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Psychosocial Factors and E-Cigarette Use: An Application of Problem Behavior Theory

Samantha A. Fitzer
Old Dominion University, sfitz011@odu.edu

PSYCHOSOCIAL FACTORS AND E-CIGARETTE USE:

AN APPLICATION OF PROBLEM BEHAVIOR THEORY

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Samantha A. Fitzer
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Approved by:

James M. Henson (Director)

Kristin E. Heron (Member)

Mary L. Still (Member)

ABSTRACT

PSYCHOSOCIAL FACTORS AND E-CIGARETTE USE:
AN APPLICATION OF PROBLEM BEHAVIOR THEORY

Samantha A. Fitzer
Old Dominion University, 2022
Director: Dr. James M. Henson

Electronic cigarette (e-cigarette) use has increased among the U.S. population in recent years with estimates showing that nearly 15% of American adults have tried an e-cigarette (Villarroel et al., 2020). Problem Behavior Theory (PBT) has successfully outlined a variety of factors that affect an individual's engagement in an identified problem behavior. In an attempt to better understand e-cigarette use among an emerging adult population (i.e., college student population), the purpose of the current study was to explore how a large subset of PBT factors may differentiate between e-cigarette user categories (nonuser, non-daily user, daily user). A sample of 487 college students over the age of 18 were collected from a Mid-Atlantic university. Positive-negative functions discrepancy (i.e., the difference between the endorsed reasons for using e-cigarettes and the endorsed reasons for not using e-cigarettes), sexual identity, other substance use (i.e., marijuana and alcohol), and control from parents and friends were identified as high-ranking splitting factors across user categories. Policy makers and prevention and intervention methods should tailor their approaches to target these factors. Such changes may result in the reduction of e-cigarette use among college students.

This thesis is dedicated to:
My parents, Julie and Mark, for instilling in me the desire to never be satisfied.
My sister, Hannah, for being my other half and much needed comedic relief.
My best friend, CJ, for his support, his love, and his patience,
Because he is my calm in the storm.

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CHAPTER I

INTRODUCTION

E-cigarettes have increased in popularity in recent years becoming the most used tobacco product by youth and second most used tobacco product by adults in the United States (U.S. Department of Health and Human Services, 2016; Centers for Disease Control and Prevention [CDC], 2020). The increasing popularity has been very pronounced among youth and young adults (National Institute on Drug Use [NIDA], 2020). In 2014, young adults aged 18 to 24 had a higher rate of current e-cigarette use than their adult counter parts aged 25 and older (U.S. Department of Health and Human Services, 2016). Increased use patterns within adolescence and emerging adulthood are concerning because this is a critical period for brain development. Specifically, the human brain is not fully developed until the age of 25 (Campellone & Kent Turley, 2021), meaning this age group risks additional negative impacts that nicotine and other chemicals found in these products can have on the still-developing brain.

E-cigarettes or vape products are a form of nicotine administration that is delivered through a vapor or aerosol inhaled into the lungs. This administration differs from conventional cigarettes (i.e., combustible cigarettes) because they produce a vapor as opposed to smoke. Due to the increasing trends in e-cigarette use, researchers have sought to understand a number of factors that may be related to e-cigarette use. Previous literature has focused on the relation between use behaviors (e.g., e-cigarette brand, flavor preferences, use history) and frequency of use (Vogel et al., 2018). Few studies have examined psychosocial factors (e.g., attitude, school performance, etc.) in e-cigarette use and, to our knowledge, none have examined such factors in relation to e-cigarette user status (i.e., non-user, non-daily user, daily user).

In 1977, Jessor & Jessor defined and outlined Problem Behavior Theory (PBT). Broadly, PBT is a way through which we can identify factors that increase or decrease an individual's engagement in an identified problem behavior. Problem behaviors are defined as behaviors that are negatively viewed by society or viewed as a source of concern (Jessor & Jessor, 1977). PBT is comprised of three systems: the personality system, the perceived environment system, and the behavior system. There are fourteen factors in the personality system and nine factors in each the perceived environment system and the behavior system for a total of thirty-two factors (Jessor & Jessor, 1977).

Within their text, the authors outlined the mechanism by which factors contribute to or prevent against engagement in problem behaviors. Examples of factors that have been previously identified to affect problem behaviors include value on academic achievement, value on independence, self-esteem, religiosity, parental and friend's support, etc. (Jessor & Jessor, 1977). PBT has successfully been applied to several problem behaviors (e.g., marijuana use, Donovan 1996; problem drinking, Jessor 1987; cigarette use, Chun et al., 2020; activist protest, Jessor & Jessor, 1977; risky driving, Jessor, 1987; sexual initiation, Madkour, 2010). Nevertheless, this framework has yet to be thoroughly tested with e-cigarette use. A single study examining PBT with e-cigarette use tested factors that were not directly outlined in the theory (i.e., stress, suicidal thoughts, feelings of hopelessness, tobacco accessibility, second-hand smoke exposure, etc.; Chun et al., 2020). Because of PBT's success in distinguishing between users and nonusers of cigarettes (Rooney & Wright, 1982), alcohol, and marijuana (Jessor et al., 1980), the present study asserted that the factors in PBT will reliably distinguish between e-cigarette user categories as well.

Although current research has focused on how e-cigarette use is associated with user behaviors and demographic characteristics, the literature must now advance to examining psychosocial factors such as perceived acceptance and personal values that may play a role in the instigation or avoidance of e-cigarette use among an emerging adult population (e.g., college students). The current study examined twenty-nine PBT factors that are listed in Figure 1. The goal was to identify which factors most reliably distinguish what e-cigarette user category college students belong to. Identifying factors that instigate or prevent e-cigarette use is essential in the overarching goal of promoting healthy behaviors in the college student population.

To summarize, the current study examined which PBT factors are associated with e-cigarette user status among college students. The aim of the proposed study was to examine which PBT factors are most successful in differentiating between the three e-cigarette user categories: non-user, non-daily user, daily user. The current study can contribute to the literature by applying PBT to e-cigarette use, examining a variety of psychosocial factors and their associations with e-cigarette use, and assisting in the identification of factors that could be targeted in future interventions to decrease e-cigarette use among college students.

Literature Review

E-cigarette Use

In 2019, the United States saw an outbreak of lung injuries related to the use of e-cigarette products (CDC, 2020). As of February 18, 2020, the CDC has reported 68 deaths in patients with an e-cigarette related lung injury (CDC, 2020). In fact, 16.2% of the lung injuries reported were in individuals under the age of 18 and 61.9% were individuals aged 18-34 (Perrine et al., 2019). Additionally, e-cigarettes frequently contain high levels of acetyl propionyl and diacetyl that have been linked to an irreversible lung injury called "popcorn lung," where the

smallest air passages in the lungs get irritated and cause shortness of breath and coughing (Farsalinos et al., 2015). Given the known serious health effects, use of such products is of concern. The most alarming trend in e-cigarette use is its popularity among teens. The National Institute on Drug Abuse (NIDA) found in their annual Monitoring the Future survey that 16.6% of 8th graders, 30.7% of 10th graders, and 34.5% of 12th graders have used vapor nicotine products in the past year (NIDA, 2020). Unfortunately, this surge of vape products is not unique to middle and high school students. In fact, 36% of a college student sample reported having ever used a JUUL, a popular e-cigarette manufactured product, and 21% reported having done so in the last 30 days (Ickes et al., 2020). The recent spike in e-cigarette use among young people is a major health concern that has contributed to the deterioration of the nicotine and tobacco use prevention work within this age range.

E-cigarettes have become more widely accepted as alternatives to cigarettes. In fact, many e-cigarette users have reported that their motivations for use were to quit or reduce their combustible cigarette use and because e-cigarettes are viewed as a healthier alternative (Pokhrel et al., 2015; Park et al., 2019). A sample of college students even reported a higher acceptance of using e-cigarettes in public as compared to conventional cigarettes (Trumbo & Harper, 2013). However, when beliefs about e-cigarettes are surveyed from a sample of adults with a larger age range, responses show lower agreement on statements that positively view e-cigarette use (e.g., "if I vape or use e-cigarettes, it will be less harmful to me than if I smoke regular cigarettes") and higher agreement on statements that negatively view e-cigarettes (e.g., "if I vape or use an e-cigarette every day, I will become addicted"; Tan et al., 2016). These findings highlight a broader societal belief that the harms of e-cigarettes outweigh the potential benefits. Problem behaviors are defined as behaviors that are negatively viewed by society or seen as a source of

concern (Jessor & Jessor, 1977). Thus, e-cigarette use, especially in young adults, constitutes a problem behavior.

Several researchers have examined factors related to e-cigarette use. For instance, e-cigarette use has been found to be associated with ease of tobacco purchase at grocery or convenient stores and secondhand smoke exposure (Chun et al., 2020), being a former cigarette smoker (Giovenco et al., 2014), having individuals in the home who vape and a low perception of harm (Barrington-Trimis et al., 2015), and having problems with parents (Lindström et al., 2018). Despite our knowledge on factors associated with e-cigarette use, studies have yet to determine if said factors could serve as predictors of e-cigarette use engagement. The current study was interested in examining PBT factors as predictors of engagement in e-cigarette use, more specifically an individual's belonging in one of three user categories: non-user, non-daily user, and daily user.

In measuring e-cigarette use categories, several studies have taken different approaches in categorizing users. The categorization approach the current study used is seen throughout the literature and classifies users based off of their use of e-cigarettes in the past month (Roberts et al., 2018). The first group is non-users; these are individuals who do not report any use of e-cigarette and/or vape products in the past month. The second group is non-daily users; this category includes individuals who have reported using e-cigarettes and/or vape products in the past month and do so with any frequency ranging from "*once a month or less*" up to "*5 to 6 days per week*" (Roberts et al., 2018). Lastly, the third group is daily users which includes individuals who have reported using e-cigarettes and/or vape products in the past month and do so with an everyday frequency. These three categories of users will serve as our dependent variable. Much remains unexplored within the e-cigarette literature, and we aimed to expand this knowledge by

identifying factors that will differentiate between an individual's belonging in one of the three defined user categories.

Problem Behavior Theory

Problem Behavior Theory (PBT) developed by Jessor & Jessor (1977) is a model that considers a variety of factors that subsequently contribute to the instigation or prevention of an individual's engagement in a problem behavior. This theory was initially developed with a sample of high school students in 1969 and further expanded to college students in 1970 (Jessor & Jessor, 1977). The model of PBT is decomposed into three systems: the personality system, the perceived environment system, and the behavior system. The present study was interested in determining if a variety of PBT factors can successfully predict an individual's e-cigarette user category status.

Personality System

The personality system is a representation of the nature of the individual and the factors within this system are in three separate structures: the motivational-instigation structure, the personal belief structure, and the personal control structure (Jessor & Jessor, 1977).

Motivational-Instigation Structure. The motivational-instigation structure contains the goals an individual strives for, their source(s) of motivation for said goals, and the influences that provoke their engagement in particular behaviors (Jessor & Jessor, 1977). The motivational-instigation structure contains seven factors: value on academic achievement, value on independence, value on affection, independence-achievement value discrepancy, expectation for academic achievement, expectation for independence, and expectation for affection (Jessor & Jessor, 1977). The combination of these factors is meant to represent the value placed on certain

goals and their motivational properties relating to the engagement in certain behaviors. These goals and motivations are more abstractly linked with the engagement in problem behaviors.

The current study examined six of these factors, excluding the independence-achievement value discrepancy. This factor was excluded because the scales used to measure value on independence and value on academic achievement are incongruent and do not produce a meaningful calculated difference because their ranges are different from one another. Value on independence and value on academic achievement were measured independently. Additionally, independence-achievement value discrepancy was not found to be significantly different between alcohol abstainers, nonproblem drinkers, and problem drinkers amongst both high school and college samples (Jessor & Jessor, 1977). Therefore, we did not anticipate this excluded factor to significantly differentiate e-cigarette user categories within a college student sample. Of the factors examined, the "value" factors characterize how important behaviors relating to the construct are to the individual and the "expectation" factors characterize how sure an individual is that certain behaviors relating to the construct will occur.

Personal Belief Structure. The second structure of the personality system is the personal belief structure. This structure contains the cognitive controls that are used to prevent the engagement in a problem behavior (Jessor & Jessor, 1977). Four factors are included: social criticism, alienation, self-esteem, and internal-external locus of control (Jessor & Jessor, 1977). Social criticism is "the degree to which there is acceptance or rejection of the values, norms, and practices of the larger society" (Jessor & Jessor, 1977). This factor was excluded because the original measure of social criticism contained topics that were no longer relevant for the current society (e.g., the Vietnam War). Alienation refers to an individual's uncertainty about the self, concern over meaninglessness in daily life, and feelings of exclusion from those around them

(Jessor & Jessor, 1977). Self-esteem refers to the confidence one has in their own worth. Finally, internal-external locus of control (LOC) refers to one's belief regarding control over the situations and experiences that influence their lives. Someone with an internal LOC believes that the outcomes of our actions depend upon what we do, whereas someone with an external LOC believes that events outside of one's personal control dictate their situations and experiences. An individual who has low social criticism, low alienation, high self-esteem, and an internal locus of control is less likely to engage in problem behaviors because they accept societal norms, find purpose in their life, feel socially connected, hold themselves in high regard, and believe they control their own destiny (Jessor & Jessor, 1977). The beliefs an individual holds form the cognitive controls that prevent involvement in problem behaviors, and individuals can have strong or weak cognitive controls.

Personal Control Structure. The last structure of the personality system is the personal control structure. This structure is similar to the personal belief structure because it contains factors that limit participation in problem behaviors. However, the factors within the personal control structure are more directly related to the problem behavior. The three factors included in this structure are attitudinal tolerance of deviance, religiosity, and positive-negative functions discrepancy (Jessor & Jessor, 1977). The first construct, attitudinal tolerance of deviance, is the perceived degree of wrongness of deviant behaviors which range in severity (e.g., cheating in school, selling drugs, carrying a firearm); the more tolerance a person has for deviant behaviors, the more likely they are to engage in any number of problem behaviors (Jessor & Jessor, 1977). The second construct, religiosity, is a person's general involvement in religious practices and activities; greater religiosity is believed to decrease an individual's engagement in problem behaviors. The third construct, positive-negative functions discrepancy, is the comparison

between the endorsed reasons for engagement in the problem behavior versus the reasons for not engaging. Those who have more reasons against engagement are protected from the problem behavior, whereas those who have more reasons to engage are more likely to follow through with the problem behavior.

Past Research on the Personality System of PBT. The current study examined 12 factors from the personality system of PBT. Across the different behaviors examined through the lens of PBT, general trends have emerged among problem behaviors such as alcohol consumption, marijuana involvement, and deviant behavior in the past year as well as conventional behaviors such as grade-point average. In the personality system specifically, we see the most significant correlations coming from the factors in the motivational-instigation structure and the personal control structure. When examining for differences across age (i.e., high school versus college) and sex (i.e., male and female), findings reveal that these groups are largely similar with trends being slightly stronger for males (Jessor & Jessor, 1977). In comparing the correlations among the personality factors with the problem behaviors and conventional behaviors, the theory is once again supported because these correlations reveal opposite trends. Overall, when examining college students, most of the personality system factors were significantly related to variation in problem and conventional behaviors (i.e., times drunk in past year, marijuana behavior involvement, deviant behavior in past year, multiple problem-behavior index, church attendance, grade-point average in past year; Jessor & Jessor, 1977).

In addition to the success the personality system factors have had in accounting for variation in problem and conventional behaviors, they have also functioned to distinguish between marijuana non-user and user categories. Users were only categorized by lifetime use

(i.e., have used marijuana at least once or never at all) and therefore had a broad range of users grouped together; however, several personality system factors were significantly different among the user groups (Jessor & Jessor, 1977).

Perceived Environment System

In addition to the nature of the actor, the actor's environment, and their perception of it are integral to the instigation or prevention of participation in many problem behaviors. The perceived environment system contains two structures: the distal structure and the proximal structure.

Distal Structure. The distal structure focuses on factors that can be linked to participation in problem behaviors through mediation or theory (Jessor & Jessor, 1977). In other words, these factors are not as clearly or directly linked to the problem behavior. PBT includes six factors in this structure: parental support, parental controls, friend support, friend controls, parent-friend compatibility, and parent-friend influence (Jessor & Jessor, 1977). The "support" variables represent the perception of readily available support in the form of encouragement and interest from both parents and friends. Similarly, the "control" variables represent the perception of strict standards and the use of sanctions for disapproved behaviors from both parents and friends. Parent-friend compatibility is characterized by the level of agreement between an individual's parents and friends on matters pertaining to what is important in life and what the individual's future holds. The final variable in the distal structure, parent-friend influence, determines whether a person's parents or friends have a greater amount of influence over their beliefs and behaviors. The combination of these factors characterizes the social context in which an individual is rooted, as either being parent- and family-oriented or peer- and friend-oriented.

Those who are peer- and friend-oriented have a greater proneness to engage in problem behaviors (Jessor & Jessor, 1977).

Proximal Structure. The proximal structure similarly includes social contextual factors as well, but the factors are more directly or obviously related to the problem behavior. The factors included in this structure are parent approval of problem behavior, friend approval of problem behavior, and friend model of problem behavior (Jessor & Jessor, 1977). These factors provide information about the prevalence and acceptance of the problem behavior within an individual's environment and the subsequent support for its occurrence. More approval for the problem behavior from both parents and friends, along with having more friends model the problem behavior, increases an individual's likelihood of engaging in that problem behavior.

Past Research on the Perceived Environment System of PBT. The current study examined all 9 factors from the perceived environment system of PBT. Through investigating the factors of the perceived environment system, the factors in the proximal structure, which are most closely related to the problem behavior, produce higher correlations compared to the factors in the distal structure (Jessor & Jessor, 1977). Even so, amongst a sample of college students, several of the factors (i.e., friend support, friend controls, parent-friend compatibility, parent-friend influence) significantly differed across levels of marijuana involvement (Jessor & Jessor, 1977). Overall, results reveal that distal structure factors may be more important in determining engagement in problem behaviors among high school students as compared to college students (Jessor & Jessor, 1977).

Not only were these trends apparent in an examination of multiple problem behaviors, but they also hold true when examining mean differences between marijuana non-users and users. Equivalent to the description above, users were categorized by lifetime marijuana use. Among

high school students, every factor in the perceived environment system was significantly different between the marijuana user groups excluding friend support (Jessor & Jessor, 1977). In a follow-up study with college students, the proximal structure factors remained highly significant, whereas a portion of the distal structure factors became non-significant (Jessor & Jessor, 1977). Regardless of the initial work on PBT, more recent work has identified peer groups as important factors in behavior. In a study of substance use and exercise, findings suggest that college students' engagement in these behaviors was correlated with their peers' engagement in these same behaviors (Barnett et al., 2014). Thus, peer behaviors and support appear to play a critical role in engagement in problem and conventional behaviors among college students.

Behavior System

Finally, beyond an individual's personality and perceived environment, lies their behaviors. The behavior system consists of two structures: the problem-behavior structure and the conventional behavior structure.

Problem Behavior Structure. The problem-behavior structure includes seven variables: marijuana use, sexual intercourse, activist protest, drinking, problem drinking, general deviant behavior, and multiple problem-behavior index (Jessor & Jessor, 1977). Engagement in any or multiple of these problem behaviors have been linked to further problem behaviors (Ary et al., 1999). Therefore, engagement in one problem behavior is closely linked to engagement in multiple problem behaviors. For the current study, the following were examined: marijuana involvement, sexual activity, activist protest, drinking and problem drinking, and general deviant behavior (i.e., conventional deviant behaviors such as stealing, aggression, and disruptive behavior). The multiple problem-behavior index was excluded because it combines all behaviors

in the problem behavior structure and does not function as an efficient way to examine factors independently.

Conventional Behavior Structure. Conversely, the conventional behavior structure represents behaviors that are socially approved and may even be expected; such conventional behaviors serve as deterrents for engagement in problem behaviors. This structure consists of two variables: church attendance and academic performance (Jessor & Jessor, 1977). The two structures of the behavior system (i.e., the problem and conventional behavior structures) function opposite of one another, and, in tandem, predict the instigation or prevention of problem behavior engagement.

Past Research on the Behavior System of PBT. Although engagement in one problem behavior may not directly lead to engagement in further problem behaviors, it does make it more likely. Conversely, engagement in conventional behaviors suggests a commitment to the conventions of society and therefore makes engagement in problem behaviors less likely. For example, when examining the onset of marijuana use and its correlation with general deviant behavior, church attendance within the past year, and grade-point average, all factors were significantly different across the user categories (i.e., non-users, early initiates, later initiates, and long-time users; Jessor & Jesssor, 1977). General deviant behavior was highest among long-time users whereas the conventional behaviors, church attendance and grade-point average, were highest amongst non-users (Jessor & Jesssor, 1977). Because the problem and conventional behaviors built into the theory have significantly differed among marijuana user categories, it was suspected a similar relationship would hold for e-cigarette user categories.

The Current Study

To better understand factors that influence e-cigarette use behaviors, the current study applied PBT to e-cigarette user categories in a college student population. The study was exploratory in nature and aimed to address the following research objectives:

Objective 1: To examine person-characteristics and the twenty-nine outlined PBT factors to identify which factors are most prominent in differentiating between non-users and e-cigarette users.

Objective 2: To examine person-characteristics and the twenty-nine outlined PBT factors to identify which factors are most prominent in differentiating between non-daily and daily e-cigarette users.

CHAPTER II

METHOD

Participants

Participants were recruited through the psychology participant research pool as well as university announcements at a Mid-Atlantic university. Eligible participants were over the age of 18 and enrolled at the university. Participants were told that researchers were interested in how a variety of psychological and social factors may impact patterns of e-cigarette use.

A total of 578 eligible participants took the online survey. Participants were excluded from analyses for several reasons: not reporting e-cigarette use ($n = 6$), completing the survey in under 5 minutes ($n = 61$), and dropping out mid-survey leaving over a third of their relevant responses blank ($n = 24$). The final sample ($N = 487$) was predominantly female (74.3%) with a mean age of 20.72 years old ($SD = 2.77$). Most of the sample identified as White (44.1%) followed by Black or African American (35.3%), Other (12.1%), and Asian (6.8%). Within this sample, 35.2% reported ever using e-cigarettes, 28.3% reported using e-cigarettes within the past 12 months, and 17.7% reported using e-cigarettes within the past 30 days. When categorized, the final sample had non-users ($n = 401$), non-daily users ($n = 52$), and daily users ($n = 34$). Participant characteristics of the full sample and based on e-cigarette user status are displayed in Table 1.

Measures

E-cigarette Use

E-cigarette users were separated into three categories based upon their use of e-cigarettes in the past month. Participants responded to two items to determine their e-cigarette user category. First, participants reported their past 30-day use of e-cigarettes by responding never/more than 30 days ago/within the last 30 days to the following "Have you ever used e-

cigarettes?" Secondly, to determine frequency of use, participants were asked "About how often did you usually use e-cigarettes/e-liquid in the past month?" (every day, 5 to 6 days a week, 3 to 4 days a week, 1 to 2 days a week, 2 to 3 days a month, I did not use e-cigarettes/e-liquid in the past month; Roberts et al., 2018). Non-users are defined as those who reported "*never/more than 30 days ago*" use of e-cigarettes. Non-daily users are defined as those who reported use of e-cigarettes in the past month with a frequency of use ranging from "*2 to 3 days a month*" to "*5 to 6 days a week*." Daily users are defined as those who reported use of e-cigarettes in the past month at an "*every day*" frequency. The defined categories were found to be useful in distinguishing across e-cigarette users and yielded significant differences in alcohol consumption (Roberts et al., 2018). In the absence of validated measures for the categorization of e-cigarette users, we were guided by the current literature and are confident the present categorization is logical and presents strong face validity.

Problem Behavior Theory Constructs

Personality System

      Value on Academic Achievement. A 4-item scale was used to measure value on academic achievement. Participants were asked to rank how important a variety of academic outcomes are to them (e.g., "How important is it to you… To get at least a B average this year?" and "To be considered a bright student by your professors?") on a 4-point Likert scale from 1= *Not important at all* to 4 = *Very important* (Krueger & Turbin, 2006). The items are then summed and produce a composite score ranging from 4 to 16, with a higher score representing placing greater value on academic achievement. This scale has acceptable reliability in a sample of college students (α = .74; Krueger & Turbin, 2006).

Value on Independence. The two-item scale originally developed in early studies of PBT by Jessor et al. (1968) was used to measure value on independence. Participants were asked to rank how important their independence is to them (e.g., "How important is it to you to say what you think even if other people don't agree with you?") on a 4-point Likert scale from 0 = *Not important at all* to 3 = *Very important* (Krueger & Turbin, 2006). The items are then summed and produce a composite score ranging from 0 to 6, with a higher score representing placing greater value on independence. Internal consistency was sufficiently demonstrated among a college student sample (α = .78; Jessor & Jessor, 1977).

Value on Affection. A two-item scale assessed participant's value on affection. Participants were asked to rank how important it is to them to be liked by others (e.g., "How important is it that you feel that the people you like also like you?") on a 4-point Likert scale from 0 = *Not important at all* to 3 = *Very important* (Jessor, Graves, & Hanson, 1968). The items are then summed and produce a composite score ranging from 0 to 6, with a higher score representing placing greater value on affection. This scale was found to have very good internal consistency (α = .89) in a sample of college students (Jessor & Jessor, 1977).

Expectation for Academic Achievement. A 4-item scale was used to assess expectation for academic achievement (Jessor, Costa, & Turbin, 2002). Participants were asked to rank how sure they are that they will achieve a number of academic outcomes (e.g., "How sure are you that you will: Come out near the top of the class on exams?" and "Have good enough grades to get into graduate or professional school if you like?") on a 4-point Likert scale from 1 = *Not sure at all* to 4 = *Pretty sure* (Jessor, Costa, & Turbin, 2002). The items are then summed and produce a composite score ranging from 4 to 16, with a higher score representing higher expectations for

academic achievement. This scale had good internal consistency (α = .87; Jessor et al., 2002) in a sample of adolescents.

Expectation for Independence. A 3-item scale developed in the originating studies on PBT was used to assess expectation for independence (Jessor, Graves, & Hanson, 1968). Participants were asked to rank how strongly they expect different situations to occur (e.g., "To be able to do things in the family pretty much the way you want" and "That friends will pretty much let you do things your own way") on a 4-point Likert scale from 0 = *Not strongly at all* to 3 = *Pretty strongly* (Jessor, Graves, & Hanson, 1968). The items are then summed and produce a composite score ranging from 0 to 9, with a higher score representing higher expectations for independence. This scale exhibited an acceptable level of internal consistency (α = 0.71; Jessor & Jessor, 1977) in a sample of college students.

Expectation for Affection. A 3-item scale developed in the originating studies on PBT was used to assess expectation for affection (Jessor, Graves, & Hanson, 1968). Participants were asked to rank how strongly they expect a number of situations to happen (e.g., "To get affection from others in your family" and "To be *liked* by others you work with") on a 4-point Likert scale from 0 = *Not strongly at all* to 3 = *Pretty strongly* (Jessor, Graves, & Hanson, 1968). The items are then summed and produce a composite score ranging from 0 to 9, with a higher score representing higher expectations for affection. This scale had very good internal consistency (α = .90) among a college student sample (Jessor & Jessor, 1977).

Alienation. A 4-item scale was used to measure alienation. Participants were asked to rank how strongly they agree or disagree with four statements (e.g., "I often feel left out of things that others are doing" and "Hardly anything I'm doing in my life means very much to me") on a 4-point Likert scale from 1= *Strongly disagree* to 4 = *Strongly agree* (Jessor et al., 2006). The

items are then summed and produce a composite score ranging from 4 to 16, with a higher score representing greater feelings of alienation. This scale has acceptable internal consistency in a sample of college students ($\alpha = .79$; Jessor et al., 2006).

Self-esteem. The Rosenburg Self-Esteem Scale (RSE) is a 10-item scale used to measure an individual's global self-worth through assessing both positive and negative feelings about the self (Rosenberg, 1979). Participants are asked to rank their agreement or disagreement on 10 statements (e.g., "At times I think I am no good at all" and "I feel that I'm a person of worth") on a 4-point Likert scale from 1 = *Strongly agree* to 4 = *Strongly disagree*. The RSE produces a global score of self-esteem ranging from 0 to 30, with a higher score representing higher levels of self-esteem. The RSE exhibits high reliability with test-retest correlations ranging from .82-.88 and Cronbach's alpha ranging from .77 to .88 across a variety of adult samples (Blascovich et al., 1991). Additionally, the RSE has demonstrated concurrent, predictive, and construct validity alongside significant correlations with other measures of self-esteem (i.e., Coopersmith Self-Esteem Inventory; Rosenberg, 1979).

Internal-External Locus of Control. A brief locus of control (LOC) survey was used to assess levels of internal and external locus of control (Lumpkin, 1985). This survey contains 6 items, 3 for internal LOC and 3 for external LOC. Participants were asked to rank their level of agreement or disagreement for six statements (e.g., "When I make plans, I am almost certain I can make them work" and "Many times I feel that I have little influence over the things that happen to me") on a 5-point Likert scale ranging from 1 = *Strongly disagree* to 5 = *Strongly agree*. The brief survey produces a composite score for internal LOC and external LOC separately, each ranging from 3 to 15, with a higher score representing higher levels of internal or external LOC. The brief version of the scale had marginal internal consistency ($\alpha = .68$) in a

national probability sample (Lumpkin, 1985); which is similar to or an improvement from longer forms of the scale that have produced Cronbach's alphas ranging from .65 to .79 (Lumpkin, 1985). Furthermore, the brief LOC measure was found to be valid based upon correlations with prior research and the ability to replicate similar scores produced by the full LOC measure (Lumpkin, 1985).

Perceived Environment System

Attitudinal Tolerance of Deviance. A seven-item scale was used to measure attitudinal tolerance of deviance (Jessor et al., 2006). Participants were asked to report how wrong a variety of deviant behaviors are (e.g., "To cheat on tests or homework" and "To sell or deal drugs") on a 4-point Likert scale from 1= *Not wrong at all* to 4 = *Very wrong*. The measure produces a global score ranging from 7 to 28, with a higher score representing lower tolerance for deviance. This measure has been used in previous PBT research and was found to have acceptable internal consistency in samples of college students (α = .68; Jessor et al., 2006).

Religiosity. A 4-item scale was used to measure religiosity (Jessor et al., 2006). Participants were asked to report how important four statements are to them (e.g., "To be able to rely on religious teachings when you have a problem" and "To be able to turn to prayer when you're facing a problem") on a 4-point Likert scale from 1= *Not important at all* to 4 = *Very important*. The measure produces a global score ranging from 4 to 16, with a higher score representing greater feelings of religiosity. This measure has been used in previous PBT research and was found to have excellent internal consistency in a sample of college students (α = .94; Jessor et al., 2006).

Positive-Negative Functions Discrepancy. In measuring positive-negative functions discrepancy, the major categories for e-cigarette use and non-use identified by Park et al. (2019)

were used. Participants were asked to select their reasons for e-cigarette use (e.g., "For popularity" and "Because they are a healthier alternative to conventional cigarettes") and non-use (e.g., "Because there is a risk of addiction" and "Because there are harmful health effects"). There were 4 positive function items and 4 negative function items. Participants respond yes (scored as 1) or no (scored as 0) to each item. The items are summed across positive functions and negative functions separately. The scale then produces a composite score by taking the difference between the endorsed positive functions sum and the endorsed negative functions sum. The final score ranges from -4 to 4, with a higher score representing more reasons to use e-cigarettes than reasons not to (i.e., greater positive functions than negative functions).

Parental Support. A 3-item scale was administered to assess parental support. Participants were asked to report how often their parent(s) perform supportive behaviors (e.g., "Do your parent(s) or guardian(s) encourage you to do what you are interested in doing and show an interest in those things themselves?" and "Are your parent(s) or guardian(s) interested in how you think and feel?") on a 4-point Likert scale from 1 = *Almost never* to 4 = *Almost always* (Jessor et al., 2006). The global score for the three items ranges from 3 to 12, with a higher score representing greater parental support. These same items have been used in past PBT research and were found to have good internal consistency in a sample of college students (α = .80; Jessor et al., 2006).

Parental Controls/Sanctions. The 5-item measure of parental controls or sanctions used by Jessor, Costa, and Turbin (2002) examines how likely parents are to administer sanctions for engagement in negative behaviors (e.g., using e-cigarette/vape products, lying, and drinking alcohol). Participants are asked to rank how likely they are to get in trouble for such behaviors on a 4-point Likert scale from 1 = *Definitely not* to 4 = *Definitely would*. Summing together all the

items, a global score is produced ranging from 5 to 20, with a higher score representing higher parental control and greater parental sanctions.

Friend's Support. A 2-item scale was administered to assess friend's support. Participants were asked to report how often their friends perform supportive behaviors (e.g., "Are your friends interested in what you think and how you feel?" and "When you have personal problems, do your friends try to understand and let you know they care?") on a 3-point Likert scale from 1 = *Hardly ever* to 3 = *Almost always* (Jessor et al., 2002). The global score for the two items ranges from 2 to 6, with a higher score representing greater friend's support.

Friend's Control. A 4-item scale was administered to assess friend's control. Participants were asked to report how likely their friends are to stop them from engaging in negative behaviors (e.g., "If you were going to do something people think is wrong, would your friends try to stop you?" and "If you were going to do something that's against the law, would your friends try to talk you out of it?") on a 4-point Likert scale from 1 = *Definitely would not* to 4 = *Definitely would* (Jessor et al., 2002). The global score for the four items ranges from 4 to 16, with a higher score representing greater friend's control.

Parent-Friend Compatibility. A 3-item scale was used to measure the compatibility of beliefs between parents and friends. Participants were asked to report how much their parents and friends agree on three items (e.g., "Would your **friends** agree with your **parents** (or the adults you live with) about what is really important in life?") on a 4-point Likert scale from 1 = *Not at all* to 4 = *A lot* (Jessor et al., 2002). The global score for the three items ranges from 3 to 12, with a higher score representing greater parent-friend compatibility.

Parent-Friend Influence. A 4-item scale was administered to assess parent-friend influence. Participants were asked to report if they depend more on their parents or friends in

certain situations (e.g., "If you had to make a **serious** decision about your personal life, who would you depend on more for advice – your friends or your parents?" and "What about your outlook on life – what's important to do and what it is important to become? Who has had more influence on you, your friends or your parents?") on a 3-point Likert scale from 1 = *Parents more* to 3 = *Friends more* (Jessor et al., 2002). The global score for the three items ranges from 4 to 12, with a higher score representing greater friend influence.

      Parental Approval Problem Behavior. To assess parental approval of engagement in e-cigarette or vaping behaviors, participants were asked to report the extent to which their parent(s) or guardian(s) approve of such behaviors. By slightly modifying the questions used by Boyle & Boekeloo (2006) measuring parental acceptance of alcohol consumption, we asked students to report on a 5-point Likert scale ranging from 1 = *Strongly disapprove* to 5 = *Strongly approve*, the degree to which each parent/guardian approves of their smoking/vaping occasionally, regularly, and excessively. Participants first reported the number of parent(s)/guardian(s) they had with a minimum of 0 and a maximum of 3. The sex of each parent/guardian was reported prior to answering approval questions. Typically, the scale produces two variables: father/male guardian composite score and mother/female guardian composite score. In the case that two same-sex parent(s)/guardian(s) were reported, the scores were averaged together. Conversely, if only one parent/guardian was reported, only one composite score was calculated, based upon the sex of the reported parent/guardian. The separate composite scores can range anywhere from 3 to 15 with a higher score meaning greater parental approval and support of the behavior. The mother and father scales have acceptable reliabilities respectively in a sample of first-year college students ($\alpha = .76$ and $\alpha = .78$; Boyle & Boekeloo, 2006).

Friend's Approval Problem Behavior. A single item was used to measure friend's

approval of problem behavior. Participants were asked to report their friend's level of agreement

or disagreement with the statement "How do your friends or acquaintances feel about someone

your age using e-cigarette and/or vape products?" on a 4-point Likert scale from 1 = *They*

approve to 4 = *Strongly disapprove* (Jessor et al., 2006). Scores range from 1 to 4, with a higher

score representing lower friend approval of the problem behavior.

Friends Model Problem Behavior. Another single item was used to measure friends

modeling of problem behavior. Participants were asked to report how many of their friends or

acquaintances use e-cigarette and/or vape products on a 4-point Likert scale from 1 = *None of*

them to 4 = *Almost all of them* (Jessor et al., 2006). Scores range from 1 to 4, with a higher score

representing more friends modeling the problem behavior.

Behavior System

Marijuana Involvement. The marijuana behavior report (MBR) scale examines

marijuana use in any form through 4 items. These items are designed on a Guttman scale such

that the questions, when ranked, represent greater commitment to the use of marijuana (Jessor &

Jessor, 1977). Guttman scales are designed so that the response to any given item can accurately

predict responses to all items appearing before it; this is true when the scale properly measures a

single trait (e.g., marijuana involvement). The four items, ranked from lowest commitment to

highest commitment are as follows: "Have you ever tried marijuana? (0 = *Never,* 1 = *Once,* 2 =

More than once)," "Have you ever been very high or "stoned" on marijuana to the point where

you were pretty sure you have experienced the drug effects? (*Never, Once, More than once*),"

"Do you or someone close to you usually keep a supply of marijuana so that it's available when

you want to use it? (0 = *No,* 2 = *Yes*)," and "Do you use marijuana a couple of times a week or

more when its available? (0 = *No, 2 = Yes*)" (Jessor & Jessor, 1973). Each item is scored from 0 to 2 producing a global score ranging from 0 to 8 with lower scores denoting non-use or experimental use and higher score signifying regular use and a higher commitment to the use of marijuana (Jessor & Jessor, 1973). Reproducibility coefficients within a Guttman scale model are defined as 1 minus the sum of errors divided by the total number of responses; values of at least .90 provide strong support for the validity of a Guttman scale. Scalability coefficients in a Guttman scale model are defined as 1 minus the ratio of observed error to expected error. This scale has demonstrated high reproducibility with coefficients of .96 and .98 and high scalability with coefficients of .86 and .95 with high school and a college student samples, respectively (Jessor & Jessor, 1977).

Sexual Activity. Sexual activity was assessed by 7 items. This measure not only characterizes whether someone has been sexually active (i.e., virginity status), but it also examines when sexual activity began, how often one is sexually active, and number of sexual partners (Jessor et al., 2006). Participants are asked to self-report engagement in sexual intercourse (i.e., 1 = *Yes* and 0 = *No*) and related details on initiation to sexual intercourse, number of sexual partners in the past, frequency of sexual intercourse, and condom use during sexual intercourse (i.e., 1 = *Yes* and 0 = *No*). The scale will produce a categorical variable sorting participants into those who have become sexually active (non-virgin status) and those who have not (virgin status).

Activist Protest. A single item was used to categorize participants into those who have and have not engaged in militant activism or peaceful demonstration. This status question was developed by Jessor and Jessor (1977) and asks participants "In the past year, have you

participated in militant activism or peaceful demonstration?" and categorizes them based upon their answer, 1 = *Yes* and 0 = *No*.

Drinking & Problem Drinking. The Alcohol Use Disorders Identification Test (AUDIT) is a 10-item questionnaire used to screen for unhealthy alcohol use (Allen et al., 1997). Participants are asked multiple questions relating to their drinking behaviors (e.g., "How often do you have a drink containing alcohol?" and "How often do you have six or more drinks on one occasion?"). Each item is scored from 0 to 4 with different Likert descriptions for the different items, and the last two items having possible scores of 0, 2, or 4. The AUDIT not only allows for the classification of lifetime alcohol use (i.e., never consumed alcohol or have consumed alcohol), but the global score ranging from 0 to 40 has cut off values for different levels of problem drinking. A global score of 8+ is associated with harmful or hazardous drinking and a score of 13+ in women and 15+ in men is a likely indicator of alcohol dependence (Allen et al., 1997). An AUDIT cut-off score of 6 was found to have a sensitivity of 91% in detecting high-risk drinkers indicating the measure is valid in a college student population (Kokotalio et al., 2004). This questionnaire is widely used and has been found to have good internal consistency among college students (α = 0.80; Allen et al., 1997).

General Deviant Behavior. A 9-item measure developed by Jessor and colleagues (2002) was used to measure general deviant behavior. Participants were asked how often they have engaged in a few deviant behaviors (e.g., cheated on tests or homework, taken something of value that doesn't belong to you, and carried a weapon, like a knife or gun, on campus) on a 5-point Likert scale from 1 = *Never* to 5 = *5 or more times*. The composite score of the scale ranges from 9 to 45, with a higher score representing greater engagement in general deviant behaviors.

Church Attendance. A single item measure was used to determine church attendance (Jessor et al., 2006). Participants were asked "How many times have you gone to church or religious services during the past month" and answered on a 7-point Likert scale from 1 = *None* to 7 = *8 or more times*. A higher score represents more frequent church attendance in the past month. Ultimately, this was transformed into a binary variable due to zero-inflation. Those who reported attending church in the past month were scored a 1 and those who did not report attending any services were scored a 0.

Academic Performance. In line with the original work on PBT conducted by Jessor & Jessor (1977) academic performance was measured by a single, self-report item. Students were asked to report their current grade point average (GPA) on a 4.0 scale. In the earliest data collection for PBT, the correlations between self-reported GPA and institutional recorded GPA were high, .89 for males and .91 for females (Jessor & Jessor, 1977). Additionally, a more recent review established a mean correlation of .90 between self-reported GPA and GPA on school records for college students (Kuncel et al., 2005). Given the high correlations between self-reported GPA and the school's record of GPA, we determined a self-report measure to be an adequate representation of school performance among college students.

Procedure

Data collection took place between February 2022 and May 2022. The study received exempt status (1864283-1) from the university institutional review board before materials were made accessible to potential participants. Participants were recruited from a psychology participant research subject pool as well as university announcements at a large Mid-Atlantic university. All data collection occurred online via a survey completed in Qualtrics. Those interested in the study were asked to review eligibility criteria prior to starting the survey.

Participants were first presented with a notification statement and prompted to consent prior to participation. The complete survey was estimated to take 45 minutes to complete. Participants were compensated differently depending upon recruitment method. Those recruited through university announcements were directed to a separate survey where they were asked to enter an email address for a chance to win one of two $50 Amazon gift cards. Those recruited through the participant research pool were awarded with research credit for their participation.

Statistical Analysis

The study had twenty-nine PBT factors and eight demographic variables predicting membership in one of three e-cigarette user categories: non-user, non-daily user, daily user. Recursive partitioning (RP) was used to analyze the data because it "examines all available predictors and identifies a hierarchy of variables that are, in succession, most related to the outcome measure" (Hellemann et al., 2009).

Prior to RP analyses, a missing value analysis was run using SPSS version 28.0 (IBM Corp., 2021). Results from Little's Missing Completely at Random test revealed that incomplete data was missing at random ($\chi^2 = 12683.18$, df $= 14137$, $p = 1.000$). Missing data was addressed using expectation maximization (EM) imputation prior to analyses. EM imputation is good for missing at random cases (Aljuaid & Sasi, 2016); thus, this method was used to impute missing values. All imputed variables had around 5% missingness or less. One item of the AUDIT ("How many drinks containing alcohol do you have on a typical day when you are drinking?") was the exception with 10.2% missingness; analyses were run both with a) data sets where these missing values were EM imputed and b) data sets where case deletion was used for subjects missing this item. The resultant trees were not different from one another. Therefore, all presented trees were products of data sets where the second item of the AUDIT was imputed to

allow for larger sample sizes. Outliers were then addressed and winsorized for internal LOC ($n =$ 2), GPA ($n = 4$), composite AUDIT scores ($n = 6$), and composite deviant behavior scores ($n = 9$).

Recursive partitioning analyses were run in R version 4.2.0 (R Core Team, 2013) using the rpart package (Therneau & Atkinson, 2022) to generate three different trees: Figure 2, a tree to predict being a non-user or an e-cigarette user of any frequency; Figure 3, a tree to predict being a non-daily e-cigarette user or a daily e-cigarette user; and Figure 4, a tree to predict being a non-user or non-daily e-cigarette user. All the measures described above as well as eight demographic variables (i.e., age, race, ethnicity, sex, gender, sexual identity, class standing, and relationship status) were included in the model as potential factors to predict e-cigarette user status.

The rpart function uses several measures of impurity (e.g., Gini index) to determine if a node should be added to the tree or not. Thus, the resulting node will be the one with maximal impurity reduction (Therneau & Atkinson, 2019). Additionally, a complexity parameter (cp) is set to 0.01, to prevent our trees from over-fitting to the sample. The cp places a requirement for minimum error improvement before adding additional nodes to the tree. If improvement is less than 0.01, the node becomes terminal.

RP analysis is a nonparametric statistical approach that uses all the predictor variables to successively differentiate between levels of the outcome measure (i.e., e-cigarette user category). The RP analysis ordered the variables from most important to least important in their contribution to differences among the outcome measure. RP does so by evaluating each predictor variable separately and choosing the variable that best discriminates between the levels of the outcome measure; the chosen predictor variable forms the first "node" in our classification tree.

This process is done repeatedly on each newly created subsample or "branch" until none of the remaining predictor variables produce a meaningful split (i.e., node) in the sample.

CHAPTER III

RESULTS

Descriptive Statistics

Using PBT, 29 constructs were assessed; scores and alpha reliability coefficients on the various scales for the full sample and based on e-cigarette user status are displayed in Table 2. Characteristics of the sample will be summarized for each system in PBT (i.e., personality, perceived environment, and behavior). To examine differences in these variables across e-cigarette user status (i.e., non-user, non-daily user, daily user) several one-way, between-subjects analysis of variances were conducted. Results from these analyses as well as post-hoc group difference tests are presented in Tables 1 and 2. Fourteen constructs significantly differed across e-cigarette user status. Within the personality system, none of the motivational-instigation or personal belief structure constructs differed across groups (see Table 2). However, two of the three constructs in the personal control structure, religiosity ($p < .001$) and positive-negative functions discrepancy ($p < .001$), did significantly differ across groups. Specifically, religiosity was higher among non-users and non-daily users and lowest amongst daily e-cigarette users, however non-users and daily users were the only groups to significantly differ. Further, positive-negative functions discrepancy was lowest (more reasons to not use e-cigarettes) among non-users and highest (more reasons to use e-cigarettes) among daily users; each user group significantly differed from one another.

The perceived environment system contains two structures, the distal structure, and the proximal structure. Two of the distal structure constructs, parental control ($p < .001$) and friend control ($p < .001$) significantly differed across user statuses. Specifically, both friend and parent control were highest for non-users of e-cigarettes and lower for the user groups (non-daily and

daily). The other four distal structure constructs did not significantly differ across user groups (see Table 2). Within the proximal structure, all constructs significantly differed across e-cigarette user status. Male ($p = .001$) and female ($p = .006$) parent/guardian approval, friend modeling of e-cigarette use ($p < .001$), and friend approval of e-cigarette use/vaping ($p < .001$) varied across user status. Specifically, male and female parent/guardian approval of vaping was highest among daily users and lowest among non-users; scores on these constructs significantly differed between non-users and daily users. Additionally, friend approval of vaping was highest among non-users and lower among non-daily and daily users; non-users significantly differed from both user categories. Further, friend modeling of vaping was lowest for non-users and highest among daily e-cigarette users; all groups significantly differed on this construct.

The behavior system gauges engagement in problem and conventional behaviors. Examining the conventional behavior structure, the sample's academic performance (i.e., GPA) was above a B average on a 4.0 scale ($M = 3.23$, $SD = 0.64$). Academic performance did not significantly differ among e-cigarette user status ($p = .394$). Furthermore, the majority (72.7%) reported no church attendance in the past month. Binary church attendance significantly differed among e-cigarette user status ($p = .030$), such that non-users had greater church attendance than daily e-cigarette users. Some of the problem behavior structure constructs did produce significant differences. Marijuana involvement ($p < .001$), alcohol consumption behaviors (i.e., AUDIT, $p < .001$), and sexual behavior (i.e., virgin or non-virgin, $p < .001$) all significantly differed across user status such that non-users had lower reports of marijuana use and alcohol consumption and were more frequently virgins than the user groups (non-daily and daily). Nearly a third of the sample ($n = 156$, 32%) had never had sexual intercourse before (i.e., virgin). Although it did not

produce significant differences across user groups, 86% of students did not engage in activist protest in the past year.

Predictors of Non-use and E-cigarette Use

Figure 2 displays predictive factors of e-cigarette non-users and users (non-daily and daily collapsed together), addressing objective 1. This model contained all 487 study participants to distinguish e-cigarette non-users from users. The predictors highlighted in this tree include positive-negative functions discrepancy, sexual identity, parent control, marijuana involvement, alcohol consumption behaviors (i.e., AUDIT), self-esteem, deviant behaviors, and religiosity.

The primary node from which all branches start was positive-negative functions discrepancy (i.e., reported reasons for using and not using e-cigarettes). Scores on this construct ranged from -4 to 4; scores of -4 represent someone endorsing all four reasons to not use e-cigarettes and no reasons for using e-cigarettes, whereas scores of 4 represent someone endorsing all four reasons to use e-cigarettes and no reasons for not using e-cigarettes. Of the total 487 study participants, 366 (75.15%) reported a positive-negative functions discrepancy less than -1.4, which means they endorsed at least 1.4 more reasons to not use e-cigarettes than to use e-cigarettes. These 366 participants were then branched again using their positive-negative functions discrepancy scores, such that those reporting a score of less than -2.3 (endorsing 2.3 or more reasons to not use; $n = 310$, 63.66%) were categorized as e-cigarette non-users. The other 56 students who reported positive-negative functions discrepancy scores greater than or equal to -2.3, but less than -1.4 (reporting, at most, 2.3 more reasons to not use), were then branched by sexual identity. Most of the remaining 56 students identified as heterosexual/straight ($n = 35$, 7.19%) and were thus terminally categorized as non-users. Those identifying as a sexual minority (i.e., lesbian, bisexual, queer, asexual, pansexual, questioning, gay, and/or other) were

subsequently branched based upon parental control. Scores for parental control ranged from 5-20 with higher scores signifying higher parental control. Those reporting lower parental control (< 12; $n = 7$, 1.44%) were terminally categorized as non-users, whereas those who identified as a sexual minority and had higher parental control scores (≥ 12; $n = 14$, 2.87%) were terminally sorted as e-cigarette users.

From the primary node, 121 (24.85%) reported a positive-negative functions discrepancy score greater than or equal to -1.4, meaning that they reported, at most, 1.4 more reasons to not use e-cigarettes over reasons to use. These college students were branched based upon their involvement with marijuana. Scores on the scale ranged from 0 to 8, with higher scores representing a greater commitment to marijuana use. A minority of branched individuals reported very low marijuana involvement (< 2, $n = 16$, 3.29%) and were terminally categorized as an e-cigarette non-user. Those reporting higher marijuana involvement (≥ 2, $n = 105$, 21.56%) were then branched based on their alcohol consumption behaviors (i.e., AUDIT scores). AUDIT scores range from 0-40 with higher scores suggesting more hazardous drinking (i.e., 8+ = hazardous drinking; 13+ women or 15+ men = alcohol dependence). Those with very low drinking levels (AUDIT < 1.5; $n = 13$, 2.67%) were terminally sorted as e-cigarette non-users. In contrast, those who reported at least minimal levels of alcohol consumption/consequences (AUDIT ≥ 1.5, $n = 92$, 18.89%) were then branched based upon self-esteem levels (i.e., RSE scores). RSE scores ranged from 10-40 with higher scores marking higher levels of self-esteem. Those reporting lower levels (<27) of self-esteem ($n = 34$, 6.98%) were branched by sexual identity, such that sexual minority individuals with lower self-esteem were terminally categorized as e-cigarette users ($n = 13$, 2.67%). However, those identifying as heterosexual/straight with lower levels of self-esteem were branched by deviant behavior scores.

Deviant behavior composite scores ranged from 9-45 with higher scores meaning greater engagement in deviant activities (e.g., cheating, lying, etc.). Eleven (1.64%) reported low levels of deviancy (< 12) and were thus sorted as e-cigarette users. Those reporting higher levels of deviancy ($\geq$ 12; n = 13, 2.67%), although still relatively low-end scores, were terminally categorized as non-users.

Moving back up in the Figure 2 regression tree, 58 (11.91%) students reported having higher levels of self-esteem (RSE $\geq$ 27) and were thus branched based on their levels of religiosity. The scale for religiosity ranges from 4-16 with higher scores signifying greater levels of religiosity. Students with high self-esteem, but low levels of religiosity (< 12) were ultimately categorized as e-cigarette users (n = 35, 7.19%). Higher levels of religiosity ($\geq$ 12) were reported by 23 students (4.72%) who were finally separated by their alcohol consumption behaviors (i.e., AUDIT scores). Those with higher, but still relatively low, levels of drinking (AUDIT $\geq$ 6.5) were categorized as e-cigarette users (n = 12, 2.46%), whereas 11 (2.26%) individuals reporting AUDIT scores less than 6.5, but higher than 1.5, were categorized as non-users.

Overall, the model for predictors of e-cigarette non-user and user status suggests that endorsed reasons for using and not using e-cigarettes, sexual identity, and the use of other substances (i.e., cannabis and alcohol) are high-order predictors of e-cigarette use by category.

Predictors of Non-Daily Use and Daily Use

Predicting non-daily e-cigarette use and daily e-cigarette use is illustrated in Figure 3. This tree addressed the study's second objective. The sub-sample of e-cigarette users included 86 college students. There were three key predictors that were able to discern a non-daily user from a daily e-cigarette user: positive-negative functions discrepancy, parent control, and friend control. The primary node in this model remained the same as the first (see Figure 2). Positive-

negative functions discrepancy split e-cigarette users such that those reporting scores less than -0.19 (n = 34, 39.53%) were categorized as non-daily e-cigarette users. This means that those reporting greater than 0.19 more reasons for not using e-cigarettes than using e-cigarettes, were classified as a non-daily e-cigarette user. Conversely, those with positive-negative functions discrepancy scores of -0.19 or greater (n = 52, 60.47%) were then split by their reported level of parental control. Parental control scores ranged from 5-20, higher scores representing greater control from parents. Half (n = 26, 30.23%) reported parental control scores less than 13, and they were categorized as daily e-cigarette users. This suggests that college students who endorsed more reasons to use e-cigarettes than to not use e-cigarettes with low to moderate levels of parental control were daily e-cigarette users. The other half (n = 26, 30.23%) who reported higher parental control scores ($\geq$ 13) were further split on their reported friend control. Scores for the friend control construct ranged from 4-16 with higher scores marking more reported control from friends. When reporting higher friend control ($\geq$ 11), 19 (22.09%) college students were categorized as non-daily users, whereas reports of lower friend control (< 11) categorized students as daily users (n = 7, 8.14%).

Predictors of Non-use and Non-Daily Use

Although comparisons between the non-user and non-daily user categories was not an *a priori* objective of the current study, we were interested in discerning the non-user from someone who just uses e-cigarettes recreationally (i.e., non-daily user). The Figure 4 tree was built to differentiate between e-cigarette non-user (n = 401) and non-daily (n = 52) user status. The predictors that were selected to achieve this goal included positive-negative functions discrepancy, alcohol consumption behaviors (AUDIT), sexual identity, friend approval of problem behavior, and parent-friend compatibility.

Consistent with the first two trees, positive-negative functions discrepancy remained the primary node. In this tree, 310 (68.42%) college students reported a functions discrepancy score less than -2.3, categorizing them as non-users. This indicates that students who reported at least 2.3 more reasons to not use e-cigarettes than to use e-cigarettes were categorized as non-users. Those who reported positive-negative functions discrepancy scores greater than or equal to -2.3 were then branched by their drinking behaviors. When the levels of alcohol consumption behaviors were extremely low (AUDIT < 1.5), college students were classified as non-users (n = 33, 7.28%). When drinking levels were higher ($\geq$ 1.5), sexual identity defines the categorization. Sexual minority students (n = 30, 6.62%) branched to parent-friend compatibility. This construct was measured on a scale from 3-12 with higher scores marking greater congruence or compatibility between parent and friend beliefs on what is important in life, what kind of person one should become, and what someone should get out of school. Half of sexual minority students (n = 15, 3.31%) reported parent-friend compatibility scores greater than or equal to 7.5, categorizing them as non-daily e-cigarette users. The other half of sexual minority students who reported lower levels of parent friend compatibility (< 7.5) were sorted into the e-cigarette non-user category. The 110 (24.28%) students who identified as heterosexual/straight were subsequently split based upon their reported friend approval of vaping. Approval ratings ranged from 0 to 4 with higher scores showing less approval for vaping. Those who reported "*they approve*" when asked how their friends feel about someone their age vaping or using e-cigarette products (approval rating < 2) were terminally categorized as non-daily users (n = 18, 4.00%). The majority (n = 62, 13.69%) who reported low friend approval (i.e., they neither approve nor disapprove, they disapprove, or they strongly disapprove) for vaping (scores $\geq$ 2) underwent their final split based on their positive-negative functions discrepancy scores. College students

reporting 0.61 more reasons to use e-cigarettes than to not use e-cigarettes were categorized as non-daily users ($n = 13$, 2.87%). The other 49 (10.82%) students reporting positive-negative functions discrepancy scores less than 0.61 were categorized as non-users.

CHAPTER IV

DISCUSSION

The primary aims of the study were to examine eight person-characteristics and the twenty-nine outlined PBT factors in an attempt to categorize e-cigarette non-users from users as well as non-daily e-cigarette users from daily users. Three regression trees were built to analyze factors between e-cigarette user statuses.

The first recursive partitioning tree examined all factors to distinguish between e-cigarette non-users and e-cigarette users of any frequency. A total of eight factors split the entire sample into user or non-user status: positive-negative functions discrepancy, marijuana involvement, sexual identity, self-esteem, parent control, religiosity, deviant behavior, and alcohol consumption behaviors (AUDIT). Pathways to e-cigarette user status are complex and layer several factors on top of one another. However, based on the highest-order factors, college students within this sample were e-cigarette non-users if they generally reported more reasons to not use e-cigarettes than to use e-cigarettes, had low engagement in marijuana use, identified as heterosexual/straight, or had extremely low levels of alcohol consumption. E-cigarette users were characterized by the layering of several factors, some of which include reporting more reasons for using e-cigarettes than not using e-cigarettes, being a sexual minority individual, having low levels of religiosity, and greater alcohol consumption behaviors. The complete model is displayed in Figure 2.

The second tree examined all factors to distinguish between non-daily e-cigarette users and daily e-cigarette users. Only three factors emerged as necessary to distinguish between the e-cigarette user frequency levels: positive-negative functions discrepancy, parental control, and friend's control. College students reporting greater reasons to not use e-cigarettes were sorted as

non-daily users. On the other hand, those reporting more reasons to use e-cigarettes than not use e-cigarettes were subsequently split based upon the control of their parents or friends. Students with low parental control or with high parental control, but low friend control were categorized as daily users. High parent control and high friend control led to non-daily user status. The complete model is displayed in Figure 3.

The final tree examined all person-characteristics and PBT factors to distinguish non-users and non-daily users. In this tree, five factors split the sample: positive-negative functions discrepancy, alcohol consumption behaviors, sexual identity, friend approval of problem behavior, and parent-friend compatibility. The pathways to e-cigarette user status are complex and layer several factors on top of one another. However, the highest-order predictors show that reporting more reasons to not use e-cigarettes or having low alcohol consumption behaviors led to non-user status. Among the lower-order predictors are sexual minority status and high parent friend-compatibility or low friend approval of problem behavior, which led to non-daily user status. The complete model is displayed in Figure 4.

Overall, the regression trees built through recursive partitioning analysis established many constructs as important distinguishing factors, the most prominent of which included positive-negative functions discrepancy, alcohol consumption behaviors (i.e., AUDIT), and a variety of parent and friend related constructs across trees. Interestingly, sexual identity also emerged as a major split in the trees when comparing e-cigarette non-users to a user group (i.e., non-daily user and users of any frequency). This suggests that sexual minority students were disproportionately categorized into an e-cigarette user category as compared to their heterosexual/straight counterparts.

Although Problem Behavior Theory was developed in the 1970s, its general structure still has relevant applications today. To our knowledge, this is the first direct application of the full PBT model with e-cigarette use as the defined problem behavior. Seminal findings from PBT suggest the most significant correlations with problem behaviors (e.g., alcohol consumption, cannabis use, etc.) were with constructs in the motivation-instigation structure, personal control structure, proximal structure, and problem behavior structure (Jessor & Jessor, 1977). Findings from the current study highlighted positive-negative functions discrepancy (personal control construct), alcohol consumption behaviors (problem behavior structure), and parent/friend related constructs (distal and proximal structures) across the constructed trees.

Among PBT personality constructs, positive-negative functions discrepancy, the consistent primary node across trees, had low negative cut-off values (i.e., -1.4, -0.19, -2.3). These low values suggest it did not take many endorsed reasons to use e-cigarettes before students were separated into potential user groups. Self-esteem was another relevant personality system construct presented in the regression trees. Self-esteem only emerged when distinguishing non-users from users of any frequency. Self-esteem, in conjunction with other factors (e.g., religiosity, sexual identity, deviant behaviors and alcohol consumption behaviors) split college students between users and non-users as a mid-level predictor. This suggests that self-esteem may serve as a protective or risk factor for e-cigarette use, dependent upon other PBT constructs. Religiosity was a low-level split as seen in Figure 2. Generally, lower levels of religiosity led to potential e-cigarette user groups while higher levels of religiosity, in conjunction with lower alcohol consumption behaviors (AUDIT < 6.5), were a protective factor against engagement in e-cigarette use.

Out of the nine perceived environment factors considered, four were included as distinguishing factors across the regression tress: parent control, friend control, friend approval of vaping, and parent-friend compatibility. Parent and friend control factors across user categories (non-daily and daily) indicated that lower control from these sources was associated with greater frequency of e-cigarette use. However, parent control across non-users and users of any frequency revealed a pattern for sexual minority college students such that greater parent control was predictive of e-cigarette use. This suggests that parent factors may differentially impact college students based on their sexual minority status. In the examination of non-users and non-daily users, two environmental factors created splits among the sub-sample, friend approval of vaping and parent-friend compatibility. Friend approval of vaping, for students identifying as heterosexual/straight, was greater among non-daily users compared to non-users. This shows that greater approval of a problem behavior from those within an individual's social network was predictive of engagement in that problem behavior. College students with a sexual minority status were split by parent-friend compatibility on beliefs regarding what is important in life and what the future holds. Greater compatibility in beliefs led to the e-cigarette non-user category. Trends here suggest that friend approval alone is of greater importance to those who are not a sexual minority person, whereas those who are a sexual minority individual rely more on the congruence of beliefs from both their parent(s)/guardian(s) and friends to accurately distinguish e-cigarette user status. In an examination of social support networks for LGBT young adults, various sources of support (i.e., family, friends, community) were considered for their impact on positive life outcomes such as well-being and self-esteem (Snapp et al., 2015). Social support from all sources served as a protective factor for positive outcomes among LGBT young adults. However, when considering all other forms of support, family acceptance of one's sexual

minority identity remained a significant predictor of adjustment during young adulthood. Findings from this study suggest that additional support from familial sources is critical for sexual minority individuals.

Relating to the behavior system, substance use behaviors, specifically marijuana and alcohol also emerged as important factors. Alcohol cut-off values, when comparing non-users to both users (across frequencies) and non-daily users, were low (i.e., 1.5) when creating high-order splits in the regression trees. However, as a lower-level predictor, AUDIT cut-off scores were much higher (i.e., 6.5). Findings suggest that only minimal reports of alcohol consumption behaviors are necessary to separate students into potential user groups. However, when more factors are considered first, than a greater level of alcohol consumption behaviors better splits students into an e-cigarette user category. Marijuana involvement also led to more frequent splits into e-cigarette user categories. Taken together, alcohol and marijuana use behaviors suggest that involvement in substance use in the greater sense, makes the use of e-cigarettes more likely. Additionally, general deviant behavior was a final split between a subset of non-users and users. Minimal levels of reported engagement in deviant behaviors were sufficient to sort students as users and higher reported deviant behaviors were sorted as non-users. Although unexpected, this result may be explained by deviance regulation theory (DRT). DRT predicts that individuals strive to behave in ways that will create a positive self-image (Blanton & Christie, 2003). When comparing reasons to use e-cigarettes between adolescents and adults, adolescents tend to report using e-cigarettes because they are cool and portray a sense of trendiness, and adults typically report using e-cigarettes to quit the use of conventional cigarettes (Sapru et al., 2020). While other general deviant behaviors (e.g., lying, cheating, etc.) are not viewed the same way. With a college student sample, it is probable that e-cigarette use is seen as a utility to achieve a positive-

self-image or higher social status among peers. As such, e-cigarette users may engage in less generally deviant behaviors and more e-cigarette use to better serve their self-image (Katz et al., 2020). Overall, findings from each system support the extension of PBT to e-cigarette use.

Interestingly, sexual identity, a person-characteristic, emerged as a predictor for models comparing e-cigarette non-users to user categories. Specifically, sexual minority students were sorted into user categories with greater proportion than heterosexual/straight students in our sample. This is consistent with recent findings showing higher rates of e-cigarette use for bisexual individuals (Liautaud et al., 2021) and sexual minority individuals broadly (Hoffman et al., 2018). The existing literature provides possible explanations for the sexual identity disparity seen across e-cigarette use. Recently, in a sample of high school students, exposure to tobacco and e-cigarette advertisements significantly differed across sexual identity status (Azabga & Shan, 2022). Results found that sexual minority adolescents (i.e., "Lesbian or Gay", "Bisexual" or "Not Sure") reported seeing tobacco and e-cigarette advertisements with greater frequency than heterosexual adolescents. It is possible that tobacco companies are purposefully targeting media outlets related to sexual minority persons (e.g., LGBT organizations). Additionally, stressful life events and lesbian, gay, and bisexual discrimination mediated substance use disorder disparities across sexual minority identities (Krueger et al., 2020). Findings indicate that sexual minority subgroups have higher rates of substance use disorders; stressful life events and sexual identity-related discrimination appear to partially explain this connection (Krueger et al., 2020). Research should focus on identifying the mechanisms producing this e-cigarette use disparity to properly target sexual minority individuals through prevention and intervention methods.

Theoretical Implications

Early in its development, PBT was applied directly to a variety of problem behaviors. In more recent years, researchers have taken a conceptual approach to PBT. Studies have substituted the theory's constructs for one's deemed fitting within the three major systems (personality, perceived environment, and behavior). For example, Alexander et al. (2018) defined household violence as a perceived environment construct in examining adolescent drug use. Similarly, Chun et al. (2020) claimed to test PBT for e-cigarette, cigarette, and dual use among a sample of Korean adolescents. However, the model included variables such as stress, suicidal thoughts, feelings of hopelessness, and secondhand smoke exposure, which do not clearly map onto the designed systems of PBT. The current study was a direct application of PBT and as such, included the constructs outlined by Richard Jessor. In doing do, support was found for the examination of e-cigarette use as a problem behavior.

Formative PBT designs explored correlations between the systems' constructs and problem behaviors. This methodology of examination may have contributed to the broad significant correlations for nearly all PBT constructs in originating work with high school and college students (Jessor & Jessor, 1977). To move beyond simple bivariate relationships, the present study used a novel statistical approach, recursive portioning, to determine which factors are most prominent in differentiating between e-cigarette use status. As such, a smaller subset of factors was observed across the generated trees. Due to the plethora of constructs examined, conclusions about the importance of the identified factors in differentiating between e-cigarette user status is notable.

Practical Implications

Identifying factors that differentiate e-cigarette non-users, non-daily users, and daily users is informative for policy changes and prevention and intervention efforts. The uppermost nodes in the produced trees are suitable targets for these changes. High-ranking nodes include positive-negative functions discrepancy, sexual identity, other substance use (i.e., marijuana and alcohol), and control from parents and friends.

Intervention techniques should use methods that promote increasing reasons to not using e-cigarettes and decreasing reasons for using e-cigarettes. Specifically, motivational interviewing (MI), a client-centered therapeutic technique could achieve this by enhancing client's motivations to change behaviors (Hettema et al., 2005). Through this intervention technique, e-cigarette users may identify why and how they could alter their use of e-cigarettes. MI might include informing students about the health effects and other harms of e-cigarettes as well as altering the perception of e-cigarette use as "cool" and "attractive." Policies preventing advertisements that target vulnerable populations (e.g., sexual minority individuals) could aid in decreasing e-cigarette use rates. Furthermore, universities might provide additional support to sexual minority students to teach healthy coping mechanisms for stress and experienced sexual identity discrimination. Preliminary evidence suggests that a resilience and coping intervention (RCI) could be successful in fostering resiliency and hope while reducing stress and levels of depression in undergraduate students (Houston et al., 2017). However, a recent review found that very few interventions exist for reducing substance use for sex and gender minority youth specifically (Coulter et al., 2019). Initial interventions tailored to sexual minority youth emphasize skills-based training to achieve desirable outcomes (Craig et al., 2019; Schwinn et al., 2015). Last, intervention and prevention methods tailored toward polysubstance use may be

effective. Current attempts to target the cessation of multiple substances is limited, but disproves

fear that the cessation of one substance will lead to greater use of another due to compensation or

withdrawal effects (Hill et al., 2013). By targeting these factors, policy makers and field

professionals can potentially decrease e-cigarette use among college students, thus, improving

health behaviors and health outcomes in this emerging adult population.

Strengths, Limitations, and Future Research Directions

Despite the relatively low sample size of e-cigarette users, one strength of this study was

the large sample size. Compared to other recursive partitioning exploratory analyses, the present

study was well above the typical sample size. This allows for the collected sample to be more

representative of college students, our population of interest. Another strength was examining

results through recursive partitioning. This exploratory, multivariate analysis is commonly used

among many scientific fields such as medicine and biology. However, it is not commonly

adopted by the social sciences. Using this analytic approach allowed for conclusions on the rank-

order importance of person-characteristics and PBT factors categorizing college students' e-

cigarette user status. Findings from this analysis highlight the importance of many factors being

explored for their role in e-cigarette use.

Several limitations of the current study present exciting avenues for future research to be

conducted. To properly replicate PBT, several study constructs were single-item measures.

Single-item measures may not properly capture the construct and may be less sensitive and less

reliable. Future work should focus on the key discerning constructs from our analyses and apply

reliable and validated measures of the identified constructs. The present study was a between-

subjects design and examined how factors at one time point are associated with e-cigarette use.

Research questions at the person-level cannot be addressed with this design. Researchers could

examine e-cigarette use and daily factors (e.g., affect, stress, social interactions) within-persons, using an ecological momentary assessment design, which would allow participants to report on behaviors within a more precise timeframe to the actual behavior, minimizing recall bias. A within-persons design would allow researchers to address questions relating to causality of e-cigarette use as well as person-level factors that could be potential targets for intervention techniques. The present study used a convenience sample, which limits generalizability. Researchers should use probability sampling methods to strengthen conclusions and generalizability of results.

Conclusions

Findings from this study identified relevant person-characteristics and PBT factors that categorized college students as e-cigarette non-users, non-daily users, and daily users. The strongest identifying factors were positive-negative discrepancy, sexual identity, other substance use (marijuana and alcohol), and parent/friend-related constructs. This has implications for policy change as well as prevention and intervention methods to decrease e-cigarette use among college students. Continued examination of e-cigarette use among this vulnerable population is critical to promote healthy living.

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APPENDICIES

FIGURE 1

Model of PBT Factors in Current Study

Personality System

Motivational-Instigation Structure
Value on Academic Achievement
Value on Independence
Value on Affection
        Expectation for Academic Achievement
Expectation for Independence
Expectation for Affection
Personal Belief Structure
Alienation
Self-esteem
Internal-External Locus of Control
Personal Control Structure
Attitudinal Tolerance of Deviance
Religiosity
Positive-Negative Function Discrepancy

Perceived Environment System

Distal Structure
Parental Support
Parental Controls
Friend's Support
Friend's Controls
Parent-Friend Compatibility
Parent-Friend Influence
Proximal Structure
Parent Approval Problem Behavior
Friends Approval Problem Behavior
Friends Models Problem Behavior

Behavior System

Problem Behavior Structure
Marijuana Involvement
Sexual Activity
Activist Protest
Drinking and Problem Drinking
General Deviant Behavior
Conventional Behavior Structure
Church Attendance
Academic Performance

Problem Behavior

E-cigarette User Status
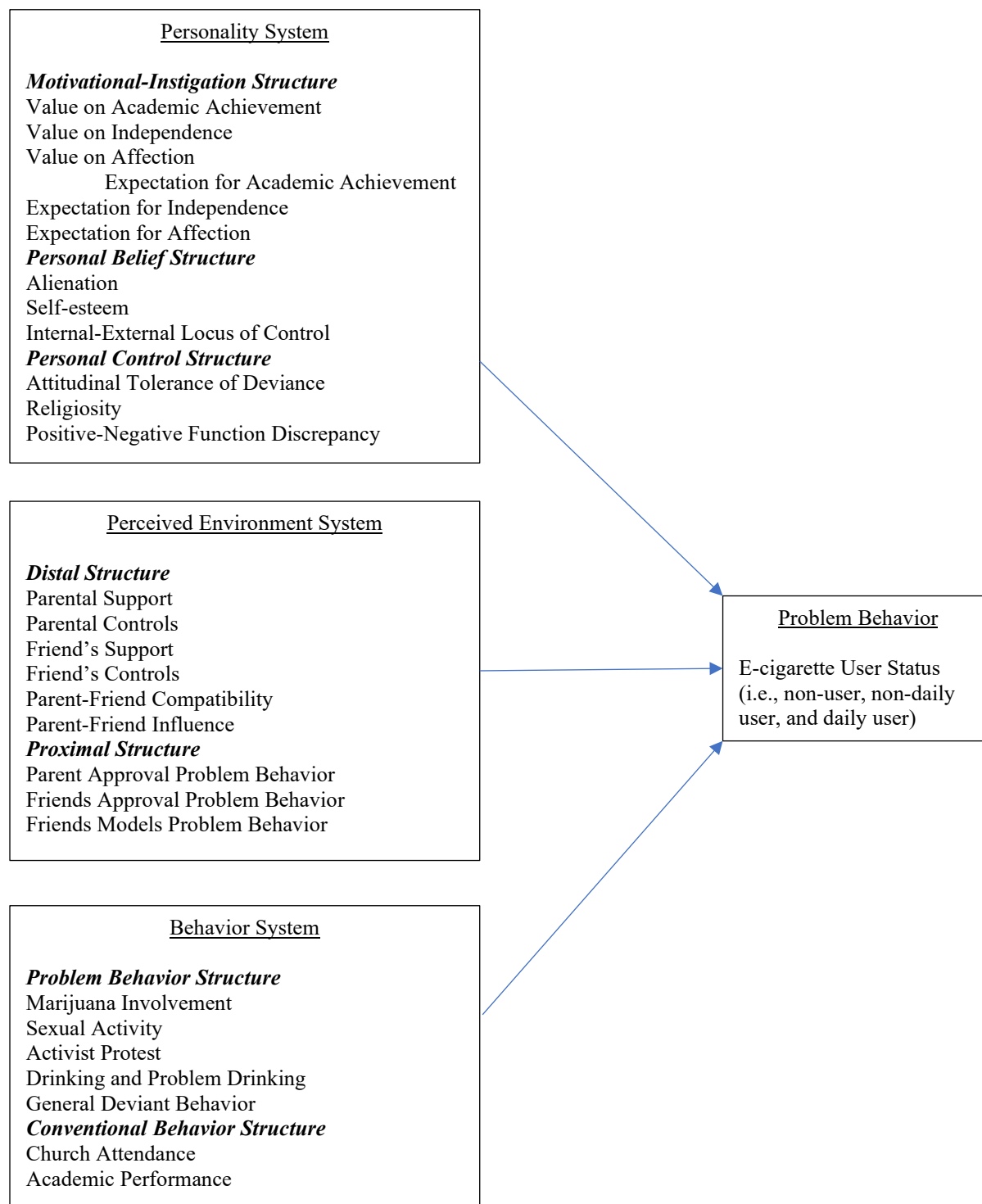(i.e., non-user, non-daily
user, and daily user)

FIGURE 2

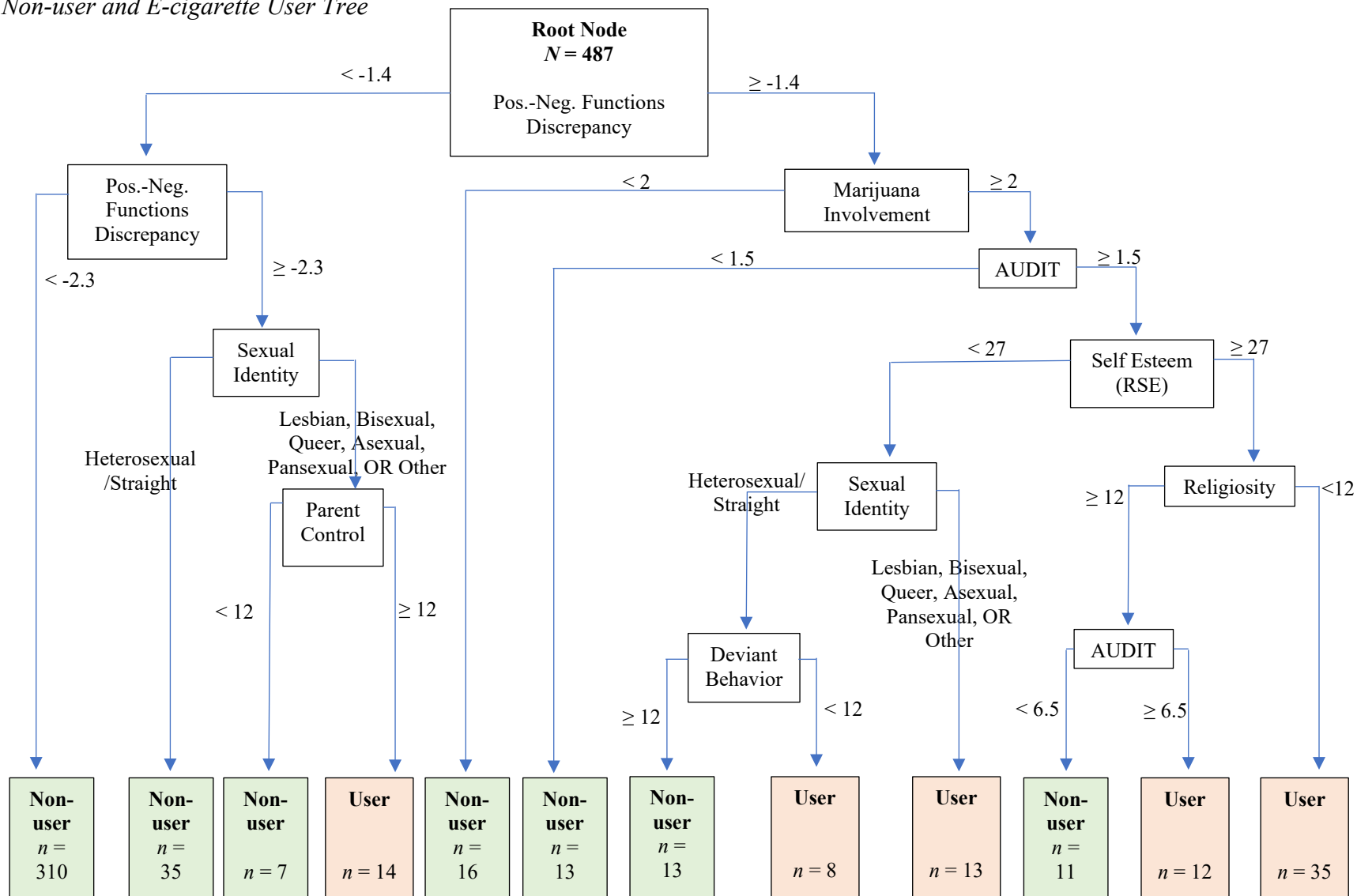*Non-user and E-cigarette User Tree*
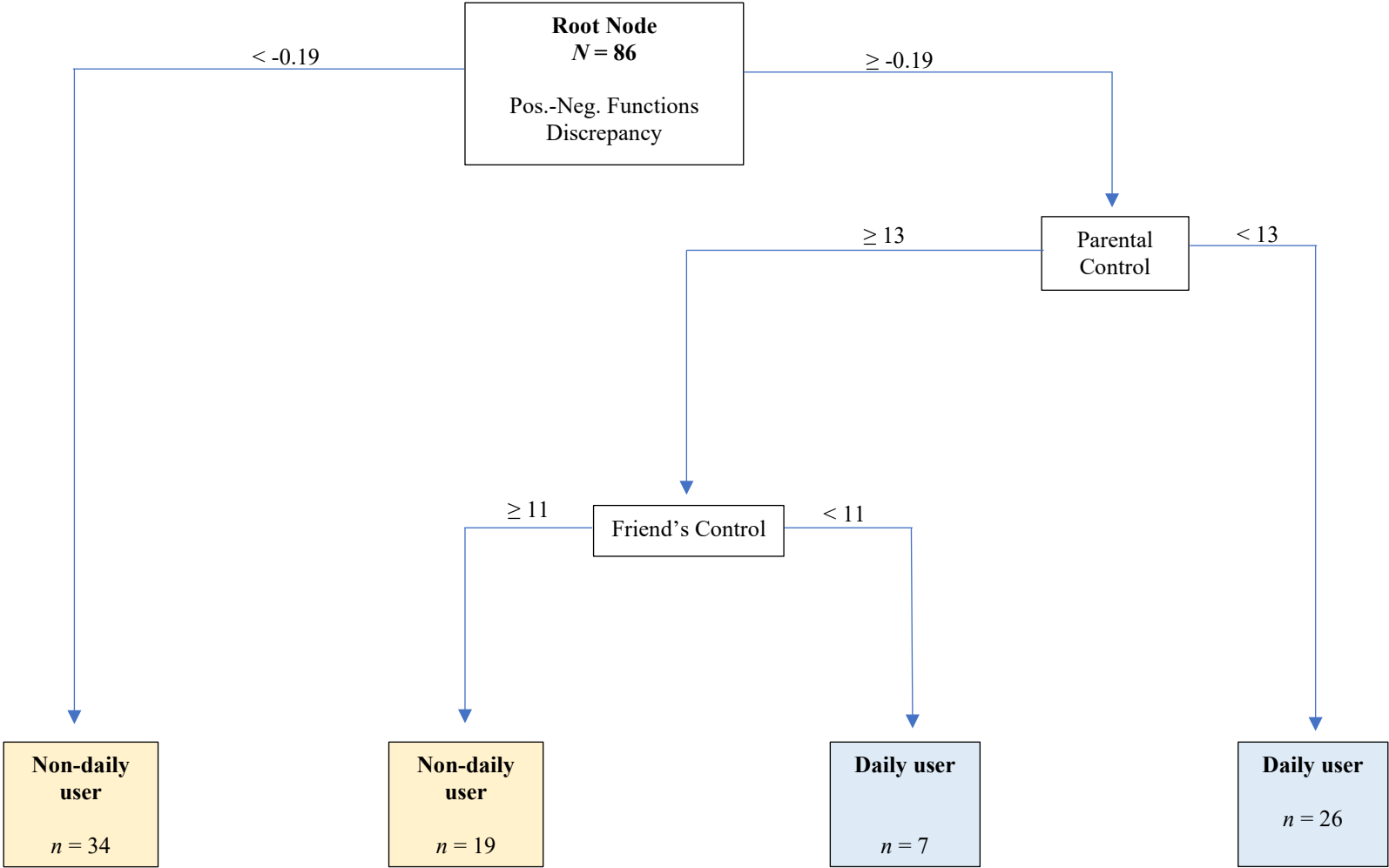
FIGURE 3

Non-daily User and Daily User Tree
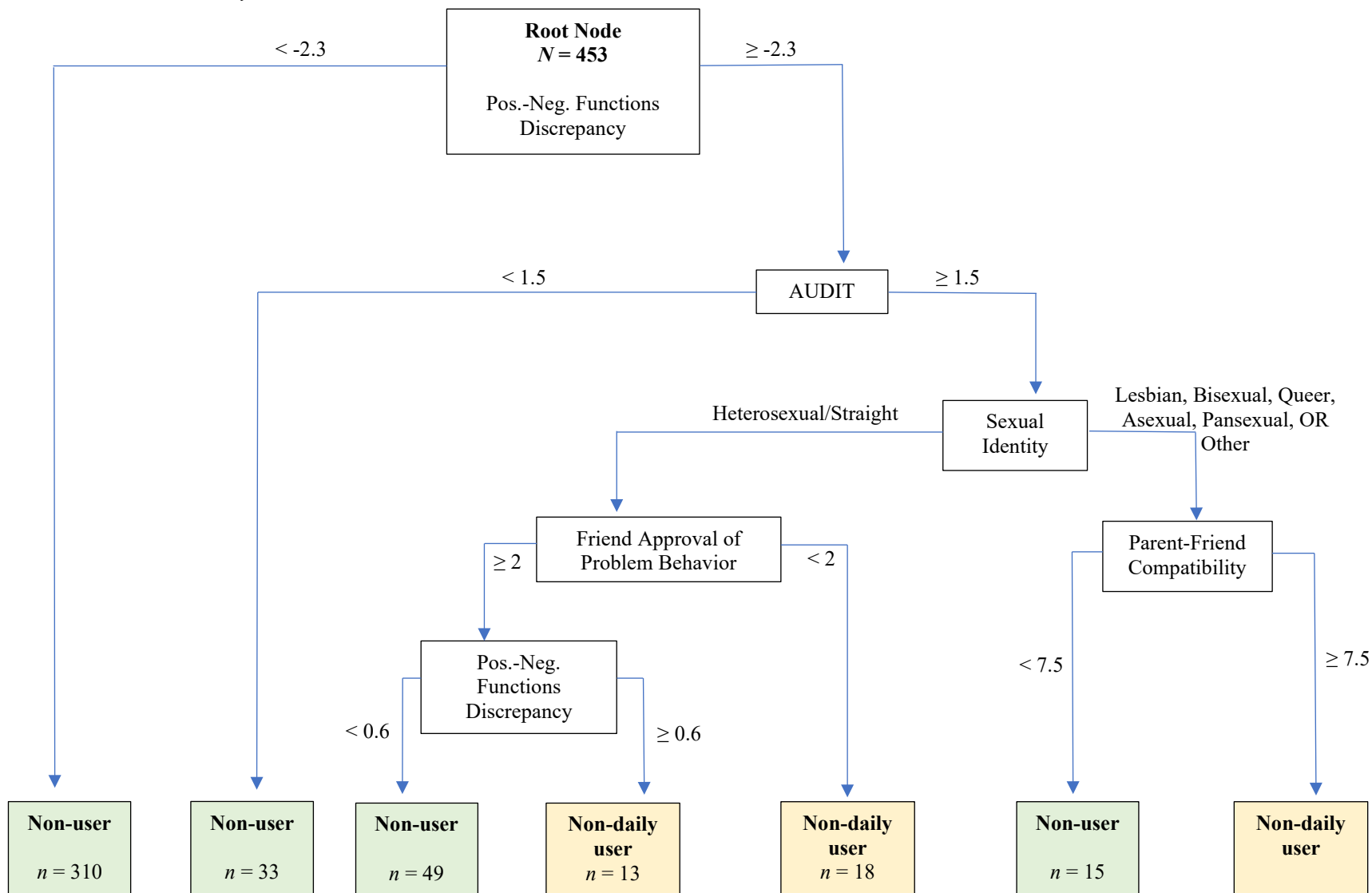
FIGURE 4

Non-user and Non-daily User Tree

TABLE 1

Participant Characteristics for the Full Sample, and Based on E-cigarette User Status

| | | E-cigarette User Status | | | | |
	Overall Sample N = 487	Non-user (n = 401, 82.3%)	Non-daily user (n = 52, 10.7%)	Daily user (n = 34, 7.0%)	ANOVA p-value	Homogenous Groups [a]
Age (M, SD)	20.72, 2.77	20.70, 2.89	20.56, 1.87	21.15, 2.35	.605	ABC
Sex (n, %)					.236	ABC
Male	118, 24.2%	106, 26.4%	6, 11.5%	6, 17.6%		
Female	362, 74.3%	289, 72.1%	45, 86.5%	28, 82.4%		
Other	1, 0.2%	1, 0.2%	0, 0.0%	0, 0.0%		
Gender (n, %)					.239	ABC
Woman	348, 71.5%	277, 69.1%	43, 82.7%	28, 82.4%		
Man	117, 24.0%	105, 26.2%	6, 11.5%	6, 17.6%		
Trans woman	0, 0.0%	0, 0.0%	0, 0.0%	0, 0.0%		
Trans man	0, 0.0%	0, 0.0%	0, 0.0%	0, 0.0%		
Gender queer/non-conforming	2, 0.4%	1, 0.2%	1, 1.9%	0, 0.0%		
Nonbinary	12, 2.5%	10, 2.5%	2, 3.8%	0, 0.0%		
Other	4, 0.8%	4, 1.0%	0, 0.0%	0, 0.0%		
Class Standing (n, %)					.323	ABC
Freshman	153, 31.4%	130, 32.4%	13, 25.0%	10, 29.4%		
Sophomore	108, 22.2%	90, 22.4%	13, 25.0%	5, 14.7%		
Junior	107, 22.0%	87, 21.7%	11, 21.2%	9, 26.5%		
Senior	113, 23.2%	91, 22.7%	13, 25.0%	9, 26.5%		
Graduate	6, 1.2%	3, 0.7%	2, 3.8%	1, 2.9%		
Race (n, %)					.003	A, BC
American Indian or Alaska Native	2, 0.4%	1, 0.2%	1, 1.9%	0, 0.0%		
Asian	33, 6.8%	28, 7.0%	2, 3.8%	3, 8.8%		

Table 1 Continued

	Overall Sample N = 487	E-cigarette User Status			ANOVA p-value	Homogenous Groups [a]
		Non-user (n = 401, 82.3%)	Non-daily user (n = 52, 10.7%)	Daily user (n = 34, 7.0%)		
Black or African American	172, 35.3%	160, 39.9%	10, 19.2%	2, 5.9%		
Native Hawaiian or Pacific Islander	4, 0.8%	4, 1.0%	0, 0.0%	0, 0.0%		
White	215, 44.1%	155, 38.7%	33, 63.5%	27, 79.4%		
Other	59, 12.1%	51, 12.7%	6, 11.5%	2, 5.9%		
Relationship Status (n, %)					.071	ABC
Single (not dating)	236, 48.5%	203, 50.6%	23, 44.2%	10, 29.4%		
Dating one partner	179, 36.8%	145, 36.2%	16, 30.8%	18, 52.9%		
Dating several partners	6, 1.2%	4, 1.0%	2, 3.8%	0, 0.0%		
In a monogamous relationship	39, 8.0%	27, 6.7%	8, 15.4%	4, 11.8%		
Engaged to be married or married	25, 5.1%	20, 5.0%	3, 5.8%	2, 5.9%		
Sexual Identity (n, %)					.066	ABC
Heterosexual or straight	352, 72.3%	302, 75.3%	28, 53.8%	22, 64.7%		
Lesbian	10, 2.1%	8, 2.0%	1, 1.9%	1, 2.9%		
Bisexual	57, 11.7%	36, 9.0%	12, 23.1%	9, 26.5%		
Queer	5, 1.0%	3, 0.7%	1, 1.9%	1, 2.9%		
Asexual	2, 0.4%	2, 0.5%	0, 0.0%	0, 0.0%		
Pansexual	10, 2.1%	8, 2.0%	1, 1.9%	1, 2.9%		
Questioning	6, 1,2%	4, 1.0%	2, 3.8%	0, 0.0%		
Gay	7, 1.4%	6, 1.5%	1, 1.9%	0, 0.0%		
Other	30, 6.2%	24, 6.0%	6, 11.5%	0, 0.0%		
Ethnicity (n, %)					.771	ABC
Not Hispanic, Latino or Spanish origin	423, 86.9%	349, 87.0%	45, 86.5%	29, 85.3%		

Table 1 Continued

	Overall Sample N = 487	E-cigarette User Status			ANOVA p-value	Homogenous Groups [a]
		Non-user (n = 401, 82.3%)	Non-daily user (n = 52, 10.7%)	Daily user (n = 34, 7.0%)		
Mexican or Mexican American	15, 3.1%	10, 2.5%	2, 3.8%	3, 8.8%		
Cuban	4, 0.8%	4, 1.0%	0, 0.0%	0, 0.0%		
Puerto Rican	13, 2.7%	10, 2.5%	2, 3.8%	1, 2.9%		
Other	31, 6.4%	28, 7.0%	2, 3.8%	1, 2.9%		

Note. Non-user = "never" or "more than 30 days ago" use of e-cigarettes, non-daily user = past 30-day e-cigarette use with frequency ranging from "2 to 3 days a month" to "5 to 6 days a week," and daily user = past 30-day e-cigarette use with an "every day" frequency.

[a] The letters A, B, and C correspond to e-cigarette user statuses non-user, non-daily user, and daily user, respectively. Significant differences between groups were examined using Tukey's HSD post-hoc test. To illustrate these results, the homogenous groups column lists the homogenous subsets across e-cigarette user categories. For example, if AB, BC is listed, there was a detected significant difference between A (non-user) and C (daily user).

TABLE 2

PBT Measures for the Full Sample, and Based on E-cigarette User Status

| | Overall Sample N = 487 | E-cigarette User Status | | | Cronbach's alpha | ANOVA p-value | Homogenous Groups [a] |
		Non-user (n = 401, 82.3%)	Non-daily user (n =52, 10.7%)	Daily user (n =34, 7.0%)			
Value on Academic Achievement (M, SD)	13.78 (2.22)	13.77 (2.22)	13.80 (2.17)	13.88 (2.32)	.75	.957	ABC
Value on Independence (M, SD)	4.73 (1.14)	4.70 (1.16)	4.98 (0.87)	4.74 (1.21)	.56	.250	ABC
Value on Affection (M, SD)	4.94 (1.27)	4.89 (1.29)	5.19 (1.16)	5.15 (1.21)	.82	.168	ABC
Expectation for Academic Achievement (M, SD)	11.69 (2.92)	11.62 (2.94)	12.15 (2.72)	11.74 (2.95)	.87	.465	ABC
Expectation for Independence (M, SD)	6.08 (1.84)	6.06 (1.88)	6.29 (1.39)	5.94 (1.95)	.71	.635	ABC
Expectation for Affection (M, SD)	6.19 (1.86)	6.17 (1.90)	6.42 (1.46)	6.09 (1.98)	.70	.620	ABC
Alienation (M, SD)	9.30 (2.74)	9.19 (2.76)	9.74 (2.42)	9.83 (2.84)	.78	.202	ABC
Rosenberg Self-esteem (M, SD)	28.70 (5.76)	28.76 (5.90)	28.09 (5.18)	28.95 (4.90)	.89	.711	ABC
Internal Locus of Control (M, SD)	10.66 (1.89)	10.65 (1.91)	10.82 (1.70)	10.55 (2.02)	.48	.775	ABC
External Locus of Control (M, SD)	8.65 (2.15)	8.67 (2.16)	8.63 (2.03)	8.35 (2.23)	.55	.706	ABC
Attitudinal Tolerance of Deviance (M, SD)	23.00 (3.85)	23.17 (3.85)	22.21 (3.65)	22.20 (4.01)	.80	.107	ABC
Religiosity (M, SD)	10.61 (4.41)	10.93 (4.39)	9.77 (3.92)	8.13 (4.55)	.96	< .001	AB, BC
Positive Functions (M, SD)	0.38 (0.75)	0.19 (0.57)	1.44 (0.87)	1.03 (0.76)	.56	< .001	A, B, C

Table 2 Continued

	Overall Sample $N = 487$	E-cigarette User Status			Cronbach's alpha	ANOVA p-value	Homogenous Groups [a]
		Non-user ($n = 401$, 82.3%)	Non-daily user ($n = 52$, 10.7%)	Daily user ($n = 34$, 7.0%)			
Negative Functions (M, SD)	2.90 (1.42)	3.22 (1.18)	1.98 (1.51)	0.53 (1.16)	.84	< .001	A, B, C
Positive-Negative Functions Discrepancy (M, SD)	-2.52 (1.83)	-3.03 (1.46)	-0.54 (1.58)	0.50 (1.08)		< .001	A, B, C
Parental Support (M, SD)	8.55 (2.75)	8.60 (2.72)	8.13 (2.78)	8.68 (3.00)	.89	.503	ABC
Parental Control (M, SD)	14.67 (4.28)	15.00 (4.20)	13.88 (4.38)	11.97 (4.17)	.86	< .001	AB, BC
Friend Support (M, SD)	5.02 (1.09)	5.03 (1.08)	4.98 (1.14)	5.03 (1.11)	.83	.958	ABC
Friend Control (M, SD)	13.02 (2.42)	13.19 (2.36)	12.87 (2.27)	11.38 (2.70)	.82	< .001	AB, C
Parent-Friend Compatibility (M, SD)	8.28 (2.25)	8.32 (2.23)	8.25 (2.16)	7.91 (2.67)	.83	.601	ABC
Parent-Friend Influence (M, SD)	7.10 (2.31)	7.07 (2.30)	7.27 (2.19)	7.33 (2.58)	.79	.700	ABC
Parent Approval of Vaping							
Male Approval (M, SD)	5.05 (2.85) $n = 379$	4.85 (2.75) $n = 311$	5.33 (2.89) $n = 42$	6.92 (1.90) $n = 26$	-	.001	AB, BC
Female Approval (M, SD)	4.86 (2.72) $n = 438$	4.67 (2.66) $n = 357$	5.41 (2.90) $n = 51$	6.10 (2.66) $n = 30$	-	.006	AB, BC
Friend Approval of Vaping (M, SD)	2.25 (0.90)	2.38 (0.90)	1.67 (0.55)	1.56 (0.71)	-	< .001	A, BC
Friend Modeling Vaping (M, SD)	2.02 (0.82)	1.90 (0.76)	2.44 (0.73)	2.91 (0.83)	-	< .001	A, B, C
Marijuana Involvement (M, SD)	3.37 (3.08)	2.80 (2.95)	5.98 (2.22)	6.21 (1.90)	.86	< .001	A, BC
Sexual Activity					-	< .001	A, BC

Table 2 Continued

		E-cigarette User Status					
	Overall Sample $N = 487$	Non-user ($n = 401$, 82.3%)	Non-daily user ($n = 52$, 10.7%)	Daily user ($n = 34$, 7.0%)	Cronbach's alpha	ANOVA p-value	Homogenous Groups [a]
Virgin (n, %)	156 (32.0%)	149 (37.2%)	6 (11.5%)	1 (2.9%)			
Non-virgin (n, %)	331 (68.0%)	252 (62.8%)	46 (88.5%)	33 (97.1%)			
Activist Protest					-	.358	ABC
Activist	68 (14.0%)	56 (14.0%)	5 (9.6%)	7 (20.6%)			
Non-activist	419 (86.0%)	345 (86.0%)	47 (90.4%)	27 (79.4%)			
AUDIT (M, SD)	4.47 (4.97)	3.63 (4.41)	8.06 (5.13)	8.82 (6.18)	.88	< .001	A, BC
Deviant Behavior (M, SD)	12.19 (3.97)	12.01 (3.86)	13.31 (4.51)	12.50 (4.16)	.74	.077	ABC
Church Attendance					-	.030	AB, BC
None (n, %)	354 (72.7%)	282 (70.3%)	42 (80.8%)	30 (88.2%)			
1-8+ times (n, %)	133 (27.3%)	119 (29.7%)	10 (19.2%)	4 (11.8%)			
Academic Performance/GPA (M, SD)	3.23 (0.64)	3.22 (0.65)	3.26 (0.64)	3.37 (0.50)	-	.394	ABC

Note. Non-user = "never" or "more than 30 days ago" use of e-cigarettes, non-daily user = past 30-day e-cigarette use with frequency

ranging from "2 to 3 days a month" to "5 to 6 days a week," and daily user = past 30-day e-cigarette use with an "every day"

frequency.

[a] The letters A, B, and C correspond to e-cigarette user statuses non-user, non-daily user, and daily user, respectively. Significant

differences between groups were examined using Tukey's HSD post-hoc test. To illustrate these results, the homogenous groups

column lists the homogenous subsets across e-cigarette user categories. For example, if AB, BC is listed, there was a detected

significant difference between A (non-user) and C (daily user).

VITA

Samantha A. Fitzer

Department of Psychology   Phone: 763-447-8278

250 Mills Godwin Life Sciences Building   Email: sfitz011@odu.edu

Norfolk, VA 23529

EDUCATION

Anticipated 2022	**M.S.** Psychology Old Dominion University, Norfolk, VA
	Thesis Title: Psychosocial Factors and E-cigarette Use: An
	Application of Problem Behavior Theory
	Chair of Thesis Committee: James M. Henson, Ph.D.
2020	**B.S.** Psychology, North Dakota State University; Fargo, ND

TEACHING EXPERIENCE

Fall 2020 – Spring 2022	**Graduate Teaching Assistant**
	Courses: Lifespan Development, Drugs and Behavior, Health Psychology, Psychology of Adolescence, Psychology of Adulthood and Aging, Quantitative Methods, Old Dominion University

RESEARCH EXPERIENCE

Fall 2022 – Spring 2023	**Graduate Research Assistant**; Supervisor: Dr. Sarah Ehlke
	Lab: SGM Health Behaviors Lab, Old Dominion University
2020 – Present	**Lab Manager**; Supervisor: Dr. James M. Henson
	Lab: Health Behaviors Research Lab, Old Dominion University
2018- 2020	**Undergraduate Research Assistant**; Dr. Leah Irish
	Lab: Sleep Lab; North Dakota State University

POSTER PRESENTATIONS

Ehlke, S. J., **Fitzer, S. A.**, Ganz, O., & Cohn, A. M. (2023). Differences on desire to quit smoking based on menthol preference and race among bisexual women. Poster submitted to the Collaborative Perspectives on Addiction (CPA) Meeting, Albuquerque, New Mexico.

Irish, L.A., Engwall, A., **Fitzer, S.A.**, Brown, M. (2019). Behavioral sleep restriction in a community sample. Poster presented at the Red River Psychology Conference in Fargo, ND.