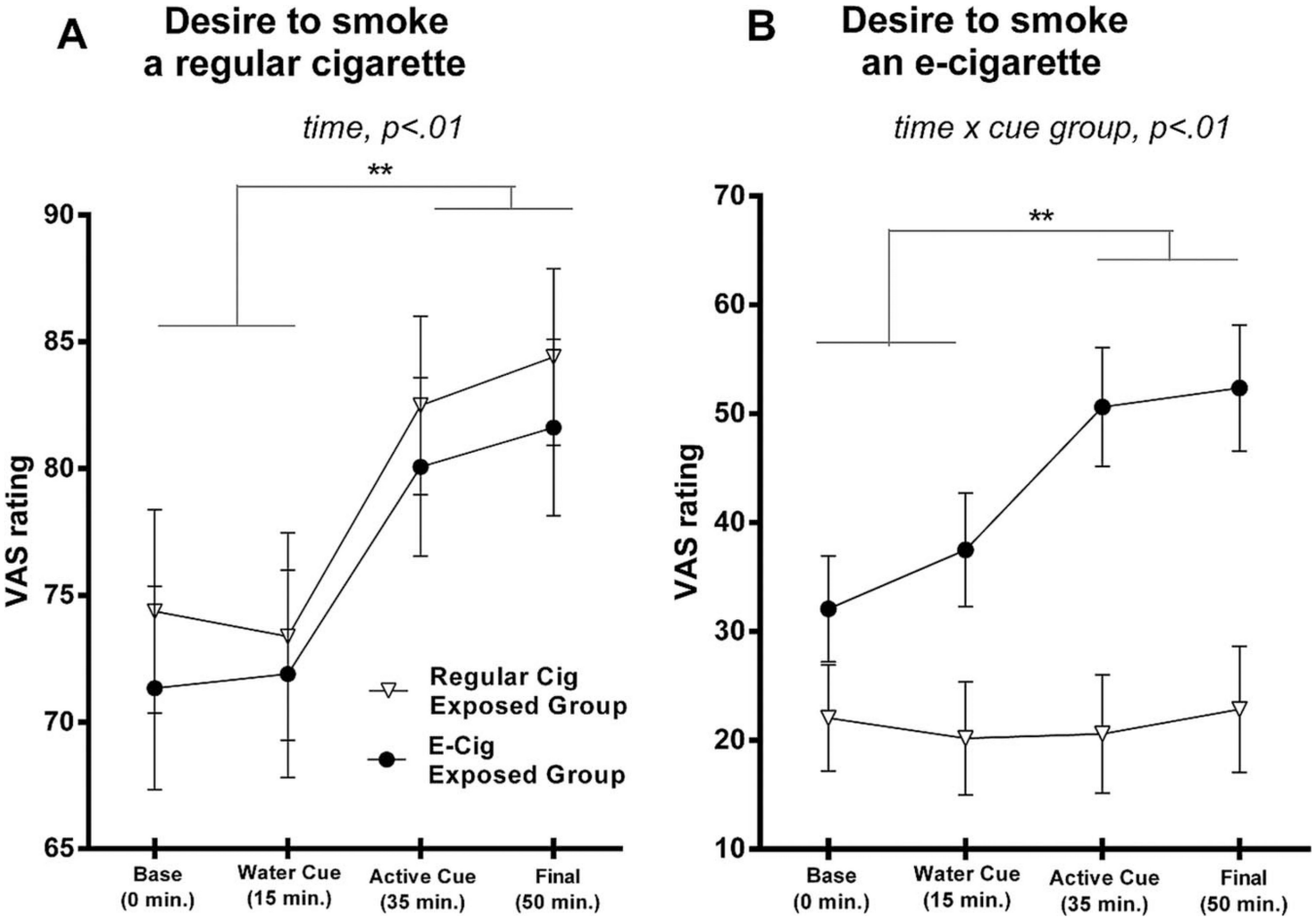

Figure 1.

Values are mean±SEM. Ratings on desire to smoke a regular cigarette, that is, preferred brand of combustible cigarette (A) and desire to smoke an e-cigarette (B) each scored on a 10 cm visual analogue scale (VAS) anchored from ‘not at all’ to ‘most ever’. Participants were randomised to either the active cue e-cigarette exposed group (n=30) or the combustible cigarette exposure group (n=30).