

AFFECTIVE VULNERABILITY ACROSS NON-DAILY AND DAILY ELECTRONIC
CIGARETTE USERS

A Thesis

Presented to

The Faculty of the Department

of Psychology

University of Houston

In Partial Fulfillment

of the Requirements for the Degree of

Master of Arts

By

Nubia A. Mayorga

July 2019

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ABSTRACT

Electronic cigarette (e-cigarette) use has risen exponentially since its initial introduction. The widespread and growing use of these novel products has prompted increased research to evaluate use from a nuanced perspective that considers patterns and antecedents of use. Specifically, research has identified sociodemographic characteristics related to varying levels of e-cigarette use frequency. Yet, limited research has investigated broad-based psychological factors related to frequent and infrequent e-cigarette use. The current study sought to address this clinically relevant research gap within a cross sectional design. Several affective vulnerability states were evaluated, including anxiety sensitivity, anxious arousal, general distress, and anhedonia across 566 (51% female, $M_{\text{age}} = 35.11$ years, $SD = 10.12$) non-daily and daily past month, adult e-cigarette users. Results demonstrated that in comparison to non-daily e-cigarette users, daily users evinced significantly higher levels of anxiety sensitivity, anxiety sensitivity cognitive concerns, anxious arousal, and general distress. No significant differences were found for the criterion variables of anxiety sensitivity social concerns, anxiety sensitivity physical concerns, and anhedonic depression. Overall, the current study provides initial and novel empirical evidence that certain affective vulnerability constructs related to anxiety may be more strongly endorsed by daily e-cigarette users. Importantly, this work adds to evolving, but thus far highly underdeveloped, e-cigarette models by highlighting the need to consider anxiety-related constructs when evaluating e-cigarette use patterns and behavior.

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Affective Vulnerability across Non-Daily and Daily Electronic Cigarette Users

Electronic cigarette (e-cigarettes) use has risen exponentially in the United States (Youth, Health, & Services, 2016; Zhu et al., 2014). Recent data report that 13.6% young adults used an e-cigarette in the past 30-days (Youth et al., 2016). The unprecedented growth in e-cigarette use has motivated researchers to investigate patterns of e-cigarette use (Biener & Hargraves, 2014; Pulvers et al., 2014). Patterns identified thus far include (a) former users, (b) current/non-daily users, and (c) current/daily users (Amato, Boyle, & Levy, 2015). Although criteria to define these categories varies across studies, consistent evidence corroborates differences in socio-demographic and smoking characteristics across individuals who comprise current/non-daily users and current/daily users (Levy, Yuan, & Li, 2017). To date, however, no research has examined other factors that may distinguish non-daily and daily e-cigarette use, such as broad-based psychological constructs.

Drawing from combustible cigarette literature, trait- and state-based psychological factors have demonstrated a strong and robust association with cigarette use (Novak, Burgess, Clark, Zvolensky, & Brown, 2003a; Zvolensky & Bernstein, 2005; Zvolensky, Johnson, Leyro, Hogan, & Tursi, 2009). One such trait-based vulnerability factor related to the maintenance of combustible cigarette use is anxiety sensitivity (AS; Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001). AS reflects individual differences in the level of fear of anticipated anxiety and arousal related sensations (Brown et al., 2001). Individuals with higher AS report smoking as a means to reduce negative mood states, endorse greater intensity of nicotine withdrawal symptoms, and report early cigarette smoking lapse and relapse (Novak, Burgess, Clark, Zvolensky, & Brown, 2003b; Zvolensky et al., 2004; Zvolensky, Stewart, Vujanovic, Gavric, & Steeves, 2009). Similar associations between AS and e-cigarette behaviors has begun to emerge. For example, recent work suggests higher AS contributes to maladaptive perceptions of e-cigarette use such as higher levels of perceived benefits of use and greater positive outcome expectancies (Zvolensky, Mayorga, & Garey,

2018). Moreover, emerging data suggests AS levels may interfere with e-cigarette cessation as evidenced by recent work that links higher levels of AS to those with previous (failed) e-cigarette quit attempts (Garey et al., in press). Despite initial evidence that individual variations in AS may influence e-cigarette use maintenance use processes, e-cigarette research on this affective vulnerability remains underdeveloped. An important continuation of this work would be to evaluate not only the general AS factor, but also whether its specific subfactors (i.e., cognitive concerns, social concerns, and physical concerns) vary across subgroups of e-cigarette users, including daily and non-daily users. Such work may inform the future development of conceptual models of e-cigarette use and guide specialized nicotine-dependence treatment protocols.

Beyond AS, the state-based factors of anxious arousal (somatic symptoms of anxiety; Watson, Clark, et al., 1995), and general distress (overall concern of one's current and future circumstances; Keogh & Reidy, 2000), may also be centrally related to e-cigarette use frequency. There is well-documented evidence for robust associations between these constructs and combustible cigarette smoking behavior (e.g., barriers to cessation, frequency; Leventhal, Waters, Kahler, Ray, & Sussman, 2009; Zvolensky & Bernstein, 2005). The precise role of these constructs in the e-cigarette literature, however, is largely unknown. Within the emerging literature, higher levels of anxious arousal is related to more severe fatigue and greater problems when trying to quit e-cigarettes (Manning, Garey, Mayorga, Shepherd, & Zvolensky, in press.). The potential contribution of e-cigarette use frequency in the experience of anxious arousal, however, has yet to be examined. Alongside anxious arousal, research has documented higher levels of psychological distress are related to increased rates of dual and exclusive e-cigarette use (Park, Lee, Shearston, & Weitzman, 2017a; Zvolensky, Jardin, et al., 2017). Further, those with more severe psychological distress express higher levels of maladaptive beliefs such as greater positive expectancies from use (Miller, Tidey, Rohsenow, & Higgins, 2017). Whether symptoms of anxious arousal and psychological

distress (i.e., general distress) are involved in e-cigarette use and vary across e-cigarette use frequency is currently unknown and warrants scientific investigation.

Anhedonia (characterized by diminishing levels of enjoyment in response to once pleasurable activities; Watson & Clark, 1997) is another state-based factor that is prospectively associated with e-cigarette use and higher frequency of e-cigarette use (Bandiera, Loukas, Li, Wilkinson, & Perry, 2017a; Bandiera, Loukas, Wilkinson, & Perry, 2016; Cummins, Zhu, Tedeschi, Gamst, & Myers, 2014). Indeed, initial work has demonstrated that those with higher levels of anhedonia report higher levels of positive reinforcement, stress reduction, and higher levels of enjoyment associated with e-cigarette use (Piñeiro et al., 2016). Although not anhedonia specific, depression more broadly is related to current e-cigarette use and dual use (Bandiera, Loukas, Li, Wilkinson, & Perry, 2017b; Marsden, 2018). Future research is needed to evaluate whether anhedonia differs across non-daily and daily e-cigarette use.

Broadly, data is accumulating to suggest affective vulnerabilities may be a risk factor for current e-cigarette use (Park, Lee, Shearston, & Weitzman, 2017b) and more maladaptive perceptions of use that may promote and maintain increased use (Garey et al., in press; Pratt, Sargent, Daniels, Santos, & Brunette, 2016). However, few studies have evaluated differences in these constructs across severity of e-cigarette use (as evinced by daily and non-daily use) among current, adult users. Examining differences in AS, anxious arousal, general distress, and anhedonia across current non-daily and daily users can provide a novel and more specific understanding of factors that distinguish patterns of use among e-cigarette users.

Extensive work has documented that AS (general and specific factors), general distress, anxious arousal, and anhedonia amplify emotional discomfort (i.e., worry, stress, anxiety; Eaton, Rodriguez-Seijas, Carragher, & Krueger, 2015; Leventhal & Zvolensky, 2015; Wolitzky-Taylor et al., 2016) and may serve as vulnerabilities to psychiatric illness (Leventhal & Zvolensky, 2015). Consistent with the negative reinforcement model of substance use (Stasiewicz & Maisto, 1993), e-cigarette users who endorse elevated symptoms across these constructs may engage in more frequent

(i.e., daily) e-cigarette use to manage such distress symptoms. However, with the reliance on e-cigarettes as a way to cope with emotional distress, individuals may be actually exacerbating their symptoms over time (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Consequently, explicating the extent of differences across daily and non-daily e-cigarette users in terms of affective vulnerability variables can provide a novel transdiagnostic perspective on relations between mood and e-cigarette use. Indeed, although these affective vulnerabilities are not psychiatric disorder specific, they are associated with the most prominent affective disorders related to nicotine use (e.g., major depression, panic disorder; Leventhal & Zvolensky, 2015; Wolitzky-Taylor et al., 2016; Zvolensky, Farris, Leventhal, & Schmidt, 2014). Therefore, exploring the transdiagnostic factors of AS and AS lower level factors, anhedonia, anxious arousal and general distress have the potential to provide key insights into broad-based psychological factors that may be related to e-cigarette use among adults.

Present Study: Aim and Hypothesis

Together, the current study sought to expand on the current e-cigarette literature by identifying psychological discrepancies among non-daily and daily e-cigarette users in terms of AS, anhedonia, general distress and anxious arousal. It was hypothesized that daily users would report increased levels of all criterion variables in relation to non-daily users.

Method

Participants

The present study included 566 participants (51.1% female, $M_{age} = 35.11$ years, $SD = 10.12$). Participants were recruited via an online survey panel program. Study eligibility criteria included an age restriction of 18-65 years old, e-cigarette use within the past 30 days, and being able to provide informed consent. Exclusion criteria included being younger than 18 years or older than 65 years, being a non-English speaker (to ensure comprehension of the study questions), and inability to give informed, and voluntary consent to participate.

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The present sample was predominately White/Caucasian (76.3%), followed by 16.1% Black/African American, 3.9% Asian, 1.8% Native American/Alaska Native, 0.4% Hawaiian, and 1.6% other. Regarding education, 23.7% of the participants received a high school diploma or equivalent, 20.8% completed some college, 11.7% earned an associate degree, 21.4% earned a bachelor's degree, 19.6% completed at least some graduate school, and 2.9% did not graduate high school or earn an equivalent diploma. More than half of the sample indicated they were married or living with someone (63.4%). The median income bracket fell within the range of \$50,000 to \$74,999.

Most participants reported daily e-cigarette use (66.1%). On average, participants reported using an e-cigarette eight times per day, being a regular e-cigarette user for 18 months ($SD = 19.4$) and reported using their first e-cigarette at the age of 28 ($SD = 12.4$). A low level of e-cigarette dependence was observed in the present sample ($M = 7.9$, $SD = 4.6$). Additionally, more than three-fourths of the participants (77.4%) reported concurrent cigarette use. Among those who reported concurrent cigarette use, participants reported smoking an average of 13.3 ($SD = 17.1$) cigarettes per day, 18.6 ($SD = 5.4$) years old when they started smoking cigarettes daily and being a daily cigarettes smoker for an average of 15.8 ($SD = 10.7$) years.

Measures

Demographics Questionnaire. Participants provided sex (0 = Male, 1 = Female), race, marital status (1 = Married or Living with someone, 2 = Widowed, 3 = Separated, 4 = Divorced/Annulled, 5 = Never Married), age, educational level (1 = Grade 6 or less to 8 = Graduate or professional degree), and annual income (1 = \$0-\$4,999 to 8 = \$75,000 or higher). Demographic information was used to characterize the sample.

Penn State Electronic Cigarette Dependence Index. The Penn State Electronic Cigarette Dependence Index is a 10-item self-report questionnaire that assesses e-cigarette dependence (Foulds et al., 2014). Specifically, strength of urges to use (Do you ever have strong cravings to smoke?), waking and night use (Do you sometimes awaken at night to have a e-cigarette?), number of times

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that an individual uses an e-cigarette (How many times a day do you usually smoke?), difficulty quitting (Did you feel more irritable because you couldn't smoke?), and experience of craving and withdrawal symptoms (Is it hard to keep from smoking?) were measured. Previous work has supported both the validity and reliability of this index (Foulds et al., 2014). A total score is used to characterize degree of dependence, with higher scores indicating greater dependence.

Electronic Cigarette Smoking History Questionnaire. The Electronic Cigarette Smoking History Questionnaire (EC-SHQ) is a 28-item self-report measure that assess an individual's e-cigarette use history. This questionnaire includes items pertaining to frequency of use, age at onset, and daily versus non-daily use (Do you use an e-cigarette daily? [0 = No, 1 = Yes]). In conjunction with e-cigarette use behaviors, the EC-SHQ also evaluated the use of combustible cigarettes (Do you currently use cigarettes? [0 = No, 1 = Yes]). The EC-SHQ was developed by the current research and has been successfully implemented in previous e-cigarette studies (Zvolensky et al., 2018).

Anxiety Sensitivity Index-3. The Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007) is an 18 item-measure derived from the original Anxiety Sensitivity Index (Reiss, Peterson, Gursky, & McNally, 1986). Respondents are asked to evaluate from 0 (*Very little*) to 4 (*Very much*) as to what extent they feel concerned regarding the possibility of adverse effects relating to their anxiety symptoms. The ASI-3 is comprised of three subscales including, cognitive symptoms (It scares me when I am unable to keep my mind on a task), physical symptoms (It scares me when my heart beats rapidly), and social symptoms (it is important for me not to appear nervous). The ASI-3 has been successfully used with e-cigarette users (Zvolensky, Mayorga, & Garey, 2018b). For the current study, all three subscales as well as the total score were utilized (cognitive: $\alpha = .95$; physical: $\alpha = .93$; social: $\alpha = .90$; total: $\alpha = .97$).

Mood and Anxiety Symptoms Questionnaire. The Mood and Anxiety Symptoms Questionnaire (MASQ-D30; Wardenaar et al., 2010), based off the original MASQ (Watson, Weber, et al., 1995), taps into levels general distress, anxiety and depression. This scale is rated from on a 5-point Likert scale ranging from 1 (*not at all*) to 5 (*extremely*) and includes the following subscales:

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anhedonic depression (e.g., I felt really happy [all items reverse coded]), anxious arousal (e.g., I was startled easily), and general distress (e.g., I felt confused). Specifically, the anhedonic depression subscale targets an individual's lack of enjoyment in once pleasurable activities and low enjoyment of positive events. Anxious arousal narrows in on the somatic symptoms individual's experience, and general distress captures the general apprehension one feels toward themselves, their current situations and future events. All three factors are extracted from this measure. The internal consistency was excellent for both subscales (anhedonic depression: $\alpha = .94$; anxious arousal: $\alpha = .96$, general distress: $\alpha = .95$).

Procedure

Participants were recruited nationally via Qualtrics Inc. Through Qualtrics Inc., participants can obtain a Qualtrics Panels account to participate in research. From this account, Qualtrics recruits a nationally representative sample of the general population by basing the percentages of each demographic on the previous year's U.S. census data (Boas, Christenson, & Glick, 2018). Interested participants were screened for eligibility and directed to the online, anonymous survey. Prior to completing the survey, participants provided informed consent. The survey took approximately 30 minutes to complete, and participants were compensated with credit through their Qualtrics account commensurate to their participation. To prevent duplicate responses, each individual IP address was allowed only one opportunity to complete the survey. Survey responses were omitted based on a criterion of most incomplete responses, and/or nonsensical responses. Each participant was given the option to choose their preferred form of compensation based off their credit, however, the total amount for completing the survey remained the same (\$8.50). The study protocol was approved by the Institutional Review Board at the institution supporting this research.

Data Analytic Plan

Data analyses were completed using SPSS version 24. First, descriptive and bivariate relations were examined among study variables. Second, seven independent one-way, between subjects Analysis of Covariance (ANCOVA) were conducted to evaluate mean differences in (a)

ASI-3 total (b) ASI-3 cognitive concerns, (c) ASI-3 social concerns, (d), ASI- 3 physical concerns, (e) anhedonia, (f) general distress, and (g) anxious arousal, in relation to daily e-cigarette smokers versus non-daily e-cigarette users. Based on prior research (King, Alam, Promoff, Arrazola, & Dube, 2013), covariates in ANCOVA tests included: sex, age, education, concurrent combustible cigarette use, and income. Both Cohens d , and partial eta squared (η_p^2) served as an indices of effect size of mean differences (Richardson, 2011). A Bonferroni correction was employed to decrease rate of Type 1 error. Based on this correction, level of significance was adjusted to .007 (i.e., .05/7) for ANCOVA estimates.

Results

Bivariate Correlations

Bivariate correlations are presented in Table 1. Point-biserial correlations revealed that relative to non-daily users, daily e-cigarette users reported significantly greater levels of AS global scores ($r = 0.17, p = 0.001$), AS cognitive ($r = 0.67, p = 0.001$), and AS physical concerns ($r = 0.16, p = 0.001$), as well as higher levels in anxious arousal ($r = 0.21, p = 0.001$), and general distress ($r = 0.17, p = 0.001$). Further, bivariate correlations suggest positive correlations across all criterion variables except anhedonia (r 's = 0.15 - 0.37, all p 's < 0.001).

Analysis of Covariance Model

ASI-3 Total. A significant difference emerged for ASI-3 total across daily and non-daily e-cigarette users [$F(1,559) = 7.65, p = 0.006$], see Table 2. When controlling for covariates, a small effect size was observed for daily e-cigarette use on ASI-3 total ($\eta_p^2 = 0.01, d = 0.20$). Daily users evidenced a higher ASI-3 total score.

ASI-3 Cognitive Concerns. A significant difference emerged in ASI-3 cognitive symptoms across daily and non-daily e-cigarette users [$F(1,559) = 7.63, p = 0.006$; Table 2]. When controlling for covariates, daily e-cigarette use exerted a small effect ($\eta_p^2 = 0.01, d = 0.20$). Daily-cigarette users reported higher levels of ASI-3 cognitive concerns.

ASI-3 Social Concerns. Results indicated non-difference in ASI-3 social concerns between daily and non-daily e-cigarette users [$F(1,559) = 5.99, p = 0.015$; Table 2].

ASI-3 Physical Concerns. Results indicated a non-significant difference across daily and non-daily e-cigarettes users for ASI-3 physical concerns [$F(1,559) = 7.15, p = 0.008$; Table 2].

Anxious Arousal. Daily and non-daily users reported significantly different levels of anxious arousal [$F(1,559) = 12.91, p < 0.001$; Table 2]. When controlling for covariates, daily e-cigarette use status exerted a small effect ($\eta_p^2 = 0.02, d = 0.28$), and daily users reported a higher level of anxious arousal symptoms.

General Distress. There was a significant difference between daily and non-daily users in regard to general distress [$F(1,559) = 11.33, p = 0.001$; Table 2]. After controlling for covariates, daily e-cigarette use status exerted a small effect ($\eta_p^2 = 0.02, d = 0.28$), with daily users reporting higher level of general distress symptoms.

Anhedonia. Results indicated non-difference in anhedonic depressive symptoms between daily and non-daily e-cigarette users [$F(1, 559) = 2.77, p = 0.10$; Table 2].

Post Hoc Tests

Due to most of the current sample reporting concurrent cigarette use (77.4%), post hoc tests were conducted to examine results among the exclusive e-cigarette users. There was a significant mean differences among AS social concerns [$F(1,122) = 3.99, p = 0.048$; daily = 11.51, non-daily = 9.09]. Significant mean differences were also evident for anxious arousal [$F(1,122) = 4.04, p = 0.047$], with daily users endorsing greater symptoms (daily = 23.79, non-daily = 19.83). Lastly, significantly different levels of anhedonia resulted across groups [$F(1,122) = 4.70, p = 0.032$] with non-daily users exhibiting elevated symptoms (daily = 29.81, non-daily = 33.79). No other significant differences were evident across any of the other studied criterion variables.

Discussion

The current study evaluated differences in the global and lower-order facets of AS as well as levels of anxious arousal, general distress, and anhedonia across non-daily and daily e-cigarette

users. Consistent with prediction, daily users reported significantly higher AS (global score, and cognitive concerns). Daily e-cigarette users also endorsed higher levels of anxious arousal relative to non-daily users, as well as higher levels of general distress. Contrary to prediction, AS social concerns, AS physical concerns and anhedonia did not significantly vary across non-daily and daily users. Thus, there is evidence to support that among e-cigarette users, levels of anxiety-based facets differ according to frequency of use. Importantly, the observed pattern of findings emerged after controlling for sex, age, education, income, and concurrent combustible cigarette use. To our knowledge, this is the first study to empirically evaluate the multidimensional nature of AS across daily and non-daily e-cigarette users. Findings were mixed with daily users endorsing significantly higher levels across some AS related factors¹. As such, aversive interoceptive aspects of anxiety, such as those tapped by the AS cognition, may be more likely to be related to daily use. Similar patterns have been found among combustible cigarette smokers (Guillot, Zvolensky, & Leventhal, 2015; Zvolensky, Feldner, et al., 2004). Moreover, levels of anxious arousal differed significantly between daily and non-daily e-cigarette users. In line with past combustible cigarette research (Evatt & Kassel, 2010), e-cigarette users may be prone to utilize e-cigarettes as a method to reduce their high arousal related affective and emotional states. These findings are also in accord with e-cigarette work that has found perceived stress and internalizing symptoms more generally are related to concurrent combustible and e-cigarette use (Cho et al., 2018; Leventhal et al., 2017). These preliminary data suggest e-cigarette users may experience anxiety symptoms differently depending on their frequency of use as well as endorse variation in the symptoms they experience. Future studies are needed to delineate the extent to which anxiety related constructs and symptoms may relate to e-cigarette use processes and behaviors among daily users over time.

Contrary to prediction, daily and non-daily users did not differ on anhedonic symptoms. This finding is not consistent with the associations of e-cigarette use as it relates to depression reported by Bandiera and colleagues (Bandiera et al., 2017a). Specifically, this study observed a relationship between e-cigarette use and depressive symptoms, such that depressive symptoms predicted

subsequent e-cigarette use. Such past work, however, focused on a global assessment of depression. Based on the current data, specific aspects of depression (of which anhedonia represents one; Leventhal, Zvolensky, & Schmidt, 2011), may operate differently among e-cigarette users. Thus, it would be advantageous for future work to examine how daily and non-daily e-cigarette users differ across specific aspects of depression. Such work would provide a nuanced understanding for the role of depression in e-cigarette use severity. Lastly, despite non-significant findings in the relation between use frequency, all covariates were significantly related to anhedonia (Table 2). As such, being female, of older age, having higher income, higher level of education, and dual use may be more centrally related to anhedonia symptoms than daily vs non-daily e-cigarette use.

Given the widespread and growing use of e-cigarettes (Amato et al., 2015), it is important to consider the current results within a clinical context. For example, results indicate that e-cigarette users may evince higher levels of anxiety related affective vulnerability levels than the general public, with daily users exhibiting higher levels than non-daily users. Specifically, in the current sample, both non-daily and daily users of e-cigarettes evidenced higher levels of AS related symptoms than previously examined clinical samples (e.g., AS average of 27.5; Taylor et al., 2007). The current sample also evidenced levels of AS on par with previous studies among daily cigarette uses (e.g., AS average of 32.7; Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001). Additionally, the current data revealed anxious arousal symptoms similar to previous samples of combustible cigarette users (e.g., 29; Zvolensky, Paulus, et al., 2017). Thus, daily e-cigarette users appear to demonstrate levels of anxiety similar to daily cigarette users and clinical samples (Taylor et al., 2007).

The current data highlight the potential utility for assessing anxiety-related constructs among daily e-cigarette users. In practice, a brief screening of these symptoms may provide clinically relevant information on their risk potential to daily e-cigarette use progression. As with combustible cigarettes, engaging in more severe, persistent use may ultimately complicate e-cigarette cessation (Hyland et al., 2004). If replicated, the current findings also suggest that it may be important to

consider the role of anxiety in the larger context of cessation efforts for e-cigarettes alone or in combination with combustible cigarettes.

Results focused on exploratory post hoc tests provide a more complicated picture relative to the primary results. Specifically, in comparison to the sample comprised of both dual and exclusive users, exclusive e-cigarette users exhibit a unique pattern of affective vulnerability in relation to frequency of use. Exclusive daily users reported increased levels of AS social concerns and anxious arousal, but not other differences were observed. Further, non-daily users reported greater anhedonia compared to daily users. These data suggest that exclusive users may showcase some, but not necessarily all, the same patterns of affective vulnerability when modeling frequency of daily use or nonuse. Given these post hoc analyses were exploratory, future work should further explore the nature of affective vulnerability among exclusive e-cigarette users to better understand this group relative to dual users. It is possible that subgroups of e-cigarette users may exist, and exclusive users may not be fully comparable to dual users at least in terms of affective vulnerability. Theory-driven research is needed to guide research on this emerging topic.

There are several study limitations. First, the present study utilized a cross sectional design and therefore causal inferences cannot be isolated. It is possible that e-cigarette use leads to higher levels of these affective states or vice versa, or some third variable explains both. Additionally, the cross-sectional nature of the present study did not permit interpretation of the interplay between combustible and e-cigarettes, or the role of affective vulnerability in dual use patterns. For example, it is possible that participants use e-cigarettes to manage their mood after reducing or quitting combustible cigarettes, which is the most commonly reported reason for use among adults (Berg, Barr, Stratton, Escoffery, & Kegler, 2014). Although e-cigarette may help in the short-term, like combustible cigarettes, negative affective states may theoretically worsen over time. It is possible mood and e-cigarette use frequency may be more pronounced among dual users. Future research is needed using a prospective research design to clarify the complex systems that dictate the interplay between combustible cigarettes, e-cigarettes, and affective vulnerability². Second, as definitions of e-

cigarette use frequency evolve, future studies should consider whether affective discrepancies exist among daily users that may use e-cigarettes on a low, moderate, and high frequency level as well as the way in which other affective vulnerability factors may be relevant to maintain use among such groups. Third, only some clinically relevant broad-based psychological vulnerability factors were examined within this study using validated self-report instruments. It would be useful to explore such vulnerabilities and others from a multimethod measurement perspective. Fourth, another limitation is the lack of comparison to persons that have never used e-cigarettes. The addition of such a group could theoretically help pinpoint the broad-based variability in overall e-cigarette use. Finally, the overall level of e-cigarette dependence was low, and therefore, the current results may not be generalizable to e-cigarette users with higher levels of dependence. To further evaluate this issue, future work should be conducted among e-cigarette users with higher levels of e-cigarette dependence.

Overall, the current work uniquely extends past research by evaluating affective vulnerability factors among non-daily and daily e-cigarette users. Results suggest that individual differences within certain psychological vulnerabilities may be more pronounced among daily compared to non-daily e-cigarette users. As with the longstanding empirical link between nicotine dependence and combustible cigarette smoking (Frandsen, Thorpe, Shiffman, & Ferguson, 2017), daily e-cigarette users may represent a vulnerable sub population from a psychological perspective (Hyland et al., 2004).

Footnotes

1. In a post hoc test, we explored the predictive role of AS total on daily use over and above covariate and state-based predictor variables. Hierarchical regression results were non-significant, suggesting AS may maintain an indirect effect on daily e-cigarette use.
2. In a separate post hoc test, the main effects and interaction of combustible cigarette use, and e-cigarette use were analyzed for all criterion variables. There were no significant results.

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Table 1. Bivariate Correlations

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	Mean (SD) or n [%]
1. Sex (female)	--													289 [51.1%]
2. Age	0.03	--												35.11 (10.12)
3. Education level	-0.21***	-0.09*	--											5.01 (1.81)
4. Annual Income	-0.17***	-0.05	0.54***	--										6.00 (2.05)
5. Daily Use (daily users)	-0.05	-0.14**	0.12**	0.17***	--									374 [66.1%]
6. Concurrent Cigarette Use	-0.65	-0.14	0.07	0.06	0.04	--								438 [77.4]
7. ASI-3 Total	-0.08	-0.23***	0.27***	0.13**	0.17***	0.07	--							31.19 (21.22)
8. ASI-3 Cognitive	-0.10*	-0.26***	0.27***	0.12**	0.67***	0.09*	0.96***	--						9.67 (7.73)
9. ASI-3 Social	-0.02	-0.21***	0.26***	0.14**	0.15***	0.05	0.95***	0.87***	--					11.23 (7.14)
10. ASI-3 Physical	-0.11*	-0.18***	0.24***	0.12**	0.16***	0.07	0.95***	0.88***	0.86***	--				10.30 (7.40)
11. Anhedonia	0.20***	0.18***	-0.37***	-0.33***	-0.15**	-0.12**	-0.32***	-0.29***	-0.27***	-0.34***	--			29.00 (10.80)
12. Anxious Arousal	-0.13**	-0.30***	0.30***	0.20***	0.21***	0.16**	0.68***	0.69***	0.60***	0.66***	-0.52***	--		25.80 (12.11)
13. General Distress	-0.11*	-0.28***	0.27***	0.15***	0.20***	0.11**	0.67***	0.67***	0.61***	0.61***	-0.39***	-0.88***	--	27.81 (11.96)

Note: N = 566; *** p < .001, ** p < .01, * p < .05. Sex: 0 = Male, 1 = Female; Education Level: 1 = Grade 6 or less to 8 = Graduate or professional degree; Annual Income: 1 = \$0-\$4,999 to 8 = \$75,000 or higher; Daily E-Cig Status: 0 = No, 1 = Yes; Concurrent Cigarette Use: 0 = No, 1 = Yes; ASI-3 Total, ASI-3 Cognitive, ASI-3 Social, ASI-3 Physical: Anxiety Sensitivity Index-3(Taylor et al., 2007); Anhedonia, Anxious Arousal, General Distress = Mood and Anxiety Symptoms Questionnaire (MASQ-D30; Wardenaar et al., 2010)

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Table 2. *ANCOVA Results and Descriptive Statistics for dependent variables*

Predictor	F	η_p^2	<i>d</i>	Significant Group Differences
<i>ASI-3 Total</i>				
Sex	0.21	<0.001	0.06	
Age	23.50***	0.04	0.41	
Education	28.17***	0.05	0.46	
Income	0.58	0.001	0.06	
Concurrent Cigarette Use	1.64	0.003	0.11	
Daily Use Status	7.65**	0.013	0.23	Daily ($M = 32.88, SD = 1.0$) > Non-Daily ($M = 27.89, SD = 1.5$) **
<i>ASI-3 Cognitive Concerns</i>				
Sex	1.11	0.002	0.09	
Age	32.68***	0.06	0.51	
Education	28.05***	0.05	0.46	
Income	1.27	0.002	0.09	
Concurrent Cigarette Use	3.01	0.005	0.46	
Daily Use Status	7.63**	0.01	0.20	Daily ($M = 10.28, SD = 0.4$) > Non-Daily ($M = 8.48, SD = 0.5$) **
<i>ASI-3 Social Concerns</i>				
Sex	1.21	0.002	0.09	
Age	19.96***	0.03	0.35	
Education	27.80***	0.05	0.46	
Income	0.14	<0.001	0.06	
Concurrent Cigarette Use	0.50	0.001	0.06	
Daily Use Status	5.99	0.011	0.21	Daily ($M = 11.74, SD = 0.4$) > Non-Daily ($M = 10.24, SD = 0.5$)
<i>ASI-3 Physical Concerns</i>				
Sex	1.61	0.21	1.0	
Age	13.1***	0.023	0.31	
Education	21.0***	0.04	0.41	

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Income	0.42	0.001	0.06	
Concurrent Cigarette Use	1.41	0.003	0.11	
Daily Use Status	7.15	0.01	0.20	Daily ($M = 10.87, SD = 0.5$) > Non-Daily ($M = 9.16, SD = 0.4$)
<i>Anhedonia</i>				
Sex	8.38**	0.02	0.28	
Age	12.09**	0.02	0.28	
Education	26.29***	0.05	0.46	
Income	12.39***	0.02	0.28	
Concurrent Cigarette Use	4.35*	0.01	0.20	
Daily Use Status	2.77	0.01	0.20	Daily ($M = 28.50, SD = 0.5$) < Non-Daily ($M = 30.0, SD = 0.7$)
<i>Anxious Arousal</i>				
Sex	1.98	0.004	0.13	
Age	45.91***	0.08	0.59	
Education	28.04***	0.05	0.46	
Income	0.06	<0.001	0.06	
Concurrent Cigarette Use	11.29**	0.02	0.28	
Daily Use Status	12.91***	0.02	0.28	Daily ($M = 27.004, SD = 0.6$) > Non-Daily ($M = 23.47, SD = 0.8$) ***
<i>General Distress</i>				
Sex	1.42	0.003	0.11	
Age	41.32***	0.07	0.55	
Education	26.40***	0.05	0.46	
Income	0.50	0.001	0.06	
Concurrent Cigarette Use	4.70*	0.01	0.20	
Daily Use Status	11.33***	0.02	0.28	Daily ($M = 28.95, SD = 0.8$) > Non-Daily ($M = 25.6, SD = 0.8$) ***
Note. N = 566; *** $p < .001$, ** $p < .01$, * $p < .05$. F = F-Statistic; η_p^2 = Partial Eta Squared; d = Cohens d ; Sex: Male, Female; Education: Education Level; Income: Annual Income; Concurrent Cigarette Use: 0 = No, 1 = Yes; Daily Use Status: Daily or Non-Daily Use; ASI-3 Total, ASI-3 Cognitive Concerns, ASI-3 Social Concerns, ASI-3 Physical Concerns: Anxiety Sensitivity Index-3(Taylor et al., 2007) ; Anhedonia, General distress, Anxious Arousal = Mood and Anxiety Symptoms Questionnaire (MASQ-D30; Wardenaar et al., 2010).				

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