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Attentional Bias in Non-Smokers Who Use an Electronic Cigarette

Fitzpatrick, Chelsea Louise

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Attentional Bias in Non-Smokers Who Use an Electronic Cigarette

by

Chelsea Louise Fitzpatrick

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# ATTENTIONAL BIAS IN E-CIG USERS

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ABSTRACT

Electronic cigarettes (e-cigarettes) have been gaining popularity in recent years and are now being used in large numbers by youth who smoke tobacco cigarettes as well as among youths who do not smoke. Previous research has indicated that substance users can develop attentional biases towards stimuli related to their use. Yet, the existence of attentional biases among users of e-cigarettes remains largely unexplored. Using a sample of non-smokers, the present study examined whether e-cigarette users develop an attentional bias toward e-cigarette stimuli and whether this can be transferred to traditional cigarette stimuli. Using eye-gaze tracking to identify attentional biases, it was found that e-cigarette users significantly differed in comparison to controls in terms of the average amount of time that they attended to e-cigarette stimuli. However, e-cigarette users did not preferentially attend to e-cigarette stimuli over neutral stimuli. Furthermore, e-cigarette users did not attend more to smoking stimuli over neutral stimuli. Rather, e-cigarette users appeared to avoid smoking cues. The results of this study indicate that e-cigarette users’ attention towards e-cigarettes is increased in comparison to non-users, which may have implications as to how they react to e-cigarette cues in real-world settings.

Keywords: Electronic cigarettes, vaping, attentional biases, non-smokers
Attentional Bias in Non-Smokers Who Use an Electronic Cigarette

Rates of electronic cigarette (e-cigarette or vaping) use have been continually on the rise since their introduction to the North American marketplace in the early 2000’s (King, Alam, Promoff, Arrazola, & Dube, 2013; McMillen, Gottlieb, Shaefer, Winickoff, & Klein, 2018; US Department of Health and Human Services, 2016). A potential reason for the popularity in the use of e-cigarettes is the perception that they are a safer alternative to traditional combustible cigarettes (Choi & Forster, 2013). Additionally, e-cigarettes have been commonly viewed as a cessation tool for combustible cigarette smoking (Siegel, Tanwar, & Wood, 2011). Recent research, however, suggests that e-cigarettes may be more harmful than once thought (Soneji, Sung, Primack, Pierce, & Sargent, 2018). Furthermore, there is evidence to indicate that e-cigarettes may also contribute to the migration towards the use of traditional cigarettes among non-smoking e-cigarette users (Spindle et al., 2017).

Despite the widespread use of e-cigarettes, the underlying mechanisms behind e-cigarette use remains poorly understood. Furthermore, cognitive processes which may influence the migration from vaping to smoking have yet to be adequately investigated. One component of cognition which may contribute to this transition are attentional biases, which occur when an individual displays heightened awareness and processing of cues related to their addiction (Field & Cox, 2008). The present research investigated whether e-cigarette users can also develop an attentional bias towards e-cigarettes in much the same way that occurs with other substances (e.g., tobacco (Bradley, Mogg, Wright, & Field, 2003), and alcohol (Townshend & Duka, 2001)). Furthermore, this study also assessed whether transference of attentional biases from e-cigarettes to traditional tobacco cigarettes can also occur among non-smoking e-cigarette users, which may
be a potential mechanism to help understand the migration from e-cigarettes to traditional cigarettes.

**Electronic Cigarettes**

An e-cigarette is a device which delivers nicotine or non-nicotine containing e-juice through inhaled vapor. The device delivers this vapor through the process of heating a solution containing propylene glycol or glycerol (glycerin), nicotine (in many cases but not always), and the option of flavoring (Grana, Benowitz, & Glantz, 2014). With an e-cigarette, individuals can vary the nicotine concentration, volume of solution in the product, carrier compound, additives/flavors and battery voltage. Furthermore, users are also able to modify the products, and can use vaping devices to administer other drugs including tetrahydrocannabinol (THC), the primary psychoactive constituent in marijuana (Morean, Kong, Camenga, Cavallo, & Krishnan-Sarin, 2015). There are also a number of different types of e-cigarettes, including disposable, rechargeable, pen-style and tank-style (Grana et al., 2014). When motives for use have been assessed, individuals report using e-cigarettes for a multitude of reasons including; fewer location restrictions, can use nicotine more, smoking cessation, thinking that there are fewer harms to health (compared to traditional cigarettes), better and more diverse flavors (i.e., don’t have the same taste as tobacco cigarettes), and are not known to damage teeth and skin as combustible cigarettes do, to name a few (Dawkins, Turner, Roberts, & Soar, 2013; Goniewicz, Lingas, & Hajek, 2013). In regard to nicotine absorption rates, they vary by both the product and the person (based on number and length of puffs), and as such, can be comparable to the nicotine absorption rates seen in conventional cigarettes (Dawkins & Corcoran, 2014; Vansickle & Eissenberg, 2013).

E-cigarette usage has been steadily increasing year-over-year (King, Alam, Promoff, Arrazola, & Dube, 2013; McMillen, Gottlieb, Shaefer, Winickoff, & Klein, 2018). For instance,
epidemiological evidence from the United States revealed that ever e-cigarette usage among young adults increased from 6.9% in 2011 to 14.3% in 2014 (US Department of Health and Human Services, 2016). Moreover, e-cigarettes are particularly popular with adolescents and young adults. Among Canadian high school students surveyed between 2014-2015, ever use for e-cigarettes was estimated to be 17.7%, and current (past 30 days) use at 5.7% (Montreuil et al., 2017). Data from the United States National Survey in 2013-2014, estimated ever use at 35.8% and current use at 13.6% among young adults aged 18 to 24 (US Department of Health and Human Services, 2016). An additional prevalence report in 2014 found that 12.6% of adults had tried an e-cigarette. When broken down by age range, young adults (18 to 24 year olds) had the highest prevalence with 21.6%, followed by 25-44 year olds with 16.6%, 45 to 64 year olds with 10.2% and lastly 65+ with 3.7% (Schoenborn & Gindi, 2015). From these studies, it can be observed that e-cigarette use is most prevalent among young adults, with both ever use and current use on the rise (Schoenborn & Gindi, 2015; US Department of Health and Human Services, 2016).

Along with this rise in prevalence there has been a coinciding increase in e-cigarette advertisements (Kim, Arnold, & Makarenko, 2014). To date, regulations restricting e-cigarette advertising have been sparse. Most concerning, e-cigarette advertisements often minimize the risks while focusing on the benefits of use (Klein et al., 2016). In 2012, 18.3 million dollars was spent on ads in the United States; representing a three-fold increase over the 6.4 million spent in 2011, with the majority of focus placed on national markets through television ads (Kim et al., 2014). Concomitant with this increase in overall advertising, youth exposure to e-cigarette ads on television increased by 256% from 2011 to 2013 (Duke et al., 2014). Not surprisingly, exposure to e-cigarette advertisements among youth was significantly associated with both current and ever e-cigarette usage, while adjusting for sex, grade, ethnicity and past 30 day tobacco use, odds ratios
ranged from 1.20 to 1.68 dependent on the type of media (internet, print, retail and television/movies) (Mantey, Cooper, Clendennen, Pasch, & Perry, 2016). Furthermore, exposure to e-cigarette advertisements increased the odds of past 30 day use by 1.22 and being in high school (opposed to middle school) was also associated with an odds ratio of 2.37 (Mantey et al., 2016). This suggests that increased exposure to e-cigarette advertisements may partially account for the findings that more students are currently using e-cigarettes. Among those exposed to e-cigarette advertisements, higher receptivity was associated with perceptions that e-cigarettes are less harmful, which in turn, was associated with higher e-cigarette usage (Pokhrel, Fagan, Kehl, & Herzog, 2015). Lastly, another large market for exposure to e-cigarettes advertising is through online videos. The majority of these videos are sponsored by marketers for e-cigarettes and videos tend to highlight economic and social benefits as well as health benefits which have been proscribed by the FDA (Paek, Kim, Hove, & Huh, 2014).

**Potential Harms of E-Cigarette Use**

As research on the health of e-cigarettes has increased, evidence has emerged to indicate that e-cigarettes may actually be doing more harm than good. While research on the dangers of using traditional tobacco cigarettes has been extensive, analogous studies focusing on the potential harms of e-cigarettes are still in their infancy. Yet, there is some indication of physical harm associated with e-cigarettes. Firstly, there is the potential for nicotine dependence associated with using e-cigarettes containing nicotine (Perkins, Karelitz, & Michael, 2015). Nicotine presents other concerns beyond dependence and being a toxic substance such as health concerns including cancer, cardiovascular diseases, and effects on reproductive health (Lee & Fariss, 2017). Conversely, little is known about e-cigarettes which do not contain nicotine (Bell & Keane, 2012), other than the
fact that e-juice without nicotine appears to be less addictive than those containing nicotine (Etter & Eissenberg, 2015).

While it does appear that e-cigarettes are less addictive than combustible cigarettes, with 74% of former cigarette smokers reporting that their e-cigarette dependence was weaker than their previous cigarette dependence (Etter & Eissenberg, 2015), the majority of e-cigarette users do believe that e-cigarettes are addictive. For instance, one study revealed that 93% of current e-cigarette users believed that e-cigarettes can be addictive, and additionally, approximately half believed they were currently dependent on e-cigarettes (Goniewicz et al., 2013).

While developing dependence for vaping is clearly concerning, recent research also suggest that some e-cigarette devices may also be responsible for other health concerns. For instance, it has been found that the chemical processes involved in the heating of e-cigarette e-juice can result in the release of formaldehyde into the vapor. Formaldehyde is a chemical which is also a suspected carcinogen (Kosmider et al., 2014). The release of formaldehyde vapor is said to resemble that of a combustible cigarette when using a propylene glycol solution and a high voltage (4.8 V) e-cigarette (Kosmider et al., 2014). Additionally, when looking at the specific use of an e-cigarette, approximately 10 puffs using a high voltage (5.0 V) e-cigarette, releases roughly twice the amount of formaldehyde when compared to one traditional cigarette (Jensen, Luo, Pankow, Strongin, & Peyton, 2015).

The harms of e-cigarettes extend beyond physical and addictive harms. Past research with combustible tobacco has found that cigarette smoking is associated with higher levels of psychological distress (Jamal et al., 2016). Similarly, a recent study has found that e-cigarette usage is also associated with psychological distress; with dual users (e-cigarettes and combustible cigarettes) experiencing the highest level of distress (Park, Lee, Shearston, & Weitzman, 2017).
Patterns of E-Cigarette Use

Dual use of tobacco and vaping is a phenomenon which occurs in both adults and youth; with dual use reported in 2% to 12% of youth US e-cigarette users (Action on Smoking and Health, 2014). In adults, 32% reported currently using one or more tobacco products, with 28% of those individuals reporting using e-cigarettes in addition to tobacco cigarettes (Lee, Hebert, Nonnemaker, & Kim, 2014). Dual users tend to use the two products quite differently. E-cigarettes tend to be used for smoking cessation and for the reduction of health risks as dual users perceive e-cigarettes as being safer and less addictive (Maglia, Caponnetto, Di Piazza, La Torre, & Polosa, 2017). In contrast, tobacco cigarettes are used more in hedonistic situations, locations where there are no restrictions on smoking, and when they are more stressed and/or anxious (Maglia et al., 2017).

In a study done by Choi & Forster (2013), over 2,000 adults from the Midwestern United States were asked about their awareness, usage and perceptions of e-cigarettes. It was found that 70% of the participants were aware of e-cigarettes, with 7% having ever-used and 1% currently using. Of those currently using, they were 1.52 times more likely to be between 20-24 years old, and 1.98 times more likely to be male. Additionally, they were 10.07 times more likely to be a current smoker, and 3.51 times more likely to be a former smoker over being a never smoker. Among current and former smokers, they were more likely to believe that e-cigarettes are less addictive than combustible cigarettes, while only current smokers were more likely to believe that e-cigarettes are less harmful and that vaping can help them to quit smoking. With the multiple relationships between e-cigarettes and tobacco cigarettes, including dual use, there is also the possibility that one begins with using an e-cigarette and later transitions to tobacco cigarette smoking.
The Link Between E-Cigarette and Later Use of Combustible Tobacco Cigarettes

Although the potential usefulness of vaping for smoking cessation is promising, there also appears to be the potential hazard associated with migration from e-cigarette use to cigarette smoking among some individuals. For example, it has been estimated that anywhere from 16.3% to 33.3% of e-cigarette users are actually current nonsmokers (i.e., never or former smokers) (Sharapova, Singh, Agaku, Kennedy, & King, 2018; McMillen et al., 2018). This estimate from McMillen’s study in 2018 has risen from 2012, when it was estimated that 17.2% and 7.7% of e-cigarette users were former and never smokers respectively (McMillen, Maduka, & Winickoff, 2012). Moreover, recent research suggests that e-cigarettes could contribute to nicotine addiction as well as the renormalization of tobacco use (McMillen et al., 2018).

In recent years, there has been an increased focus toward exploring the potential of non-smoking e-cigarette users later transitioning to tobacco use, especially among youth and adolescents. In one study conducted with 11th and 12th graders in Southern California, it was found that those currently using e-cigarettes were twice as more likely to be susceptible to cigarette use (i.e., no commitment to not smoke cigarettes) as compared to those who had never used e-cigarettes (Barrington-Trimis, et al., 2016). Additionally, a study involving adolescents in grades 6 through 12 found that the intention to smoke cigarettes was 1.7 times higher in ever e-cigarette users as compared to never users (Bunnell et al., 2015). When predicting future use of tobacco cigarettes, the usage of e-cigarettes (ever use or current use) was related to a 3.37 to 3.41 times higher chance of having tried a traditional cigarette at time two (Spindle et al., 2017). Ever use of e-cigarettes was also related to a 3.30 times higher chance of being a current smoker at time two (Spindle et al., 2017). When evaluating the relationship between e-cigarette use and subsequent smoking among adolescents who became of age to legally purchase tobacco products, e-cigarette users were
over six times more likely to have initiated cigarette smoking when compared to never users of e-cigarettes (Barrington-Trimis, et al., 2016). When specifically looking at the transition period when adolescents are able to legally purchase tobacco, the odds of initiating cigarette smoking is considerably higher than when not evaluating during this transition period.

The above studies suggest that there appears to be possible transitions in both directions. That is, it appears that some current cigarette smokers have initiated e-cigarette use and vice versa. Unfortunately, there is a paucity of research which has attempted to weigh the two transitions in terms of harms and benefits. At a population level, the balance of harm to benefit leans more toward the harm side with there being possible negative impacts to both never smokers and former smokers (Levy et al., 2017). In a study conducted by Soneji, Sung, Primack, Pierce, & Sargent (2018), using a Monte Carlo stochastic simulation model, it was estimated that e-cigarette usage in 2014 alone would amount to 1,510,000 years lost when taking into account both years gained from former smokers quitting by using e-cigarettes as well as e-cigarettes facilitating smoking cigarettes in never smokers. At this time, there has been a limited number of studies which have researched the cost vs benefit. As this is a growing area, future studies will be needed to determine concrete cost-benefit analyses of e-cigarettes as their use continues to evolve.

**Transitioning from E-Cigarettes to Traditional Cigarettes**

Importantly for the present research, there is a paucity of research examining potential mechanisms that lead to the migration to traditional cigarettes from e-cigarettes. There are several theories which could help to explain the process of transitioning from e-cigarettes to combustible tobacco cigarettes. A few of such theories are discussed below.

**The Gateway Theory.** According to the Gateway Theory, use of one drug may increase susceptibility to later trying other drugs; for example someone using cannabis may later transition to
using methamphetamines (Kandel, 1975; Kandel, Yamaguchi, & Klein, 2006). In terms of the present research, vaping can result in nicotine use/dependence, feelings and gestures associated with inhalation, and contact with smokers. Through these characteristics, individuals may begin to smoke (Etter, 2017). Exposure to these factors may ultimately serve as a ‘gateway’ to other methods for administering nicotine including cigarette smoking. In one of the few studies which has investigated this relationship, it was found that e-cigarette users were more likely to turn to traditional cigarettes at time 2 if they had affiliations with friends who smoked, had more positive smoking expectancies, and had a higher marijuana score during the baseline assessment (Wills, Gibbons, Sargent, & Schweitzer, 2016). However, more recent critiques argue that the gateway theory is flawed in terms of its’ relationship to e-cigarettes and the uptake of traditional cigarettes. For instance, the gateway theory does not explain how the uptake of e-cigarettes first occurs (Schneider & Diehl, 2016).

The Catalyst Model. Another potential explanation is the Catalyst Model. This model goes further than the Gateway theory in that it first explains why an individual would begin using an e-cigarette in the first place. In other words, what are the factors that influences an individual from not using an e-cigarette to using an e-cigarette. Thereafter, the Catalyst Model moves on to propose hypotheses which would lead one from vaping to smoking (Schneider & Diehl, 2016). Thus, whereas the Gateway Theory is a one-step process (from e-cigarettes to smoking), the Catalyst Model can be seen as two-step process (from no use to e-cigarette and then from e-cigarette use to smoking). The model proposes numerous reasons as to why one would engage in e-cigarette use, including flavor, price, role model, concealment and acceptance (more socially acceptable), as well as why one would transition to tobacco cigarettes including the addiction (nicotine addiction), accessibility (where e-cigarettes are sold, often tobacco cigarettes are too),
and experience hypotheses (experience with an e-cigarette trains one to smoke a traditional cigarette). Lastly, they also propose two hypotheses which may explain more than one pathway within the model. The liability hypothesis proposes that use of either an e-cigarette or traditional cigarette are unrelated to one another, and that individuals engage in these activities due to personality traits and socialization. And the second is the renormalization hypothesis, which proposes that e-cigarettes may lead to the renormalization of tobacco products, and as such individuals will begin to believe they are less dangerous than once thought. The renormalization hypothesis also speaks to social learning theory, with users of any kind of cigarette act as a social role model and may influence this uptake of cigarettes.

Many of the Catalyst Model’s hypotheses regarding why an adolescent would begin using an e-cigarette have been supported with studies that have researched reasons that an individual vapes. For instance, in a National Youth Tobacco Survey conducted in the United States in 2016, some of the top reasons amongst youth to use an e-cigarette coincide with the above hypotheses. The results indicated that some of the most popular reasons were that a friend or family member used an e-cigarette (39%), the available flavours (31%), and that they are less harmful than traditional cigarettes (17.1%) (Tsai et al., 2018). An additional study from 2014 which evaluated 11th and 12th graders found that susceptibility for cigarette use was increased if the individuals’ friends used or had positive attitudes towards e-cigarettes. This study further concludes that e-cigarettes may be contributing to social normalization of smoking behaviours and nicotine, and thus affecting future cigarette smoking (Barrington-Trimis, Berhane, et al., 2016).

**Cognitive Processes and Attentional Biases**

Attentional biases may also help to understand the migration from e-cigarettes to cigarettes. Number of theories have been proposed as to why an attentional bias may develop in response to
exposure to external stimuli associated with addictive behaviours. One of the earliest theories describing the development of an attentional bias relates to the influence of classical conditioning. According to learning theories, the repeated experience of pairing a substance of abuse with environmental stimuli (often unrelated to the addictive behaviour itself) will eventually lead to an increase in attention directed towards these cues during future exposures (Field & Cox, 2008). In their influential theory, Robinson and Berridge (1993) further describe why some individuals compulsively use drugs as a result of Incentive Sensitization, a theory which posits that there is a dopaminergic response which occurs following repeated administrations of the substance, resulting in increased sensitization toward the drug. In other words, the substance gains incentive salience; or “drug wanting” and these motivational properties lead to an increased likelihood of additional drug administrations (Robinson & Berridge, 2000). Related to this compulsive drug wanting, individuals develop an underlying bias in their attentional processing towards the substance as well as substance-related stimuli (Robinson & Berridge, 2008). This increased attentional processing can also be considered an attentional bias.

Transference is described as the ability of selective attention towards one addiction to be transferred to another, similar substance. In other words, it is when an individual who preferentially attends to one substance can also experience increased attention directed toward a second substance which elicits a similar response. An example of this includes a recent study done with cigarette smokers, where it was found that these individuals had also developed an attentional bias towards e-cigarettes as well as traditional cigarettes (Lochbuehler et al., 2018). Accordingly, it is feasible that the reverse may also be true; whereby e-cigarette users may also preferentially attend to cigarette cues over neutral cues, which may help in understanding the migration from e-cigarettes to traditional cigarettes.
Methods for Measuring Attentional Biases

An attentional bias can be measured using differing methodologies including both direct and indirect measures of attention. Indirect measurements include tasks such as the addiction Stroop task, dual-task procedures and flicker-induced change blindness. Whereas more direct measures include the visual probe task, attentional cueing tasks, and eye-gaze tracking (Field & Cox, 2008). Indirect measures tend to be less reliable over direct measures as there is an inference associated with indirect measures, such that we assume that slower reaction time to name a color in the addiction Stroop task is due to selective attention towards substance-related words. However, there may be alternative explanations for this delay such as attempts to avoid higher level processing of substance related words (Klein, 2007), or that the individual is experiencing subjective craving due to the substance-related words, given craving is known to utilize cognitive resources which would slow down reaction time for the substance-related words (Algom, Chajut, & Lev, 2004). These lapses of attention may indicate an attentional bias, or alternatively, may simply indicate that the individual is avoiding the substance-related words. It is also feasible that the individual is experiencing acute craving for their drug of use, which can be related to an attentional bias, but may not be directly reflective of one.

Importantly for the present study, research has found that the direct measures (i.e., eye-gaze tracking) provide a more sensitive measure of attentional biases when compared against indirect measures. Furthermore, eye-gaze tracing often displays superior reliability and construct validity (Field & Cox, 2008; Field, Marhe, & Franken, 2014). Eye movements are believed to be tightly coupled with attention (Wright & Ward, 2008), whereas an indirect measure involves a two-step process whereby the bias in attention would be assumed from some other measure (e.g., for the addiction Stroop task an individual must indicate the colour of the word shown, a slower
reaction indicating an attentional bias as they are said to be processing the word over the colour). Specifically, for measuring an attentional bias via eye-gaze tracking, an attentional bias can be identified when the group of interest significantly differs from the control group, in terms of their attention allocated towards the addiction-related stimuli (Field & Cox, 2008).

**Attentional Biases in Tobacco Smoking**

The existence of attentional biases has been established across differing addictive behaviours (Field & Cox, 2008). This includes gambling (Honsi, Mentzoni, Molde, & Pallesen, 2012), tobacco (Bradley et al., 2003), alcohol (Townshend & Duka, 2001), as well as other illicit drugs (Leeman, Robinson, Waters, & Sofuoglu, 2014). Moreover, the associated strength of an attentional bias has been shown to be positively related to the subjective craving for the substance (Field, Munafò, & Franken, 2009). Field and colleagues (2009) also found that this association differed based on the substance in question, and how the attentional bias was measured; with direct measures resulting in larger associations.

A sizeable body of evidence has identified the existence of attentional biases among tobacco users for cigarette cues. Using a modified Stroop task, Munafo, Mogg, Roberts, Bradley, and Murphy (2003) found that current cigarette smokers had a processing bias for smoking-related cues over that of neutral cues. Additional studies have aimed to determine what differences are present that may heighten an attentional bias. In a study by Bradley and colleagues (2003), it was found that when a shorter duration of time (500ms) was used for the visual probe task, an attentional bias was only observed for smokers who have had numerous failed attempts to quit. However, when a longer exposure duration was used (i.e., 2000ms), the bias was observed across all smokers regardless of previous attempts to quit. These results suggest that those with numerous attempts to quit smoking display a higher vigilance for smoking cues, and these individuals’
ATTENTIONAL BIAS IN E-CIG USERS

inability to quit smoking may be related to their attentional bias towards smoking stimuli. Waters and Feyerabend (2000) examined the role of tobacco abstinence in attentional biases toward smoking stimuli. Participants were required to abstain from smoking for 24 hours prior to testing and then completed an emotional Stroop task where they were presented with smoking and neutral words. They found that those who were abstinent showed a greater bias toward smoking cues compared to smokers who were not abstinent. In terms of the relationship between strength of attentional biases and the ability to quit smoking, one study found that those who with a greater attentional bias towards smoking-related cues were significantly more likely to relapse within one week of quitting (Waters et al., 2003). Past research using a visual probe task has found that smokers in comparison to non-smokers will attend to smoking cues for longer than neutral cues, and that this diversion of attention is related to both increased craving as well as increased affective and motivational valance associated with smoking stimuli (Mogg, Bradley, Field, & De Houwer, 2003). Given the presence of attentional biases in tobacco users, there is strong reasoning for e-cigarette users to also display attentional biases, which unfortunately has rarely been examined.

Attentional Biases in E-Cigarette Users

Compared to the much more established literature on tobacco smoking, there has been a paucity of research exploring many of these same concepts in e-cigarette users. In a study with current smokers, participants were asked to first observe a confederate drink water (control condition) and then smoke a cigarette or use an e-cigarette. Passive exposure to either e-cigarettes or cigarettes significantly increased desire and urge to smoke combustible cigarettes. Furthermore, passive e-cigarette exposure elicited also increased e-cigarette craving (King, Smith, McNamara, Matthews, & Fridberg, 2015). However, a major limitation of this study was that the sample was
not comprised of primarily e-cigarette users. Indeed, only half of the sample had past e-cigarette use and a mere 23% reported use within the past month (i.e., current use).

King and colleagues (2016) investigated whether viewing a video depicting e-cigarette use would elicit subjective urges to smoke a tobacco cigarette or use an e-cigarette. The videos consisted of advertisements for e-cigarettes or bottled water (control stimuli). This study found that e-cigarette cues in people who smoke tobacco cigarettes were able to produce increased craving ratings for both cigarette smoking as well as for e-cigarettes. However, similar to the previous study conducted by this group, a potential limitation was that the majority of participants were not regular users of an e-cigarette. In the second study, past year use ranged from 70-76%; however, past month use ranged from only 25-29%.

The most recent study on this topic examined whether smokers have developed an attentional bias for e-cigarette cues. The study utilized eye-gaze tracking to determine whether both current and former smokers display increased attention towards e-cigarette cues in comparison to neutral images. It was found that current smokers, more so than non-smokers or former smokers, displayed a bias towards e-cigarette images over neutral stimuli (Lochbuehler et al., 2018). Similar to the past two studies, this study was more focused on traditional cigarette smokers as opposed to e-cigarette users. Thus, the extent to which attentional biases toward e-cigarette imagery occurs among individuals who only vape (and don’t smoke) remains unknown.

Rationale

Currently there is a paucity of research on the cognitive processes involved in e-cigarette usage. As with many addictive substances, it is possible that e-cigarette stimuli may also become sensitized resulting in attention being prioritized towards e-cigarette cues over other neutral environmental stimuli. In turn, an attentional bias towards e-cigarette cues may also lead to further
craving and increased use as has been witnessed in attentional bias research on tobacco smokers. Additionally, there is the added potential for the transference of attentional biases for e-cigarette cues toward traditional combustible cigarettes, which if it occurs, may provide one potential mechanism for why e-cigarette use may contribute to the initiation of using traditional cigarettes among never smokers. Given that nicotine is a highly addictive substance, the potential for stimuli frequently paired with this form of nicotine administration to induce attentional biases is a topic requiring further exploration.

To my knowledge, this study was the first to directly measure attention in e-cigarette users towards both e-cigarette visual stimuli as well as tobacco cigarette stimuli. There were two primary aims in this study. The first was to determine if, much like other substance users, e-cigarette users develop an attentional bias towards e-cigarettes. If an attentional bias to e-cigarettes exists, it is theoretically conceivable that users may also develop cravings e-cigarettes following exposure, which is ultimately a concern for triggering relapse among abstainers. The second aim of this study was to examine if e-cigarette users who have never smoked also experience attentional biases toward tobacco cigarettes (i.e., transference). If this is indeed the case, consistent with the Gateway Theory, this process may be a potential explanatory factor for the enhanced risk of migration to later tobacco smoking among non-smoking e-cigarette users.

Based on the previous literature on attentional biases in traditional tobacco users, it was hypothesized that (H1) compared to a sample of non-e-cigarette users, individuals who currently vape would display an attentional bias toward e-cigarette cues over neutral stimuli; (H2) e-cigarette users would also preferentially attend to e-cigarette cues over tobacco-related cues; and (H3) consistent with possible transference, e-cigarette users would also preferentially to tobacco cigarette cues over neutral stimuli.
Method

Participants

A sample primarily composed of undergraduate students was recruited through the online research participation system (SONA) hosted by the Department of Psychology at the University of Calgary, as well as via posters placed around campus. Participants were comprised of current e-cigarette users ($n = 67$) and non-users ($n = 71$) who were matched on demographic characteristics where possible (e.g., age, gender). Ten non-users excluded from the analyses (as there was no eye-gaze tracking data for eight participants and two due to exceptionally low average dwell times) and eight e-cigarette users were ultimately excluded (as there was no eye-gaze tracking data available for three participants, three who were identified to be current smokers of traditional cigarettes on test day, one as they were a past cigarette smoker, and one who was not a current e-cigarette user). With these exclusions, the final sample included for analyses consisted of 59 e-cigarette users and 61 non-users (controls). This sample size is consistent with similar two group design eye-tracking studies previously conducted by our team (e.g., McGrath, Meitner, & Sears, 2018; Newman & Sears, 2015). Individuals were compensated with course credit for their participation (for students), or a $20 e-gift card (for community members and non-psychology students).

Prospective participants first filled out an online questionnaire, or a phone screen to determine if they met the eligibility criteria. To be included in the e-cigarette group, individuals had to report currently using e-cigarettes, defined as use within the past 30 days (Liu, Wasserman, Kong, & Foulds, 2017), and had to be never smokers (defined as smoking fewer than 100 cigarettes in their lifetime). Individuals in the non-user group had to report not currently using an e-cigarette, not having used one in the past 30 days, and had to be never smokers of traditional cigarettes.
Furthermore, all participants had to report normal to corrected vision and no colorblindness and be 18 years of age or older. If eligible, individuals signed up for a time slot to come into the Substance Use and Gambling Laboratory at the University of Calgary to complete the eye-tracking experiment and questionnaires.

**Measures**

**Demographics.** Demographic information (e.g., age, sex, ethnicity, education) was collected using a self-report questionnaire which has been used in prior studies by our lab (e.g., McGrath, Meitner, & Sears, 2018).

**E-Cigarette Usage.** Participants also completed an author-compiled questionnaire which included questions related to e-cigarette usage and other tobacco use. Items included age at which participants first tried vaping, the type of e-cigarette products they use, primary reasons for vaping, and any negative reactions to using an e-cigarette.

**E-Cigarette Dependence.** Level of e-cigarette dependence was evaluated using the Penn State Electronic Cigarette Dependence Index (Foulds et al., 2015). The PS-ECDI was developed from the Penn State Cigarette Index within a population of former smokers. It is a ten item self-report questionnaire which measures e-cigarette dependence by looking at usage, behavior and craving. Sample items include: ‘Do you sometimes awaken at night to use your e-cigarette/vaporizer?’ and ‘Do you ever have strong craving to use an e-cigarette/vaporizer?’. Total scores from 0–3 indicate not dependent, from 4–8 are low dependence, 9–12 are medium dependence, and 13+ indicate high dependence. The internal consistency of the Penn State E-Cigarette Index in the present study was $\alpha = .60$.

**E-Cigarette Craving.** E-cigarette craving was evaluated using the Questionnaire of Vaping Craving (QVC; Dowd, Motschman, & Tiffany, 2018). The QVC is a ten item self-report
questionnaire which measures an individual’s craving level for vaping by looking at desire, intention, and positive outcome. Each item is scored from 1 (strongly disagree) to 7 (strongly agree). Scores are calculated as a mean of the ten items, with higher total scores indicating higher craving levels. The internal consistency of the QVC in the present study was $\alpha = .94$.

**Psychopathology.** Individuals’ mental health was examined with the Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995), a 21-item self-report questionnaire which measures emotional states of depression, anxiety and stress. Each item is scored from 0 (never) to 3 (almost always). The DASS-21 compiles three separate subscales for psychological distress (depression, anxiety and stress), each with 7 items. Scores on each subscale are compiled separately, with ranges being indicative of normal to extremely severe. Example items include; ‘I felt that I have nothing to look forward to, I felt I was close to panic, and I found it hard to wind down’. The DASS-21 has been found to validly measure all three subsets; depression, anxiety and stress (Antony, Bieling, Cox, Enns, & Swinson, 1998; Henry & Crawford, 2005). Internal consistency was $\alpha = .91$ for depression, $\alpha = .81$ for anxiety and $\alpha = .87$ for the stress subscale in the current study.

**Substance Use.** Usage of both alcohol and cannabis was measured. The Alcohol Use Disorders Identification Test (AUDIT; (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993) was used to determine potential alcohol use problems. The AUDIT is a ten item self-report measure, where each item is scored from 0 to 4. Total scores range from 0 to 40; where a score of 8 or higher would indicate problematic alcohol use. The AUDIT covers questions regarding alcohol consumption, drinking behaviours as well as other alcohol-related problems. Items include ‘How often do you have a drink containing alcohol?’, ‘How often during the last year have you failed to do what was normally expected from you because of drinking?’, and ‘Have you or
someone else been injured as result of your drinking?’. The AUDIT has been found to show reliable and valid results when looking at alcohol related problems (Reinert & Allen, 2002). Cronbach’s alpha for the AUDIT was $\alpha = .78$ for the present study. The Cannabis Use Disorders Identification Test- Revised (CUDIT-R; Adamson et al., 2010) was used to determine potential problems with cannabis. The CUDIT-R is an eight item self-report measure, with each item scored from 0 to 4. Total scores range from 0 to 32; where a score of 13 or higher is thought to indicate problematic cannabis use. Items include ‘How often do you use cannabis’, and ‘How often during the past 6 months did you fail to do what was normally expected from you because of using cannabis?’. Internal consistency of the CUDIT in this study was $\alpha = .83$.

**Impulsivity.** The UPPS-P (UPPS-P; (Lynam, Smith, Whiteside, & Cyders, 2006) was used to assess facets of impulsivity. Specifically, the short version of the UPPS-P was utilized, the SUPPS-P (Lynam, 2013), which consists of 20 items. Each item is scored from 1 (disagree strongly) to 4 (agree strongly) with total scores indicating greater levels of impulsivity. The UPPS-P measures five domains of impulsivity; negative urgency, positive urgency, lack of premeditation, lack of perseverance, and sensation seeking. Negative and positive urgency are defined as acting rashly in response to extreme negative and positive emotions respectively, with items including ‘When I am upset I often act without thinking and I tend to lose control when I am in a great mood’. Lack of premeditation is when one acts without thinking, with one of the items being ‘I like to stop and think things over before I do them’ (reversed). Lack of perseverance is the tendency to not finish tasks, with one item being ‘I generally like to see things through to the end’ (reversed). And sensation seeking is when one enjoys experiencing new and exciting activities or sensations, with one item being ‘I quite enjoy taking risks’. The SUPPS-P has been shown to be a reliable and valid measure of impulsivity within adult populations (Cyders, Littlefield, Coffey, & Karyadi, 2014).
The internal consistencies of the subscales for this study were as follows; negative urgency ($\alpha = .79$), positive urgency ($\alpha = .79$), lack of premeditation ($\alpha = .61$), lack of perseverance ($\alpha = .78$), and sensation seeking ($\alpha = .71$).

**Apparatus (Eye-Tracking)**

An Eyelink 1000 eye-gaze tracking system (SR Research Ltd., Ottawa, Ontario) was utilized for collecting eye-gaze movements. The system uses an infrared camera to track eye movements with a sampling rate of 1000 Hz which allows for a temporal resolution of 2 ms and an average gaze error of less than 0.5 degrees of visual angle. Stimuli were presented on a 24-inch LCD monitor approximately 60 cm away from the participant.

**Stimuli**

There was a total of 180 images presented to participants, with each image presented once. Images were presented two at a time (as matched pairs) and were comprised of three separate categories; e-cigarette, cigarette and neutral stimuli. The high-resolution images were selected from stock photography websites. Images were matched in terms of the scenes presented as closely as possible to the other image simultaneously presented on the screen in order to avoid biases regarding the features, color etc. (McGrath et al., 2018). For example, one image may depict an individual holding an e-cigarette and the matched image of someone holding a pen. Cigarette images were chosen in order to determine if the incentive salience applied to e-cigarettes may be transferred onto cigarettes as well, resulting in an attentional bias toward cigarettes over that of neutral stimuli. The neutral images were matched to the e-cigarette or cigarette image in terms of colours and shape. The neutral images consisted of a pen (or a hand holding a pen) in a similar scene. E-cigarette images were presented in only 40 of the 90 trials (44%) in order to reduce potential demand characteristics. That is, given that the recruitment procedure focused on ‘e-
cigarette users’, it is possible that participants would anticipate that the experimenters are assessing attention to vaping images, and as such, may alter their viewing behavior to conform to this expectation.

**Ethics Approval**

The study obtained ethics approval from the Conjoint Faculties Research Ethics Board at the University of Calgary prior to the start of the study (REB 18-1165).

**Procedure**

Upon arrival, eligible participants were greeted by the experimenter and were first asked to complete the informed consent form. Next participants were led into a room containing the eye-tracking apparatus. Participants were provided with both written and verbal instructions for completing the eye-tracking task. Individuals were told that their eye-movements will be tracked during the slideshow, during which they are free to look at whatever image they desire. Prior to the eye-tracking task, calibration was first completed to ensure accurate eye-gaze data. Next, two practice eye-tracking trials were completed which allowed participants to orient themselves to the procedure. Following the practice trials, 90 test trials of images were presented, each trial lasting 4 seconds (Isaacowitz, Toner, Goren, & Wilson, 2008) with approximately 2 seconds between the end of one trial and the beginning of the next. Each trial began with a black dot in the center of a white screen to ensure the direction of their gaze was focused in the center of the screen. Presented in each trial was two images; the images consisted of e-cigarette, cigarette and neutral stimuli. In total, there were four sets of images; smoking vs. neutral ($n = 20$), e-cigarettes vs. neutral ($n = 20$), smoking vs. e-cigarettes ($n = 20$) and neutral vs. neutral ($n = 30$). The order in which the trials were presented was randomized for each participant, with each participant being shown all 90 trials. The 30 trials consisting solely of neutral images acted as fillers, which is in line with
previous attentional bias research (e.g., Bradley et al., 2003; Mogg et al., 2003; Mogg, Field, & Bradley, 2005). Data collection of participant’s eye-gaze movements was tracked during each trial and the entire procedure on average, lasted 10 minutes. Upon finishing the eye-tracking task, individuals returned to the testing room and completed the questionnaires. Lastly participants were debriefed regarding the purpose of the study and were then compensated with one RPS credit, or a $20 e-gift card. On average, the total time to complete all aspects of the study was ~40 minutes.

**Statistical Analyses**

Prior to analyses, eye-gaze data was screened for any eye-blinks, missing data and recording artifacts using the EyeLink Data Viewer analysis software (SR Research) with the default settings. The filler trials (neutral vs. neutral) were removed from the data as these trials were not relevant to the analyses. All analyses were performed using IBM SPSS (v25). Dependent variables of interest were: first run time, and total mean dwell time, both measured in milliseconds. First run time is the time which an individual spends attending to an image once first fixating towards it, such that a greater first run time would indicate greater interest towards this image. Total dwell time is the total amount of time spent fixating on a type of image (i.e., smoking, e-cigarettes or neutral) during the 4-second presentation of the trial. These variables were first created for each person for each trial, and then averaged across the trials for that type (i.e., vaping vs neutral trials). The data was analyzed using separate ANOVAs for each trial type (vaping smoking vs smoking neutral vs vaping neutral) for each of the dependent variables.
Results

Preliminary Analyses

The sample was largely Caucasian (55.8%), with an almost equal sample of males and females (51.7% female) who ranged in age from 18 – 35 years old \((M = 19.99, SD = 2.27)\). A full demographic profile of each group can be seen in Table 1.

E-Cigarette Use

Among the e-cigarette users, there were 27 daily users and 32 occasional users. The majority of users were not dependent on e-cigarettes or reported low dependence (64%) as measured by Penn State Electronic Cigarette Dependence Index. The top reasons for e-cigarette use included enjoying the nicotine buzz \((n = 42)\), they come in appealing flavours \((n = 28)\), and they seem less harmful than cigarettes \((n = 27)\). In terms of nicotine usage; 47 participants (87.0%) used nicotine in their e-cigarette. Full results are shown in Table 2.

Psychopathology

Among all participants, the majority fell within normal range for depression (61.7%), anxiety (49.2%) and stress (70.0%) as measured with the DASS-21. There were no differences between e-cigarette users and controls in terms of their DASS-21 scores (mean total score) for all the subscales. Full results for the DASS-21 can be seen in Table 3.

Substance Use

The average AUDIT score was 7.78 \((SD = 4.61)\) for e-cigarette users and 3.38 \((SD = 3.96)\) for controls. There was a difference between the groups \((t (118) = -5.62, p < .001, d = 1.02)\), such that e-cigarette users had a higher AUDIT score in comparison to controls. There were 37 individuals who met criteria for problematic alcohol use; 8 controls, and 29 e-cigarette users.
The average CUDIT score was 2.47 ($SD = 4.46$) for e-cigarette users and 1.02 ($SD = 2.28$) for controls. The homogeneity of variances assumption was violated, and therefore, equal variances was not assumed. There was a significant difference between the groups ($t (85.80) = -5.32, p < .001, d = 0.41$), such that e-cigarette users had a higher CUDIT score in comparison to controls. There were 3 individuals who met criteria for problematic cannabis use, all of which were e-cigarette users.

**Impulsivity**

E-cigarette users and controls did not differ on any level of impulsivity, using the SUPPS-P total scores, after adjusting for multiple comparisons using Bonferroni corrections. More comprehensive results for the SUPPS-P can be found in Table 4.

**Attentional Processing**

The primary dependent variables of interest for this study were recorded by the eye-tracker. First, average dwell time for the entire trial, across trials (how much of the four seconds was spent looking at the interest areas) was analyzed to determine whether there were individuals who had not paid attention during the task, and outliers were excluded as their total dwell time also affects the possible amount of time looking at each image during a trial (interest area dwell time). In terms of differences between e-cigarette users and non-users, there were no differences for total dwell time ($t = -.89, p = .802$). The following analyses assessed differences between non e-cigarette users, occasional, and daily e-cigarette users.

**Vaping vs Neutral Trials.** A one-way ANOVA was conducted using total dwell time difference scores as the dependent variable. The difference score was calculated by taking the vaping total dwell time and subtracting the neutral image total dwell time. ANOVA assumptions were run prior to the analysis and were met. The omnibus test was significant ($F (2,117) = 5.73,$
p = .004, partial $\eta^2 = .09$). Post-hoc tests were conducted to determine where the differences lied using Tukey’s LSD. These analyses indicated that the only significant difference was between controls and daily users ($p = .001$), such that daily users spent longer looking at vaping images in comparison to the non-users. See table 6 for all total dwell time ANOVAs.

Another one-way ANOVA was conducted using first run dwell time as the dependent variable. All assumptions of an ANOVA were met prior to analysis. There were no differences in terms of first run time for the vaping vs neutral images ($F(2,117) = 1.25, p = .289$, partial $\eta^2 = .02$). See table 7 for all first run time ANOVAs.

**Vaping vs Smoking Trials.** A one-way ANOVA was conducted using total dwell time difference scores as the dependent variable. The difference score was calculated by taking the vaping total dwell time and subtracting the smoking image total dwell time. ANOVA assumptions were run prior to the analysis and were met. The omnibus test was significant ($F(2,117) = 5.66, p = .005$, partial $\eta^2 = .09$). Post-hoc analyses indicated that controls differed from both occasional users ($p = .006$) and daily users ($p = .008$). Both occasional and daily e-cigarette users viewed the vaping images for longer in comparison to the controls. Another one-way ANOVA was conducted using first run dwell time as the dependent variable. ANOVA assumptions were run prior to analyses. There were no differences between the groups in terms of first run time for the vaping and smoking images ($F(2,117) = 2.42, p = .093$, partial $\eta^2 = .04$).

**Smoking vs Neutral Trials.** A one-way ANOVA was conducted using total dwell time difference scores as the dependent variable. The difference score was calculated by taking the smoking total dwell time and subtracting the neutral image total dwell time. ANOVA assumptions were run prior to the analysis and were met. The omnibus test was not significant ($F(2,117) = 0.12, p = .886$, partial $\eta^2 = .00$).
Another one-way ANOVA was conducted using first run dwell time as the dependent variable. ANOVA assumptions were met. There were no differences between groups in terms of first run time of smoking vs neutral images ($F(2,117) = 0.68, p = .506, \text{partial } \eta^2 = .01$).

**Multiple Regressions.** Three separate multiple regressions were run within the e-cigarette users for various usage scores, including the Penn State total score, QVC total score, and nicotine concentration used, using total dwell time as the dependent variable. These regressions were performed to determine if there were specific e-cigarette characteristics which were able to predict a higher attentional bias for e-cigarette cues or smoking cues. No assumptions for conducting multiple regression were violated (independence of observations, linearity, homoscedasticity, multicollinearity, normality and unusual points; such as outliers, leverage and influential points). The multiple regression model for the smoking vs vaping IA dwell time was not significantly predicted by the e-cigarette usage variables, $F(3, 37) = 1.30, p = .289, \text{adjusted } R^2 = .02$. Smoking vs neutral IA dwell time was also not significantly predicted by predictor variables, $F(3, 37) = 1.77, p = .169, \text{adjusted } R^2 = .06$. Lastly, vaping vs neutral IA dwell time difference was not significantly predicted by the predictor variables, $F(3,37) = 0.56, p = .646, \text{adjusted } R^2 = -.03$. Table 5 provides more specific details of the multiple regressions.

**Discussion**

Given the increasing prevalence of e-cigarette use, especially among never-smokers, and the association between e-cigarette use and tobacco, the need for research regarding e-cigarette use and the migration from vaping to tobacco smoking is becoming increasingly warranted. The purpose of the current study was to address a gap in attentional biases literature relating to e-cigarettes. Currently, the few studies that have focused on e-cigarette attentional biases have only recruited smokers who also use e-cigarettes. In other words, no study has examined attentional
bias among e-cigarette users who do not smoke, despite the increasing rise in prevalence in this group (McMillen et al., 2018; Sharapova, Singh, Agaku, Kennedy, & King, 2018). Attentional biases are an important contributing factor in addictive behaviors which relate to craving as well as subsequent relapse after attempts to quit (Field & Cox, 2008). As such, the aim of this research was to determine: (i) if individuals using e-cigarettes have developed an attentional bias towards e-cigarettes and (ii) to further assess whether this attentional bias has been transferred to traditional cigarettes using an eye-gaze tracking paradigm. The present study measured attentional biases towards e-cigarettes using a free eye-gaze tracking paradigm to determine whether e-cigarette users preferentially attend to e-cigarette stimuli over neutral stimuli and whether the attention patterns of e-cigarette users differ from that of non-users. Furthermore, the study assessed whether non-smoking e-cigarette users also preferentially attend toward another nicotine product; specifically, tobacco cigarettes.

For the psychopathology and personality characteristics, e-cigarette users and non-users did not differ in terms of their depression, anxiety, or stress as well as impulsivity facets. These results are contrary to many other substance users when compared to controls. For example, one study which had examined mental health and impulsivity among university e-cigarette users had founds that e-cigarette users were more likely to have higher anxiety and greater levels of impulsivity. However, and similar to the current study, e-cigarette use was not associated with significantly higher depressive symptoms (Grant, Lust, Fridberg, King, & Chamberlain, 2019). Another study which compared impulsivity among e-cigarette users and non-users that also used the SUPPS-P found that the groups did not differ in terms of sensation seeking, lack of premeditation and perseverance, which is also the case in the current study. However, they did find that users differed from non-users in terms of negative and positive urgency, such that e-
cigarette users scored higher on both facets (Hershberger, Um, & Cyders, 2017). E-cigarette users in the current study not showing higher levels of impulsivity may be partly due to the fact that they did not display a high severity, or dependence for e-cigarettes.

In contrast to above, e-cigarette users and non-users did differ when compared for alcohol and cannabis use, such that e-cigarette users scored higher on measures of both alcohol and cannabis use. The findings that e-cigarette users are more likely to be using other substances has been found in numerous other studies. In the study by Grant et al. (2019) discussed above, the authors also found that e-cigarette use was associated with the use of other drugs including alcohol and cannabis. This is a typical relationship among substance users and has been found in tobacco users (Schauer, Berg, Kegler, Donovan, & Windle, 2015) and alcohol users (Weinberger et al., 2019) previously. In other words, people who use one substance are likely to use other substances.

In terms of the total dwell time ANOVA, the results suggest that both controls and occasional e-cigarette users preferentially attended to neutral stimuli, while daily e-cigarette users spent slightly more time attending to the vaping images. Daily e-cigarette users significantly differed from the non-users in that, daily users attended to e-cigarette stimuli longer than the non-users did. The results suggest that those who frequently vape have developed an attentional bias towards e-cigarettes compared to neutral images. For the first run time dwell ANOVA, no significant findings were found, indicating that the groups did not differ in their initial attention towards either e-cigarettes or neutral images.

These results somewhat differ from those of previous studies which examined attentional bias for addictive substances such as tobacco (Bradley et al., 2003), alcohol (Townshend & Duka, 2001), and illicit substances (Leeman et al., 2014). Specifically, unlike the previous research, the present study found that the neutral stimuli had a strong pull for both occasional e-cigarette users
and controls. That said, the daily and occasional e-cigarette group did attend longer toward e-cigarette images than non-users, indicating at least some preference for this image category. There are several possible explanations as to why occasional e-cigarette users did not more strongly prefer the e-cigarette stimuli over neutral images. One plausible explanation would be that the e-cigarette users were not highly dependent on e-cigarettes according to the Penn State E-Cigarette Dependence Index. In other words, the majority of e-cigarette users in the sample were not dependent on e-cigarettes. Indeed, most studies on attentional biases have found that current dependence to nicotine is a strong predictor of attentional bias toward smoking cues (Munafò et al., 2003). It could have been the case that low levels of nicotine dependence, and the related lack of craving associated with nicotine withdrawal, blunted group responses toward e-cigarette imagery. Another potential explanation for these findings could be related to the novelty of the neutral imagery. That is, it may be possible that novelty effects associated with the neutral stimuli were responsible for enhanced attention toward that category. For instance, the neutral images consisted of a hand holding a pen, camera lenses, or a phone and while not novel images, offered something different for users to attend to rather than simply looking at another e-cigarette image. Finally, it is conceivable that e-cigarette users simply do not display strong attentional biases toward visual cues. The act of vaping itself involves multiple sensory domains (taste, olfactory, visual), and simply viewing images may not strongly illicit attentional responses. Future studies involving in vivo cue exposure may be required to more fully elucidate these effects.

Second, attentional preference for smoking vs. neutral trials was assessed. The results for the total dwell time analysis revealed that e-cigarette users and controls both avoid smoking stimuli when given the option to look at smoking or neutral images. The three groups did not differ in terms of their time spent looking at the smoking vs neutral stimuli. The first run dwell time
difference for the ANOVA also suggests that e-cigarette users and controls spend less time first attending to smoking images in comparison to the neutral images, and that the groups did not differ significantly. In comparison to the smoking images, all groups spent 300ms – 400ms longer when first looking at neutral images. Overall, these results suggest that e-cigarette users and controls do not differ when it comes to smoking vs neutral stimuli, and that both groups tend to avoid smoking stimuli.

These findings are contrary to original hypothesis, that there would be transference of the incentive motivation properties of e-cigarettes to traditional cigarettes. Given the demographic that many studies have focused on when looking at the transition between e-cigarettes and tobacco cigarettes; typically, high school students (Barrington-Trimis, Urman, et al., 2016; Wills et al., 2016), it is theoretically feasible that the age group in the present study is past a critical age where the transition is most likely to occur. Another possible reason that e-cigarette users do not attend to smoking stimuli over neutral, could be that they find cigarettes to be aversive, given previous findings that many e-cigarette users use an e-cigarette over smoking partially because they believe it to be safer and healthier than tobacco cigarettes (Dawkins et al., 2013). In addition to believing that vaping is healthier than smoking, this is an age group which was raised at the height of the anti-tobacco ads, and this has likely played a large role in their perceptions (Weiss et al., 2006).

In terms of the vaping vs smoking trials, similarly to what was shown when smoking images were presented with neutral images, both e-cigarette users and controls tend to avoid smoking images and focus on vaping images. Within the total dwell time ANOVA, e-cigarette users (occasional and daily users) differed significantly from controls, such that e-cigarette users spent more time on e-cigarette images than the controls. However, both controls and e-cigarette users spent more time on e-cigarettes over the smoking images. The first run time ANOVA was
not significant, indicating that e-cigarette users and non-users did not differ in terms of their initial attention towards vaping and smoking images.

This finding that both groups attend to vaping over smoking images may be partially due to the aversiveness of the smoking images, in this demographic. Having grown up at the height of the anti-tobacco ads, and then being exposed to e-cigarettes as healthier alternatives to tobacco cigarettes, may have instilled the notion that smoking is dangerous and that e-cigarettes are less dangerous.

**Potential Implications**

As the first study to measure attentional bias to e-cigarettes in e-cigarette users, the results may have policy related implications as e-cigarette users differ from non-users in their attention towards e-cigarette cues. Given this distinction, e-cigarette related cues in the real-world may have a negative impact on current e-cigarette users in general, and especially those attempting to cut down or quit use, as it may increase their e-cigarette craving and subsequent use (Field et al., 2009). However, future studies would be needed to examine whether e-cigarette cues may have adverse clinical effects (e.g., relapse) among e-cigarette users who are trying to reduce or quit their use. Additionally, while occasional and daily users did not significantly differ, there was a significant trend such that daily users demonstrated greater attentional bias. Future studies should further explore the attentional bias of occasional and daily users with greater sample sizes to examine whether frequency of use is associated with greater attentional bias among e-cigarette users.

Given that the e-cigarette users did not display a bias towards the cigarette images, another possible implication is that attentional biases may not be indicative of whether an individual will transition from e-cigarettes to cigarettes. It is possible that the transition occurs more as a result of
situational factors (i.e., an individual at a party wanting to use an e-cigarette and is offered a tobacco cigarette instead). Future research examining when e-cigarette users transition to cigarettes and what factors play a role in this transition would be highly informative.

**Future Directions**

There are numerous future directions that this research should explore. One of which our research group plans to undertake is looking at dual-users of both e-cigarettes and traditional cigarettes to determine how they differ from non-smoking e-cigarette users. This may provide insights into the attention of dual users, specifically if they have a higher bias towards tobacco cigarettes or e-cigarettes. An additional direction would be to deprive individuals of nicotine/e-cigarette use prior to their testing session in order observe if their bias is larger when in deprivation. By recruiting individuals who have and have not abstained from nicotine, a more comprehensive evaluation can be made of how e-cigarette images affect users. Lastly, as research suggests people are likely to vape in various social situations, future studies could investigate how a person’s environment affects their attention towards e-cigarettes. Results from such a study may give more indication as to which specific situation initiates one to use an e-cigarette, and furthermore, which cues to avoid if an individual is attempting to cut down. Another important future direction would be to develop a reliable scale which specifically measures e-cigarette dependence in never smokers, former smokers and dual users of traditional cigarettes and e-cigarettes rather than adapting measures from the tobacco literature, given the low internal consistency found in the present study.

**Limitations and Strengths**

The study had some methodological limitations. Firstly, measures were self-report (including the AUDIT, CUDIT, DASS-21, SUPPS-P, Penn State E-cigarette Dependence Index
and QVC). Instead, semi-structured interviews would provide a better insight into several of the constructs measured such as alcohol and cannabis use and psychopathology. This is a limitation as self-report measures may be susceptible to biases. Another possible limitation is the use of a student population. Having said that, the sample of university students can also be seen as a strength as undergraduate students are the age range in which e-cigarette use is most prevalent (Schoenborn & Gindi, 2015). An additional limitation is the poor internal consistency that was present in the Penn State E-Cigarette Dependence Index. While a limitation, this is also an interesting finding as it may point to the fact that never smoker, e-cigarette users are fundamentally different than dual users, and former smoker, e-cigarette users. As well, traditional measures of nicotine dependence may not fully translate to e-cigarette dependence. Using static images during an eye-tracking task to measure an attentional bias also limits the results. It is possible that this visual stimulus is not salient enough, and that their actual bias is towards vaping in the real world which is not being peaked in this static design. A stronger study may use dynamic stimuli or use an in-vivo approach, as well having a measure of physiological changes during the eye-tracking paradigm. The physiological component may be important as it may be able to provide additional insight over that of an individual’s attention. For example, it may be better able to determine if an individual was avoiding a certain stimulus by examining their heartrate or skin conductance.

Along with these limitations, the study also had many strengths to the design. Firstly, eye-gaze tracking was used to measure attentional biases, which as, a direct measure of attention has higher internal validity over indirect measures (Ataya et al., 2012; Christiansen, Mansfield, Duckworth, Field, & Jones, 2015; Field & Cox, 2008). An additional strength of the study was that participants were matched between groups on age and gender to ensure age and gender did not confound the results. Another strength regarding the sample was that they were all never
smokers, given that much of the past literature has focused on smokers, who may or may not be dual users. The use of strictly never smokers ensures that the biases shown toward e-cigarettes was due to e-cigarette use and not transference from tobacco cigarettes as has been found in the literature (Lochbuehler et al., 2018).

**Conclusion**

In conclusion, this was one of the first studies that measured attentional biases towards e-cigarettes with e-cigarette users. The study utilized an eye-gaze tracking design to measure attentional biases towards i) e-cigarettes and ii) tobacco cigarettes. In order to compare biases scores, both e-cigarette users and non-users were recruited, both of which were never smokers of traditional cigarettes. Overall, e-cigarette users do not display an attentional bias towards e-cigarettes, or traditional cigarettes. However, e-cigarette users do significantly differ from non-users in that they attend to e-cigarette stimuli for longer than non-users do, in the presence of either neutral or traditional cigarette stimuli. The results of this study may be able to provide future avenues for research such as examining how dual users of both e-cigarette and tobacco cigarettes balance their attention towards these stimuli. As well, future studies may want to research whether e-cigarette users with a higher bias are more likely to transition from e-cigarette use to traditional cigarette use.
References


ATTENTIONAL BIAS IN E-CIG USERS

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https://doi.org/10.1016/j.jadohealth.2016.03.003

https://doi.org/10.1371/journal.pone.0190614

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in smokers: An investigation of competing theoretical views of addiction.


### Table 1

**Demographic Characteristics of E-Cigarette Users and Non-Users**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>E-Cig Users ($n = 59$)</th>
<th>Non-Users ($n = 61$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males ($n = 30$)</td>
<td>Females ($n = 29$)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>19.40 (1.22)</td>
<td>19.21 (1.78)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>73.3% (22)</td>
<td>69.0% (20)</td>
</tr>
<tr>
<td>Chinese</td>
<td>3.3% (1)</td>
<td>6.9% (2)</td>
</tr>
<tr>
<td>South Asian</td>
<td>6.7% (2)</td>
<td>10.3% (3)</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filipino/Pacific Islander</td>
<td>6.7% (2)</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>Latin American</td>
<td>10.0% (3)</td>
<td>6.9% (2)</td>
</tr>
<tr>
<td>Southeast Asian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arab</td>
<td>3.3% (1)</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>West Asian</td>
<td>3.4% (1)</td>
<td>3.6% (1)</td>
</tr>
<tr>
<td>Other</td>
<td>6.7% (2)</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td><strong>Annual income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$0 - $25,000</td>
<td>13.3% (4)</td>
<td>20.7% (6)</td>
</tr>
<tr>
<td>$26,000 - $50,000</td>
<td>20.0% (6)</td>
<td>20.7% (6)</td>
</tr>
<tr>
<td>$51,000 - $100,000</td>
<td>33.3% (10)</td>
<td>17.2% (5)</td>
</tr>
<tr>
<td>Over $100,000</td>
<td>33.3% (10)</td>
<td>41.4% (12)</td>
</tr>
<tr>
<td>Highest level of education</td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>No degree, certificate or diploma</td>
<td>0</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>High school diploma</td>
<td>100.0% (30)</td>
<td>82.8% (24)</td>
</tr>
<tr>
<td>Trades or apprenticeship certificate</td>
<td>0</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>College, CEGEP or other non-university certificate</td>
<td>0</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>University degree, certificate or diploma</td>
<td>0</td>
<td>6.9% (2)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>96.7% (29)</td>
<td>93.1% (27)</td>
</tr>
<tr>
<td>Common-law</td>
<td>3.3% (1)</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>Married</td>
<td>0</td>
<td>3.4% (1)</td>
</tr>
</tbody>
</table>

*Note: M = mean, SD = standard deviation, E-Cig = electronic cigarette. Participants were able to select more than one ethnicity, resulting in frequency counts higher than the sample size.*
Table 2

Comparison of Male and Female E-Cigarette Users on E-Cigarette Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>E-Cig Users (n = 59)</th>
<th></th>
<th>Test Statistic</th>
<th>p</th>
<th>Effect Size (Cohen’s d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Males (n = 30)</td>
<td>Females (n = 29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M (SD)/freq (n)</td>
<td>M (SD)/freq (n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-Cigarette Use</td>
<td></td>
<td>Males</td>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occasional</td>
<td>43.3% (13)</td>
<td>63.3% (19)</td>
<td><em>t</em>(52) = 0.51</td>
<td>.614</td>
<td>0.14</td>
</tr>
<tr>
<td>Daily</td>
<td>56.7% (17)</td>
<td>33.3% (10)</td>
<td><em>t</em>(52) = 0.51</td>
<td>.614</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Nicotine Concentration</strong></td>
<td></td>
<td>22.71mg (19.35)</td>
<td>20.00mg (18.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Penn State Total Score</strong></td>
<td>4.2 (3.03)</td>
<td>3.45 (4.39)</td>
<td><em>t</em>(42) = 0.68</td>
<td>.504</td>
<td>0.20</td>
</tr>
<tr>
<td>Not dependent (0-3)</td>
<td>20.8% (10)</td>
<td>65.0% (14)</td>
<td><em>t</em>(42) = 0.68</td>
<td>.504</td>
<td>0.20</td>
</tr>
<tr>
<td>Low dependence (4-8)</td>
<td>66.7% (11)</td>
<td>10.3% (3)</td>
<td><em>t</em>(42) = 0.68</td>
<td>.504</td>
<td>0.20</td>
</tr>
<tr>
<td>Medium dependence (9-12)</td>
<td>12.5% (3)</td>
<td>13.7% (4)</td>
<td><em>t</em>(42) = 0.68</td>
<td>.504</td>
<td>0.20</td>
</tr>
<tr>
<td>High dependence (13+)</td>
<td>0</td>
<td>0</td>
<td><em>t</em>(42) = 0.68</td>
<td>.504</td>
<td>0.20</td>
</tr>
<tr>
<td>QVC Mean Score</td>
<td>2.2 (1.10)</td>
<td>1.9 (1.20)</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
<tr>
<td>Reasons for use</td>
<td></td>
<td>Males</td>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>appealing flavours</td>
<td>53.3% (16)</td>
<td>41.4% (12)</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
<tr>
<td>Experimenting with flavours</td>
<td>26.7% (8)</td>
<td>34.5% (10)</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
<tr>
<td>Most acceptable to non-smokers</td>
<td>10.0% (3)</td>
<td>20.7% (6)</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
<tr>
<td>Socializing with others</td>
<td>36.7% (11)</td>
<td>37.9% (11)</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
<tr>
<td>People who are important to me use them</td>
<td>26.7% (8)</td>
<td>55.2% (16)</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
<tr>
<td>People in the media/public figures use them</td>
<td>0</td>
<td>0</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
<tr>
<td>Help people quit smoking cigarettes</td>
<td>3.3% (1)</td>
<td>0</td>
<td><em>t</em>(57) = 1.02</td>
<td>.313</td>
<td>0.27</td>
</tr>
</tbody>
</table>
### ATTENTIONAL BIAS IN E-CIG USERS

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage 1</th>
<th>Percentage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Might be less harmful than cigarettes</td>
<td>43.3% (13)</td>
<td>48.3% (14)</td>
</tr>
<tr>
<td>Quit smoking using them</td>
<td>3.3% (1)</td>
<td>0</td>
</tr>
<tr>
<td>Use when I cannot smoke</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Feel like regular cigarettes</td>
<td>0</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>They don’t smell</td>
<td>36.7% (11)</td>
<td>27.6% (8)</td>
</tr>
<tr>
<td>Cost less than other forms of tobacco</td>
<td>30.0% (9)</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>I think they are cool and/or intriguing</td>
<td>30.0% (9)</td>
<td>31.0% (9)</td>
</tr>
<tr>
<td>I like the nicotine buzz but not cigarettes</td>
<td>76.7% (23)</td>
<td>65.5% (19)</td>
</tr>
<tr>
<td>Use them to manage my weight</td>
<td>6.7% (2)</td>
<td>3.4% (1)</td>
</tr>
<tr>
<td>Other</td>
<td>16.7% (5)</td>
<td>10.3% (3)</td>
</tr>
</tbody>
</table>

### Health effects

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage 1</th>
<th>Percentage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory problems</td>
<td>46.7% (14)</td>
<td>34.5% (10)</td>
</tr>
<tr>
<td>Headaches</td>
<td>33.3% (10)</td>
<td>48.3% (14)</td>
</tr>
<tr>
<td>Chest pains</td>
<td>10.0% (3)</td>
<td>17.2% (5)</td>
</tr>
<tr>
<td>Heart issues</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note: M = mean, SD = standard deviation, E-Cig = electronic cigarette, QVC = Questionnaire of Vaping Craving*
Table 3

Comparison of DASS-21 Scores Between E-Cigarette Users and Non-Users

<table>
<thead>
<tr>
<th>Scale</th>
<th>E-Cig Users (n = 59) M (SD)</th>
<th>Non-Users (n = 61) M (SD)</th>
<th>t Statistic</th>
<th>p</th>
<th>Effect Size (Cohen’s d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>7.73 (7.01)</td>
<td>10.79 (10.64)</td>
<td>1.86a</td>
<td>.065</td>
<td>0.34</td>
</tr>
<tr>
<td>Anxiety</td>
<td>8.61 (6.24)</td>
<td>9.64 (9.05)</td>
<td>0.73a</td>
<td>.469</td>
<td>0.13</td>
</tr>
<tr>
<td>Stress</td>
<td>12.17 (8.02)</td>
<td>14.10 (9.94)</td>
<td>1.17</td>
<td>.245</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Note: M = mean, SD = standard deviation, E-Cig = electronic cigarette, a indicates that equal variance was not assumed in the analysis, DASS-21 = depression, anxiety and stress scale
Table 4

Comparison of SUPPS-P Scores Between E-Cigarette Users and Non-Users

<table>
<thead>
<tr>
<th>Scale</th>
<th>E-Cig Users (n = 59)</th>
<th>Non-Users (n = 61)</th>
<th>t Statistic</th>
<th>p</th>
<th>Effect Size (Cohen’s d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUPPS-P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Urgency</td>
<td>2.30 (.77)</td>
<td>2.16 (.75)</td>
<td>1.02</td>
<td>.311</td>
<td>0.18</td>
</tr>
<tr>
<td>Positive Urgency</td>
<td>1.88 (.66)</td>
<td>1.71 (.64)</td>
<td>1.38</td>
<td>.170</td>
<td>0.25</td>
</tr>
<tr>
<td>Perseverance</td>
<td>1.77 (.43)</td>
<td>1.61 (.41)</td>
<td>2.02</td>
<td>.046</td>
<td>0.38</td>
</tr>
<tr>
<td>Premeditation</td>
<td>1.72 (.49)</td>
<td>1.57 (.48)</td>
<td>1.81</td>
<td>.074</td>
<td>0.33</td>
</tr>
<tr>
<td>Sensation Seeking</td>
<td>2.64 (.72)</td>
<td>2.56 (.68)</td>
<td>0.65</td>
<td>.515</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Note: M = mean, SD = standard deviation, E-Cig = electronic cigarette, SUPPS-P = short UPPS-P impulsivity scale
Table 5

*Multiple Regression using E-cigarette Usage and Eye-Tracking Scores Among E-Cigarette Users*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE_B$</th>
<th>$\beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking vs vaping</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>592.87</td>
<td>140.09</td>
<td>.34</td>
<td>.058</td>
</tr>
<tr>
<td>Nicotine concentration</td>
<td>7.64</td>
<td>3.90</td>
<td>.34</td>
<td>.058</td>
</tr>
<tr>
<td>QVC score</td>
<td>-7.75</td>
<td>70.52</td>
<td>-.02</td>
<td>.913</td>
</tr>
<tr>
<td>Penn State total score</td>
<td>-21.52</td>
<td>23.12</td>
<td>-.18</td>
<td>.358</td>
</tr>
<tr>
<td>Smoking vs neutral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-773.66</td>
<td>198.14</td>
<td>-.36</td>
<td>.042</td>
</tr>
<tr>
<td>Nicotine concentration</td>
<td>-11.62</td>
<td>5.52</td>
<td>.14</td>
<td>.443</td>
</tr>
<tr>
<td>QVC score</td>
<td>77.31</td>
<td>99.74</td>
<td>-.07</td>
<td>.721</td>
</tr>
<tr>
<td>Penn State total score</td>
<td>32.93</td>
<td>32.70</td>
<td>.19</td>
<td>.320</td>
</tr>
<tr>
<td>Vaping vs neutral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-175.55</td>
<td>186.96</td>
<td>-.08</td>
<td>.649</td>
</tr>
<tr>
<td>Nicotine concentration</td>
<td>-2.39</td>
<td>5.21</td>
<td>-.07</td>
<td>.721</td>
</tr>
<tr>
<td>QVC score</td>
<td>-33.89</td>
<td>94.12</td>
<td>.26</td>
<td>.213</td>
</tr>
<tr>
<td>Penn State total score</td>
<td>39.12</td>
<td>30.85</td>
<td>.26</td>
<td>.213</td>
</tr>
</tbody>
</table>

*Note:* $B$ = unstandardized regression coefficient; $SE_B$ = standard error of the coefficient; $\beta$ = standardized coefficient. Smoking vs vaping, DV was interest area dwell time difference score for vaping, smoking vs neutral, DV was interest area dwell time difference score for smoking, and vaping vs neutral, DV was interest area dwell time difference score for vaping.
Table 6

Comparison of Total Dwell Time Difference Scores Among Non, Occasional and Daily Users.

<table>
<thead>
<tr>
<th>Total Dwell Time Difference Score</th>
<th>Non-Users $n = 61$</th>
<th>Occasional Users $n = 32$</th>
<th>Daily Users $n = 27$</th>
<th>$F$</th>
<th>$p$</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaping vs Neutral Trials</td>
<td>-420.62 (478.86)$^a$</td>
<td>-184.40 (710.34)</td>
<td>3.48 (542.97)</td>
<td>5.73</td>
<td>.004</td>
<td>.09</td>
<td>.86</td>
</tr>
<tr>
<td>Vaping vs Smoking Trials</td>
<td>351.45 (430.03)$^{ab}$</td>
<td>649.76 (485.49)</td>
<td>656.76 (612.31)</td>
<td>5.66</td>
<td>.005</td>
<td>.088</td>
<td>.85</td>
</tr>
<tr>
<td>Smoking vs Neutral Trials</td>
<td>-669.19 (613.02)</td>
<td>-735.55 (656.69)</td>
<td>-690.18 (452.20)</td>
<td>0.12</td>
<td>.886</td>
<td>.00</td>
<td>.07</td>
</tr>
</tbody>
</table>

Note: Post hoc differences based on Tukey’s LSD. $^a$ indicates a significant difference from daily users, and $^b$ indicates a significant difference from occasional users.
Table 7

*Comparison of First Run Dwell Time Difference Scores Among Non, Occasional and Daily Users.*

<table>
<thead>
<tr>
<th>First Run Dwell Time Difference Score</th>
<th>Non-Users (n = 61)</th>
<th>Occasional Users (n = 32)</th>
<th>Daily Users (n = 27)</th>
<th>(F)</th>
<th>(p)</th>
<th>Partial (\eta^2)</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaping vs Neutral Trials</td>
<td>-195.62 (332.68)</td>
<td>-122.94 (469.98)</td>
<td>-68.45 (269.47)</td>
<td>1.25</td>
<td>.289</td>
<td>.02</td>
<td>.27</td>
</tr>
<tr>
<td>Vaping vs Smoking Trials</td>
<td>174.68 (247.22)</td>
<td>296.88 (257.32)</td>
<td>240.76 (286.99)</td>
<td>2.42</td>
<td>.093</td>
<td>.04</td>
<td>.48</td>
</tr>
<tr>
<td>Smoking vs Neutral Trials</td>
<td>-301.64 (396.06)</td>
<td>-393.41 (433.82)</td>
<td>-368.90 (286.40)</td>
<td>0.69</td>
<td>.506</td>
<td>.01</td>
<td>.16</td>
</tr>
</tbody>
</table>
Appendix

Questionnaire package that participants filled out via Qualtrics.

Demographics, E-Cigarette Usage and Psychopathology

Below you will find some questions about yourself. Although you are not required to answer any questions that make you uncomfortable, it is important to remember that all of your answers are completely confidential.

1. How old are you? _______

2. Please indicate your gender:
   - Female
   - Male
   - Other (please specify): _______________________

3. Please indicate your marital status:
   - Single (never legally married)
   - Common-Law
   - Married
   - Separated
   - Divorced
   - Widowed

4. Please indicate your ethnicity?
   - Caucasian
   - Chinese
   - South Asian (e.g. East Indian, Pakistani, Sri Lankan)
   - Black (e.g. African, Haitian, Jamaican, Somali, etc.)
   - Filipino/ Pacific Islander
   - Latin American
   - Southeast Asian (e.g. Cambodian, Indonesian, Laotian, Vietnamese)
   - Arab
   - West Asian (e.g. Afghan, Iranian)
   - Japanese
   - Korean
   - Aboriginal (e.g. First Nation, Métis, Inuit)
   - Other (please specify)____________________________________

5. Area of residence:
   - Urban
   - Rural

6. Are you currently enrolled in a post-secondary institution?
   - Yes
   - No

7. Please indicate your highest level of education completed:
   - No degree, certificate or diploma
ATTENTIONAL BIAS IN E-CIG USERS

☐ High school diploma or equivalent
☐ Trades or apprenticeship certificate or diploma
☐ College, CEGEP (general and vocational college in QC), or other non-university certificate or diploma
☐ University degree, certificate, or diploma below bachelor level
☐ Bachelor’s degree
☐ Master’s degree or diploma/certificate above bachelor level
☐ Doctorate or other professional degree (please specify) ______________________

8. Which of the following best describes your present job status (please check all that apply)?
☐ Employed full-time (30 hours per week or more)
☐ Employed part-time (less than 30 hours per week)
☐ Unemployed
☐ Student
☐ Retired
☐ Other (please specify): ______________________

9. Household income:
☐ $0 - $25,000
☐ $26,000 - $50,000
☐ $51,000 - $100,000
☐ Over $100,000

10. What colour would you identify your eyes to be (according to your driver’s license)?
☐ Hazel
☐ Brown
☐ Black
☐ Grey
☐ Green
☐ Blue
☐ Other (please specify): ______________________

11. How important is religion in your life?
☐ Very important
☐ Somewhat important
☐ Not very important
☐ Not important at all

12. How important is spirituality in your life?
☐ Very important
☐ Somewhat important
☐ Not very important
☐ Not important at all

13. What religious group are you most affiliated with?
☐ Catholic
☐ Muslim
☐ Protestant
☐ Jewish
☐ Buddhist
ATTENTIONAL BIAS IN E-CIG USERS

- Hindu
- Sikh
- No religion (e.g., agnostic, atheist, etc.)
- Other Christian (e.g., Anglican, United, Presbyterian, etc.)
- Other (please specify): ________________________

E-Cigarette/Vaping Use

1. Have you ever smoked tobacco cigarettes?
   - Yes
   - No

2. Do you currently smoke cigarettes?
   - Daily
   - Occasionally
   - Not at all

3. Have you smoked 100 cigarettes in your lifetime?
   - Yes
   - No

4. Have you ever used any of the following tobacco products? If yes, please indicate how many times you have used that product
   - Hookah: ______times
   - Small Cigars:______times
   - Chewing Tobacco:_____times
   - Smokeless tobacco products;_____times

5. Have you ever vaped or used electronic (e-cigarettes)?
   - Yes
   - No

6. Do you currently vape or use e-cigarettes?
   - Daily
   - Occasionally
   - Not at all

7. Are you currently trying to quit using e-cigarettes or vaping?
   - Yes
   - No
   - Eventually
   - Never

8. At what age did you first try vaping or an e-cigarette? ___years

9. Please describe your e-cigarette or vaping device:
   a. Is your device:
      - Rechargeable
      - Disposable
      - Other, please specify: ________________________
b. Does it contain a tank system?
   □ Yes
   □ No

c. Please select the usual level of nicotine in your e-liquid
   □ 0 mg
   □ 6 mg
   □ 12 mg
   □ 18 mg
   □ 26 mg
   □ Other: ________ mg
   □ Don’t Know

d. Do you use any other substances with your vaporizer/e-cigarette (e.g., marijuana)?
   □ No
   □ Yes, please list __________________________

10. Please describe your typical e-cigarette/vaporizing use:

   a. Approximately how many puffs per session? ___________ puffs

   b. What is your average length of session (in minutes)? ___________ minutes
11. What reasons do you use e-cigarettes/vaporizer? *Select all that apply*
   - They come in appealing flavors
   - I like experimenting with various flavors
   - They are most acceptable to non-smokers
   - I like socializing with other users
   - People who are important to me use them
   - People in the media or other public figures use them
   - They help people quit smoking cigarettes
   - They might be less harmful than cigarettes
   - I quit smoking regular cigarettes using them
   - I use them when I cannot smoke regular cigarettes
   - Using them feels like smoking regular cigarettes
   - They don’t smell
   - They cost less than other forms of tobacco
   - I use them because I think they are cool and/or intriguing
   - I like the buzz from nicotine but I don’t like regular cigarettes
   - I use them to manage my weight

12. How soon after you wake in the morning do you use your e-cigarette/vaporizer?
   - Within 5 minutes
   - 6-30 minutes
   - 31-60 minutes
   - After 60 minutes
   - I do not use every day

13. Have you ever had any of the following adverse or negative reactions to e-cigarettes/vaporizer?
   - Respiratory problems (cough, bronchitis, etc.)
   - Headaches
   - Chest pains
   - Heart issues
Penn State Index

1. How many times per day do you usually use your electronic cigarette or vaporizer? 
   Assume that one “time” consist of around 15 puffs or lasts around 10 minutes
   □ 0-4
   □ 5-9
   □ 10-14
   □ 15-19
   □ 20-29
   □ 30+

2. On days that you can use your e-cigarette/vaporizer freely, how soon after you wake up do you first use your electronic cigarette
   □ 0-5 minutes
   □ 6-15 minutes
   □ 16-30 minutes
   □ 31-60 minutes
   □ 60-120 minutes
   □ 120+

3. Do you sometimes awaken at night to use your e-cigarette/vaporizer
   □ Yes
   □ No

4. If yes, how many nights per week do you typically awaken to use your e-cigarette/vaporizer?
   □ 0-1 nights
   □ 2-3 nights
   □ 4+ nights

5. Do you use an e-cigarette/vaporizer now because it is really hard to quit?
   □ Yes
   □ No

6. Do you ever have strong cravings to use an e-cigarette/vaporizer?
   □ Yes
   □ No

7. Over the past week, how strong have the urges to use e-cigarette/vaporizer been?
   □ None/Slightly strong
   □ Moderate/Strong
8. Is it hard to keep from using an e-cigarette/vaporizer in places where you are not supposed to?
   □ Yes
   □ No

9. Did you feel more irritable because you couldn’t use an e-cigarette/vaporizer?
   □ Yes
   □ No

10. Did you feel nervous, restless or anxious because you couldn’t use an e-cigarette/vaporizer?
    □ Yes
    □ No
**QVC - Questionnaire of Vaping Craving**

Using the follow scale below, please indicate your level of agreement with the following statements:

<table>
<thead>
<tr>
<th>I have a strong desire for an e-cigarette right now.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I have an urge for an e-cigarette.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All I want right now is an e-cigarette.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I am missing vaping right now.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I am craving an e-cigarette right now.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I need to vape now.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>
I am going to vape as soon as possible.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I will vape as soon as I get the chance.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nothing would be better than vaping right now.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vaping would make me happier now.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DASS-21

Please read each statement below and circle a number 0, 1, 2 or 3, which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

- 0 Does not apply to me at all - NEVER
- 1 Applies to me to some degree, or some of the time – SOMETIMES
- 2 Applies to me to a considerable degree, or a good part of time - OFTEN
- 3 Applies to me very much, or most of the time - ALMOST ALWAYS
1. I found it hard to wind down                      0 1 2 3
2. I was aware of dryness of my mouth              0 1 2 3
3. I couldn’t seem to experience any positive feeling at all  0 1 2 3
4. I experienced breathing difficulties (eg, excessively rapid breathing, breathlessness in the absence of physical exertion) 0 1 2 3
5. I found it difficult to work up the initiative to do things 0 1 2 3
6. I tended to over-react to situations            0 1 2 3
7. I experienced trembling (eg, in the hands)      0 1 2 3
8. I felt that I am using a lot of nervous energy   0 1 2 3
9. I was worried about situations in which I might panic and make a fool of myself 0 1 2 3
10. I felt that I have nothing to look forward to   0 1 2 3
11. I found myself getting agitated                0 1 2 3
12. I found it difficult to relax                  0 1 2 3
13. I felt down-hearted and blue                   0 1 2 3
14. I was intolerant of anything that kept me from getting on with what I was doing 0 1 2 3
15. I felt I was close to panic                     0 1 2 3
16. I was unable to become enthusiastic about anything  0 1 2 3
17. I felt I was not worth much as a person         0 1 2 3
18. I felt that I was rather touchy                 0 1 2 3
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat) 0 1 2 3
20. I felt scared without any good reason           0 1 2 3
21. I felt that life was meaningless                0 1 2 3
AUDIT

Please circle the answer that is correct for you:

1. How often do you have a drink containing alcohol?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Monthly or less</td>
<td>Two to four times a month</td>
<td>Two to three times a week</td>
<td>Four or more times a week</td>
</tr>
</tbody>
</table>

2. How many drinks containing alcohol do you have on a typical day when you are drinking?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or 2</td>
<td>3 or 4</td>
<td>5 or 6</td>
<td>7 to 9</td>
<td>10 or more</td>
</tr>
</tbody>
</table>

3. How often do you have six or more drinks on one occasion?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
</tbody>
</table>

4. How often during the last year have you found that you were not able to stop drinking once you had started?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
</tbody>
</table>

5. How often during the last year have you failed to do what was normally expected from you because of drinking?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
</tbody>
</table>
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
</tbody>
</table>

7. How often during the last year have you had a feeling of guilt or remorse after drinking?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
</tbody>
</table>

8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
</tbody>
</table>

9. Have you or someone else been injured as result of your drinking?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes, but not in the last year</td>
<td>Yes, during the last year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. Has a relative or friend, or a doctor or other health worker been concerned about your drinking or suggested you cut down?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes, but not in the last year</td>
<td>Yes, during the last year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ATTENTIONAL BIAS IN E-CIG USERS

1. How often do you use cannabis?
   - Never
   - Monthly or less
   - 2-4 times a month
   - 2-3 times a week
   - 4 or more times a week

2. How many hours were you “stoned” on a typical day when you had been using cannabis? (less than 1 thru to 7 or more)?
   - Less than 1
   - 1 or 2
   - 3 or 4
   - 5 or 6
   - 7 or more

3. How often during the past 6 months did you find that you were not able to stop using cannabis once you had started?
   - Never
   - Less than monthly
   - Monthly
   - Weekly
   - Daily or almost daily

4. How often during the past 6 months did you fail to do what was normally expected from you because of using cannabis?
   - Never
   - Less than monthly
   - Monthly
   - Weekly
   - Daily or almost daily
5. How often in the past 6 months have you devoted a great deal of your time to getting, using, or recovering from cannabis?

- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

6. How often in the past 6 months have you had a problem with your memory or concentration after using cannabis?

- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

7. How often do you use cannabis in situations that could be physically hazardous, such as driving, operating machinery, or caring for children?

- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

8. Have you ever thought about cutting down, or stopping, your use of cannabis?

- Never
- Yes, but not in the past 6 months
- Yes, during the past 6 months
Below are a number of statements that describe ways in which people act and think. For each statement please indicate **how much you agree or disagree** with it.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree Strongly</th>
<th>Disagree Somewhat</th>
<th>Agree Somewhat</th>
<th>Agree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>I generally like to see things through to the end.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>My thinking is usually careful and purposeful.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>When I am in a great mood, I tend to get into situations that could cause me problems.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Unfinished tasks really bother me.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I like to stop and think things over before I do them.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>When I feel bad, I will often do things I later regret in order to make myself feel better now.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Once I get going on something, I hate to stop.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Sometimes when I feel bad, I can’t seem to stop what I am doing even though it is making me feel worse.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I quite enjoy taking risks.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I tend to lose control when I am in a great mood.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I finish what I start.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I tend to value and follow a rational, “sensible”, approach to things.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>When I am upset I often act without thinking.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>When I feel rejected, I will often say things that I later regret.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I would like to learn to fly an airplane.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Others are shocked or worried about the things I do when I am feeling excited.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I would enjoy the sensation of skiing very fast down a high mountain slope.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I usually think carefully before doing anything.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I tend to act without thinking when I am really excited.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>