RUNNING HEAD: E-CIGARETTE VISUAL APPEARANCE

TITLE: The Effects of E-Cigarette Visual Appearance on Craving and Withdrawal Symptoms in Abstinent Smokers

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Abstract

Electronic cigarette (e-cigarette) use is becoming increasing popular among smokers and there is a plethora of devices available. Nicotine delivery is clearly important for reducing tobacco craving and withdrawal symptoms, but other sensor-motor aspects of e-cigarettes (such as visual appearance) may contribute to this effect. This study explored whether it is important for an e-cigarette to visually resemble a tobacco cigarette in order to reduce craving and withdrawal symptoms. Sixty-three cigarette smokers (40% female, aged 18-65 years) who were not current e-cigarette users were randomly allocated to take ten 3-second puffs from either a white or a red first generation e-cigarette following overnight abstinence. Current craving (urge to smoke) and nicotine withdrawal symptoms (using the Mood and Physical Symptoms Scale; MPSS) were measured before and ten minutes after use. Linear regression revealed higher craving and withdrawal symptoms in the red versus the white condition but only among those who were e-cigarette naive (craving: B = .76, p = .009; withdrawal symptoms: B = 2.18, p = 0.009), not among those with e-cigarette experience (craving: B = -.08, p = 0.89; withdrawal symptoms: B = .24, p = .81), and these effects differed between groups (p = 0.04 and 0.01 for craving and withdrawal symptoms respectively). To conclude, cigarette-like appearance was associated with lower craving and withdrawal symptoms but only for those with no prior e-cigarette experience. This effect, putatively mediated via classical conditioning or expectancies, may aid understanding of smokers' initial preferences for 'cigalike' e-cigarette devices.

Keywords:

Electronic cigarettes, craving, withdrawal symptoms, sensori-motor aspects, visual appearance, cigalike

Electronic cigarettes (e-cigarettes) are battery-powered devices that deliver nicotine via an aerosol that is inhaled. Recent evidence supports their efficacy as a smoking cessation aid with quit rates at least equivalent to Nicotine Replacement Therapy (NRT; McRobbie, Bullen, Hartmann-Boyce & Hajek, 2014; Brown, Beard, Kotz, Michie & West, 2014). Although a relatively new phenomenon, public awareness and regular use of e-cigarettes has increased rapidly, doubling between 2010 and 2011 in the US (King, Alam, Promoff, Arrazola & Dube, 2013) and increasing from 3% to 18% between in 2010 and 2014 in Great Britain (Action on Smoking and Health, [ASH], 2014) although use in England has dipped recently (West & Brown, 2015).

E-cigarette use resembles the act of smoking: the user holds the device and draws on it like a cigarette; the aerosol produced is drawn into the lungs and exhaled like smoke; tobacco (or menthol) flavouring mimics the taste of inhaled tobacco smoke and many (first generation) device look exactly like tobacco cigarettes (commonly known as 'cigalikes'). Although regular e-cigarette users tend to use devices which deviate from a cigarette-like appearance (second or third generation devices; Dawkins, Turner, Roberts & Soar, 2013), 'cigalikes' currently account for 65% of the e-cigarette market share (Herzog, Gerberi & Scott, 2014) and are more commonly found in retail outlets across the UK and US. Such devices may appeal to new e-cigarette users; in a recent study of 100 (e-cigarette naïve) smokers who were asked to choose between a first or second generation device, 50% opted for a first generation 'cigalike' and did so because it looked like a tobacco cigarette (Dawkins, Kimber, Puwanesarasa & Soar 2015).

Although nicotine is clearly a critical component of tobacco dependence, a growing body of evidence points to the role of non-nicotine, sensorimotor factors in supporting smoking

behaviour. Anecdotally, smokers prefer smoking to other forms of nicotine administration (e.g., patch, gum, nasal spray), possibly due to the rapid nicotine delivery although the sensory and tactile components of smoking, including the hand-mouth activity, taste, smell and sensations in the respiratory tract are all strongly endorsed (Parrott & Craig, 1995). Smokers have also been shown to prefer smoking a denicotinised cigarette over receiving intravenous nicotine (Rose, Salley, Behm, Bates & Westman, 2010) and denicotinised tobacco smoking can alleviate nicotine withdrawal symptoms and craving (Barrett, 2010; Perkins, Karelitz, Conklin, Sayette & Giedgowd, 2010; Rose et al., 2010). These effects likely arise as a consequence of sensorimotor cues (e.g., visual appearance, hand-mouth action, taste and smell of smoke) imbuing some of the rewarding properties of smoking given their repeated pairing with nicotine administration via classical conditioning.

Acute e-cigarette use can also reduce tobacco craving and withdrawal symptoms in abstinent smokers (Bullen et al. 2010; Dawkins, Turner & Crowe, 2013; Vansickel, Cobb, Weaver & Eissenberg, 2010) and non-nicotine placebo devices have also been shown to be effective (Dawkins, Turner, Hasna & Soar, 2012). Nevertheless, the importance of the visual similarity to tobacco cigarettes has not been systematically explored. We have recently reported that a first and second generation device were equally effective in suppressing tobacco craving and withdrawal symptoms after acute use (Dawkins et al., 2015). Although not measured in this study, this may have been due to similar nicotine absorption, or because the cigarette-like appearance of the first generation device elicited a conditioned drug-like response (Stewart, de Wit & Eikelboom, 1984; Carter & Tiffany, 2001) that made up for inferior nicotine delivery in first-generation devices (Farsalinos et al., 2014). Given the documented importance of sensorimotor aspects of smoking, it is possible that an e-cigarette that looks visually similar to

a tobacco cigarette may be more useful for reducing acute cigarette craving and withdrawal symptoms than one that does not. Here we tested the importance of visual appearance using a first generation 'cigalike' device and varied just one aspect of visual appearance: colour (white: visually similar to a cigarette vs. red: visually dissimilar to a cigarette), with nicotine content and all other components remaining identical (orange cartridge, size, shape, flavour). We hypothesised that, relative to the red condition, abstinent smokers in the white condition, would show a greater reduction in craving and withdrawal symptoms following a standard 10 puff regime.

Method

Participants

Sixty-three current smokers (27 [40%] female,) aged between 18 and 65 years (mean 27, SD 11) and willing to remain abstinent overnight, were recruited via poster advertisements at the University of East London (UEL), e-mail and social networking websites. All were daily smokers who had been smoking for at least one year, not currently interested in quitting and had not used an e-cigarette in the past 30 days.

Procedure and Measures

Appointments were arranged via e-mail, at which point participants were reminded not to smoke or use other nicotine containing products overnight (i.e. for at least 10 hours) prior to the appointment. After written informed consent was obtained, participants provided a breath carbon monoxide (CO) sample measured using a Bedfont piCO+ smokerlyser to confirm their self-reported overnight abstinence with a level less than 10 ppm required for participation. Baseline demographic information, previous experience with e-cigarettes and smoking behaviour including severity of nicotine/tobacco dependence measured using the 6-item Fagerström Test for Cigarette Dependence (FTCD; Fagerström, 2012) was collected (possible range 0-10). Participants then rated their current urge to smoke (craving) on a single-item 5-point rating scale, from 0 (no urges) to 5 (extremely strong urge). Nicotine withdrawal symptoms were assessed using the Mood and Physical Symptoms Scale (MPSS; West & Hajek, 2004) which includes six core items (depressed mood, anxiousness, irritability, restlessness, hunger, poor concentration) rated on a scale from 1 (not at all) to 5 (extremely) summed to form a total score (possible range 6-30). Following random allocation (via coin toss) to group (red vs. white), all participants took ten, three-second puffs on a regular strength (18 mg/ml) 'tobacco' flavour rechargeable e-cigarette from E-lites with a 30-second inter-puff interval (consistent with that of Vansickle & Eissenberg, 2012). After ten minutes, current craving and withdrawal symptoms were rated for a second time. Participants were not paid for their participation but they were allowed to keep the e-cigarette.

Statistical Analysis

Linear regression was used to assess the effect of condition (red vs. white) on craving and withdrawal symptom scores. Primary analyses were conducted adjusting for baseline craving, withdrawal symptoms, age, gender, ethnicity and cigarettes smoked per day (CPD). Given that some participants reported prior use of an e-cigarette (current users were excluded), post hoc analyses tested for an interaction between condition and prior e-cigarette use. Where evidence for an interaction effect was observed, secondary analyses, also adjusting for baseline variables and stratified by prior e-cigarette use were used to explore the nature of the interaction. All test assumptions for linear regression were met. Our sample size provided 80% power to detect an effect size of d = 0.72 at an alpha level of 5%, equivalent to a difference of 0.5 points on the craving measure (assuming SD = 1) and 1 point on the MPSS (assuming SD = 3). All analyses were conducted with IBM SPSS Statistics (version 20).

Results

Demographic, smoking related information and baseline craving and withdrawal symptoms are shown in Table i. None of the demographic variables (age, gender, ethnicity, CPD) or baseline craving or withdrawal symptom emerged as a significant predictor of either craving or withdrawal symptoms. Twenty-two participants had previously used an e-cigarette. Prior e-cigarette use ranged from 1 to 20 occasions (mean mean 3; SD 4) with 68% reporting using only once or twice.

Craving

In the primary analysis, we observed no strong evidence of a main effect of condition on craving (B = +0.376, 95% CI -0.117 to +0.870, p = 0.132). However, there was evidence of a condition x prior e-cigarette use interaction (B = -0.012, 95% CI -0.024 to -0.001, p = 0.038). Secondary analyses stratified by prior e-cigarette use confirmed that craving was higher by 0.78 points (95% CI +0.21 to +1.34) in the red compared with the white condition among those who had not used an e-cigarette in the past (B = +0.775, 95% CI +0.205 to +1.344, p = 0.009), but there was no increase in craving (-0.08 points; 95% CI -1.23 to +1.13) among those who had (B = -0.079, 95% CI -1.283 to +1.126, p = 0.891). See Figure 1.

Withdrawal Symptoms

In the primary analysis, withdrawal symptom scores were 1.50 points higher (95% CI +0.16 to +2.76) in the red compared with the white condition (B = +1.887, 95% CI +0.606 to +3.169, p = 0.005). There was also evidence of a condition x prior e-cigarette use interaction (B = -0.038, 95% CI -0.067 to -0.009, p = 0.012). Secondary analyses stratified by prior e-cigarette use confirmed higher withdrawal symptoms in the red compared with the white condition among those who had not used an e-cigarette in the past (2.18 points higher; 95%CI +0.57 to +3.78; B = +2.177, 95%CI +0.573 to +3.781, p = 0.009) but not for those who had (0.24 points higher; 95% CI -1.85 to +2.34; B = +0.243, 95% CI = -1.850 to +2.337, p = 0.808). See Figure 2.

Discussion

Although many smokers choosing an e-cigarette for the first time opt for 'cigalike' devices (Dawkins et al., 2015), whether the visual similarity of an e-cigarette to a tobacco cigarette is important for the alleviation of craving and withdrawal symptoms has not been explored. In abstinent smokers who had not used an e-cigarette in the past, after adjusting for baseline values, we observed lower craving and withdrawal symptoms after using the white (visually similar to a cigarette) compared with the red (visually dissimilar to a cigarette) e-cigarette. For participants with previous e-cigarette experience, no such difference was found, suggesting that cigarette-like appearance may be an important factor in alleviating acute craving and withdrawal symptoms but only for e-cigarette naive smokers. However, this moderating effect of prior experience was not specifically hypothesised, and therefore should be treated with caution until replicated independently.

Sensorimotor cues such as visual appearance act as conditioned reinforcers that can become moderately reinforcing in their own right (Stewart, de Wit & Eikelboom, 1984). Given that nicotine content was identical in the visually similar and dissimilar conditions, a conditioned drug-like response is consistent with the lower craving/withdrawal symptoms in the visually similar condition observed here. An alternative explanation is that the visually similar (white) e-cigarette was perceived as more effective, although unfortunately expectations regarding effectiveness were not measured. Either way, whether via an unconscious conditioning mechanism or a conscious expectancy effect or indeed both, there is evidence here that acute craving and withdrawal symptom alleviation is not exclusively attributable to nicotine delivery.

In the current study, the effect of visual appearance was only found in participants with no e-cigarette experience and most of those who had previously tried an e-cigarette had done so only once or twice (68%). Whilst visual similarity to a cigarette may therefore be useful for reducing craving and withdrawal symptoms in the initial stages of e-cigarette use, this effect may dissipate fairly quickly. This may explain why many smokers initially opt for 'cigalikes' (Dawkins et al., 2015) whilst continuing users transition to cigarette dissimilar second and third generation devices (Dawkins et al., 2013; Etter & Bullen, 2011; Farsalinos et al., 2013; McQueen, Tower & Sumner, 2011) which may offer superior nicotine delivery (Farsalinos et al., 2014).

There are several limitations to the present study. First, the exclusive focus on visual cigarette-like appearance. Whilst this makes for a more controlled experimental study, it does not acknowledge the importance of other sensorimotor factors such as vapour production, taste and design. Moreover, red 'cigalike' devices are less commonly available and it is the second and third generation refillable devices that are competing with 'cigalikes' in the marketplace. We have previously compared a 'cigalike' and second generation device and found they were equally effective at reducing craving and withdrawal symptoms (Dawkins et al., 2015) but differences in nicotine delivery between the devices were not measured and complicates interpretation. Second, it is possible that the types of previous e-cigarettes used (e.g., first, second or later generation device) might influence subjective ratings of craving and withdrawal symptoms but we did not collect this information. Third, although overnight abstinence from smoking was CO verified, it is possible that participants may have used other nicotine-containing products or medications which influenced craving and withdrawal

symptoms. It is unlikely, however, that this would differentially one group over another, given the experimental nature of our design.

The clinical significance of the findings for longer-term smoking abstinence remain unclear given the effects were limited to lower craving and withdrawal symptoms in a sub-sample of e-cigarette naive smokers after only 10 e-cigarette puffs. Moreover, the difference, whilst significant, was small (0.78 points on the urge to smoke scale and 2.18 points on the MPSS scale). A longer-term follow up study would determine how long the effect is retained and whether it has any predictive utility for smoking cessation. In the meantime however, it may be prudent for researchers to consider recording e-cigarette history since it may influence subjective reporting.

In conclusion, compared with a cigarette-dissimilar device, an e-cigarette that visually resembled a tobacco cigarette was associated with lower tobacco craving and withdrawal symptoms in e-cigarette naive abstinent smokers. Similar effects were not observed in those with previous e-cigarette experience suggesting the effect may be short-lived. This may be one of the reasons why many smokers favour 'cigalikes' initially but often transition to cigarette-dissimilar second and third generation devices over time (Dawkins et al., 2013; 2014, McQueen, Tower & Sumner, 2011).

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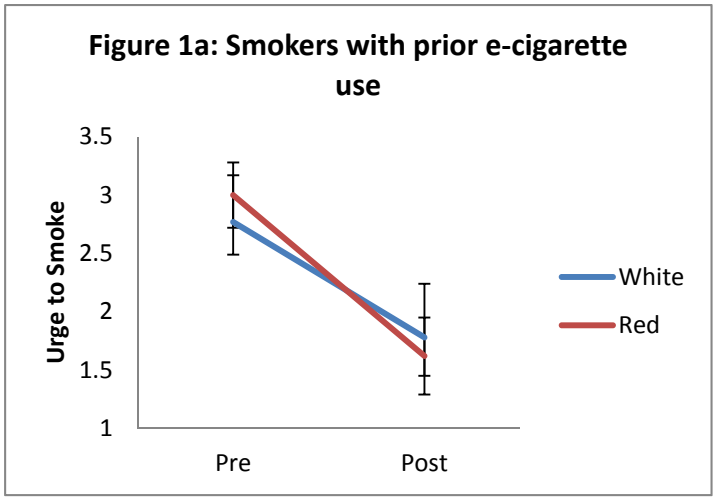
Tables and Figures

Table i: Demographic and Smoking Related Information for the Visually Similar (White) vs. Visually Dissimilar (Red) E-Cigarette Groups

	White N = 33	Red N = 30
	Mean (SD)	**Mean (SD)**
Age	25.48 (9.27)	27.83 (2.21)
CPD	12.58 (8.05)	11.43 (5.42)
Years Smoked	8.92 (7.24)	7.98 (5.23)
FTCD	5.45 (2.69)	5.13 (1.87)
Baseline Urge to Smoke	2.70 (1.29)	2.63 (0.96)
Baseline Withdrawal Symptoms	14.52 (4.40)	13.30 (3.90)
	N (%)	**N (%)**
Female	11 (33%)	16 (53%)
Previous e-cigarette use (Yes)	9 (27%)	13 (43%)
European ethnicity	16 (48%)	20 (67%)

CPD: cigarettes per day; FTCD: Fagerstrom Test of Cigarette Dependence (possible range: 0-10); Urge to Smoke possible range: 0-5; Withdrawal Symptoms (MPSS) possible range: 6-30).

Figure 1: Mean Craving (urge to smoke) scores at Baseline and Ten Minutes after E-Cigarette Use for the Visually Similar (White) vs. Visually Dissimilar (Red) Condition in a) Smokers with Prior E-Cigarette Use and b) Smokers with No Prior E-Cigarette Use. Urge to smoke possible range (1-5). Error bars are 1SE.



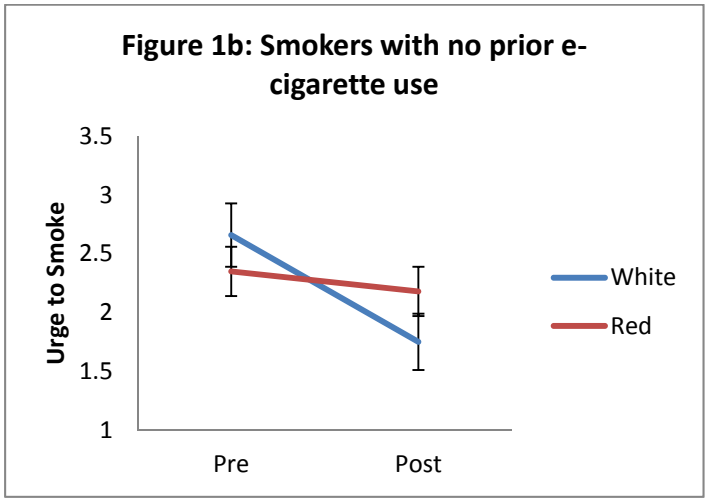


Figure 2: Mean Withdrawal Symptoms (MPSS) scores at Baseline and Ten Minutes after E-Cigarette Use for the Visually Similar (White) vs. Visually Dissimilar (Red) Condition in a) Smokers with Prior E-Cigarette Use and b) Smokers with No Prior E-Cigarette Use. MPSS possible range: 6-30. Error bars are 1SE

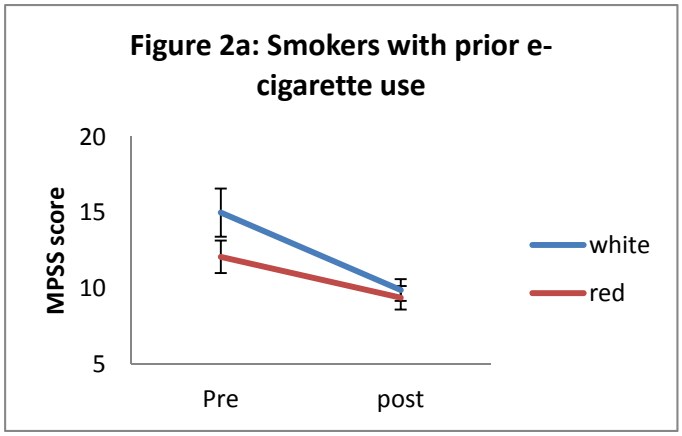


Figure 2a: Smokers with prior e-cigarette use
MPSS score
20
15
10
5
Pre
post
white
red

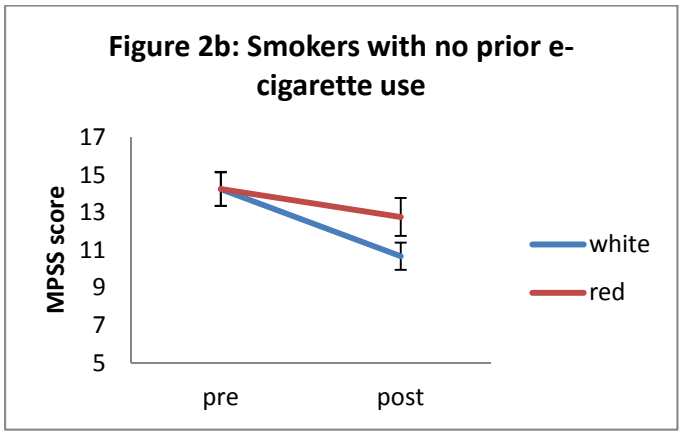


Figure 2b: Smokers with no prior e-cigarette use
MPSS score
17
15
13
11
9
7
5
pre
post
white
red