Alcohol, Sleep and Five-Factor Personality Characteristics: A Latent Profile Analysis

by

Raina Hafftka

A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements
for the Degree of
Doctor of Philosophy in Counseling Psychology

Auburn, Alabama
May 2, 2020

Keywords: Sleep, Alcohol, Personality, Big Five, Latent Profile Alalysis

Approved by

Marilyn Cornish, Chair, Associate Professor of Counseling Psychology
Christopher Correia, Professor of Psychology
Evelyn Hunter, Assistant Professor of Counseling Psychology
Ben Hinnant, Associate Professor of Human Development and Family Studies

Abstract

To date, a substantial body of research has demonstrated that undergraduate students are often found to experience poor sleep quality, as well as frequently high levels of alcohol usage. Furthermore these two concerns are frequently found to be significantly correlated. Additionally, past research has illustrated how certain Big Five personality domains relate to patterns of high alcohol consumption and low sleep quality, as well as which personality domains relate to low alcohol consumption and high sleep quality. The present study (N = 305) extended previous research by combining these three constructs—sleep, alcohol, and personality—using latent profile analysis. It was hypothesized that a 4-class solution would be found, that higher alcohol consumption would correlate with sleep disturbance, and that certain personality traits would be predictive of class membership. These hypotheses were partially supported by the results. A 4-class model was found to be the best-fitting solution, which appeared to be differentiated by levels of alcohol consumption. All classes were found to experience sleep disturbance independent of alcohol use, and possible reasons for this outcome are discussed. Additionally, a number of personality types were found to be predictive of alcohol class assignment in ways that were primarily aligned with previous research findings. Implications for clinical practice with college students, as well as future study directions are discussed.

Acknowledgements

First I want to thank the two professors who have served as my committee chairs throughout this project. Dr. Joseph Buckhalt for his guidance and assistance in starting this endeavor, as well as Dr. Marilyn Cornish for her significant support in finishing it. I also want to thank the rest of my committee, including Dr. Chris Correia, Dr. Ben Hinnant, Dr. Evelyn Hunter and the University Reader Dr. Dan Svyantek for their constructive feedback and assistance throughout this project. I want to thank the participants in this study who, quite literally, made completing this study possible. Additionally, I feel fortunate to be able thank my family and friends, particularly my program peers, who have supported and helped me through my doctoral training in innumerable ways. Finally, my greatest appreciation and gratitude goes out to my husband Dr. Kevin Feiszli, who from day one has shown me unconditional support in countless ways.

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I. Introduction

College students are a unique population with their own distinctive propensities and concerns. Two concerns, which research has consistently highlighted to be particularly prevalent in this population, are problematic alcohol use and sleep-related issues (Buboltz, et al., 2009; Haas, et al., 2015). Each of these areas can potentially bring their own, and at times overlapping, implications and consequences, such as academic problems, compromised driving, and health concerns (Gaultney, 2010; McBride, Barrett, Moore, & Schonfeld, 2014; Wechsler, et al., 2002). Moreover, a strong literature base has demonstrated ways in which at times these concerns do not exist independently or in isolation. Both alcohol use and sleep quality have consistently been found to be correlated with each other (Fucito, et al., 2015; Roehrs & Roth, 2001a), and some research suggests that the two concerns may act cumulatively to cause heightened problems together more than either creates independently (Kenney, LaBrie, Hummer, & Pham, 2012). Understanding these potential interrelations between these two concerns are important for possible treatment implications. For instance, the potential exists to increase treatment parsimony by addressing these concerns simultaneously or in conjunction, rather than as two distinct presenting issues.

Individual differences in personality are often investigated as sources of vulnerability to risk of psychological and behavioral problems. Studies have found that certain personality traits tend to correlate with specific levels of both alcohol use (Lemos-Giráldez & Fidalgo-Aliste, 1997; Livingston, Oost, Heck, & Cochran, 2015) and sleep quality (Calkins, Hearon, Capozzoli, & Otto, 2013; Duggan, Friedman, McDevitt, & Mednick, 2014). Thus far, research linking personality and alcohol, and research linking personality and sleep, have remained primarily separate. Nonetheless, there are notable findings from each of these areas that may have

important implications for understanding the relations among the three areas. Similar personality domains are associated both with the positive sides of sleep and alcohol use (high sleep quality and non-problematic levels of alcohol use), as well as the more negative sides of these areas (sleep disturbance and problematic alcohol use). Further research is needed to clarify the nature of these relations and their underlying mechanisms.

One methodology that has thus far been rarely utilized to examine these variables together, but which shows significant potential for doing so, is latent profile analysis (LPA). This methodology has the potential to discover latent (existing but unobserved) classes within a larger group and elucidate how such classes may differentially correspond to other variables and conditions. Some research has already used this methodology to show distinct classes within the area of sleep concerns as well as highlight separate ways that these classes have corresponded to alcohol use patterns (DeMartini & Fucito, 2014). To date however, this paradigm has not been done in reverse by investigating the possibility of mean differences in sleep based on latent groups. Further, no such study using LPA has included measures of personality. The purpose of this study was to utilize a novel combination of associated constructs (i.e., sleep, alcohol use, and personality) to investigate the existence of latent groups and the relationship between group membership and related behaviors. To this end it was hypothesized that an LPA would find a four-class solution, representing two lower and two higher alcohol consumption patterns, in which one class of each has low rates of alcohol-related consequences, and the other has high rates of such consequences. Furthermore, it was expected that higher alcohol use would correlate with sleep disturbance and that scores on the Big Five personality domains would be significantly predictive of class assignment, in predictable patterns based on background

research. The date the present study is the first to determine how LPA classes based on alcohol use relate to personality and to sleep.

II. Literature Review

Undergraduates and Sleep Quality

To date, a large body of research has demonstrated that undergraduate college students often have poor sleep quality, including insufficient quantity of sleep, irregular sleep schedules, excessive daytime sleepiness, and poor self-reported perceptions of sleep quality (Carter, Chopak-Foss & Punungwe, 2016; Lund, Reider, Whiting, & Prichard, 2010). Moreover, low numbers of college students actually report high sleep quality. One sample found that only 11.5% of undergraduates said they had good sleep quality (Buboltz, et al., 2009) and another study found that only 8% of their sample self-reported their sleep quality to be "very good" (Carter, et al., 2016). Additionally, undergraduate students have reported only feeling rested an average of just under three days out of seven (Oswalt & Wyatt, 2015). Relating to this finding, while some experts suggest college students need 8.5-9.5 hours of sleep per night for optimal functioning (National Sleep Foundation, 2014), in one sample only 29.4% of college students indicated attaining eight or more hours of sleep per night (Lund, et al., 2010).

Undergraduate students have also been noted to show highly irregular sleep patterns compared to other populations, including shorter periods of overall sleep duration throughout the week followed by longer sleep duration on weekends (Machado, Varella, & Andrade, 1998). This pattern often is characterized by delayed bed times and wake up times on weekends. Among a sample of undergraduate students, 35% were found to stay awake until 3 a.m. at least once per week, and 20% reported that they stayed awake the entire night on at least one occasion during the past month (Lund, et al., 2010). Such irregularity and variability in sleep schedules can result in dysregulation of the circadian rhythm, putting college students at increased risk for showing signs of various circadian rhythm sleep-wake disorders (Kloss, Nash, Horsey, & Taylor,

2011). These types of disorders result from a persistent pattern of inconsistency between the natural circadian rhythm and an individual's sleep-wake schedule due to their social, professional or physical environment (American Psychiatric Association, 2013). This pattern can commonly lead to issues of excessive daytime sleepiness, insomnia, and other sleep related impairment.

Concerns in the realm of sleep irregularity are increasingly becoming recognized as equally problematic and detrimental as issues of insufficient sleep duration. This is particularly the case since an increasing amount of research has suggested that poor sleep hygiene can at times be equally harmful to overall sleep quality as insufficient hours of sleep (Bassett, Lupis, Gianferante, Rohleder, & Wolf, 2015; Pilcher, Ginter, & Sadowsky, 1997). In order to compensate for less and more irregular sleep it has been reported that college students show increased napping (Ye, Hutton Johnson, Keane, Manasia, & Gregas, 2015). To this point, 43% of college students report having taken a nap at least one time per week (Ye, et al. 2015). Furthermore, those students reporting more frequent and longer napping behaviors also tended to report less sleep during weeknights and more sleep on the weekends (Ye, et al. 2015).

Undergraduates and Alcohol Use

Similar to high rates of sleep-related problems, undergraduates have also been found to show heightened rates of other problematic behaviors, one of which is alcohol consumption. Alcohol is considered to be the most frequently used substance on college campuses in the United States (Haas, et al., 2015), where national surveys find that close to half of all students report engaging in one or more instances of binge drinking within the previous month (consuming five or more drinks at one time for a male or four or more drinks for a female; Substance Abuse and Mental Health Services Administration, 2006). College campuses also see

elevated rates of alcohol use disorders, with one national survey finding that alcohol use disorder was the most common psychiatric disorder represented in their sample of college students, making up 20.37% of the disorders studied (Blanco, et al., 2008). Furthermore, these patterns do not appear to be merely age related phenomena. Among adults ages 18-22, those who are enrolled full-time in college have been found to be more likely to use alcohol and to binge drink when compared to similarly aged non-college-enrolled counterparts (Substance Abuse and Mental Health Services Administration, 2010). The high rate of college drinking is particularly concerning since college drinking has been associated with many other negative consequences, including, but not limited to, alcohol poisoning, driving while intoxicated, sexual assault and other injury, blackouts and academic problems (McBride, et al., 2014; Wechsler, et al., 2002).

Alcohol Consumption and Sleep Quality

Beyond considering these issues separately, recent findings have highlighted significant associations and interactions between alcohol consumption and sleep patterns in young adults. Individuals who report less sleep tend to show higher levels of alcohol consumption than those reporting more sleep (Fucito, et al., 2015; Roehrs & Roth, 2001a). Specifically in college students, higher alcohol use has been correlated with shorter sleep duration, less sleep-wake regularity, oversleeping on weekends, and sleep-related impairment (DeMartini & Fucito, 2014; Singleton & Wolfson, 2009). Students who drank more additionally had less nighttime sleep and had overall later sleep schedules (Singleton & Wolfson, 2009). Furthermore, at moderate and higher levels of consumption, such as those often seen in college students, alcohol can decrease rapid eye movement (REM) sleep and REM sleep onset (Ebrahim, Shapiro, Williams, & Fenwick, 2013). This association is important because REM sleep is understood to serve important functions relating to working memory and memory consolidation (Lau, Wong, Lau,

Hui, & Tseng, 2015). Alcohol at low doses has not been shown to have a definitive impact on REM sleep in either direction (Ebrahim, et al., 2013).

Other research has highlighted ways in which lower sleep quality may promote or exacerbate alcohol use. One way this happens is when alcohol is used as a means to induce sleep. But while alcohol can induce sleep onset, it is also associated with poorer quality sleep, namely sleep fragmentation – repeated awakenings during the night (Ebrahim et al., 2013). As many as half of individuals diagnosed with alcohol use disorder and close to a quarter of individuals diagnosed with insomnia report having previously used alcohol to aid sleep (Brower, 2003; Johnson, Roehrs, Roth, & Breslau, 1998). This phenomenon is also seen in college students, as greater sleep disturbance is found to predict both higher and more frequent alcohol consumption and the use of drinking to induce sleep (Kenney, et al., 2012; Lund et al., 2010). Looking at disordered sleep has also shown potential for use in predicting which individuals who are recovering from problematic alcohol use are at greatest risk for relapse (Roehrs & Roth, 2001b). Because of these relations, sleep difficulties can be considered to be a risk factor for developing an alcohol use disorder (Brower, 2003). Starting in childhood, sleep disturbance predicts the continuation of sleep disturbances in young adulthood, which then predicts the presence of alcohol-related issues (Wong, Brower, Nigg, & Zucker, 2010). Specifically, overtiredness in youth has been shown to predict later binge drinking, driving while intoxicated, and blackouts in early adulthood (Wong, et al., 2010).

Of particular importance is the idea that alcohol use problems and sleep-related concerns may act cumulatively, such that their combined presence contributes to greater consequences than either issue would independently (DeMartini & Fucito, 2014). An example is the finding that among heavy drinking college students, those who also report higher amounts of sleep

disturbance tend to experience greater numbers of alcohol-related negative consequences (e.g.,. passing out, academic issues, neglecting responsibilities, etc.), when compared to those who are also heavy drinkers but who report good sleep quality (Kenney, et al., 2012). For these reasons, it is important to understand the ways in which sleep-related issues and alcohol-related issues may exert effects both upon each other, as well as in combination with each other. In addition to these constructs, another important area that research has found to correlate with both sleep quality and alcohol use is the study of personality.

The Big Five Model of Personality

The study of personality psychology frequently focuses on aspects of human diversity that are arranged within the individual (Baumeister & Finkel, 2010). In doing this, the idea of traits becomes highly important and can be thought of as specific dimensions of variability (Baumeister & Finkel, 2010). These traits, and specifically an individual's unique makeup of traits, can be observed in a person's individual thought, behavior, and emotional patterns. In the more macro study of personality, however, models of personality have been created and researched as ways to study individual differences in personality on a much broader scope. To date, the Big Five model is one of the most frequently researched personality models and splits personality among five domains consisting of Conscientiousness, Extraversion, Agreeableness, Openness to experience, and Neuroticism (Goldberg, 1993). Each of these domains refer to aspects of peoples' personality that can be placed on a dimension, typically ranging from low to high, in each of these areas (Baumeister & Finkel, 2010).

Conscientiousness. One of the Big Five personality traits, conscientiousness, correlates with diligence and carefulness, and relates to the degree to which an individual regulates and controls their impulses and instincts (Baumeister & Finkel, 2010). People who are high in this

trait tend to be controlled and self-disciplined, rather than spontaneous or carefree. They tend to be dependable and high achieving, and at times can be at risk of becoming overly perfectionistic (De Raad, 2000). Conversely, those who are low in this trait tend to avoid structure, acting more from spontaneity than strategy (Baumeister & Finkel, 2010). They may frequently procrastinate or struggle to complete tasks. Overall, individuals who are low in this personality trait tend to be more laidback and carefree, as well as less goal-oriented or meticulous, when compared to those who are high in conscientiousness. Unsurprisingly, levels of conscientiousness have frequently been found to have implications for various health-related aspects of life. For instance, childhood levels of conscientiousness have been connected to health behaviors 40 years later in life (Hampson, Goldberg, Vogt, & Dubanoski, 2006) and one meta-analysis was able to connect higher levels of conscientiousness to longer life (Kern & Friedman, 2008).

Extraversion. Another of the Big Five traits, extraversion, is characterized by sociability, assertiveness, confidence, talkativeness, and social energy (Baumeister & Finkel, 2010). Individuals high in this trait can be thought of as thriving on, and gaining energy from, social stimulation and interaction, frequently seeking out opportunities to engage with others (De Raad, 2000). These individuals are often described as the 'life of the party,' frequently appearing to be energetic, friendly, and adaptable during social interactions. Indeed, those individuals high in this trait often possess more social fluidity than those lower on this particular continuum (Baumeister & Finkel, 2010). Exemplifying this, more extraverted men were found to be more successful at interacting with women who were strangers to them than were their more introverted counterparts (Berry & Miller, 2001). Those low in extraversion, frequently called introverts, tend to be less frequently involved in social situations. These individuals can often be perceived as more reserved, quiet, and solitary. For this reason introverts are often mislabeled as being shy or

socially anxious, however, in actuality these traits are quite distinct (Baumeister & Finkel, 2010). Individuals who are low in extraversion, introverts, simply have a lower drive for social stimulation, separate from being uncomfortable with, or afraid of, social interaction (De Raad, 2000). These individuals instead are more frequently focused on internal stimuli such as thoughts, feelings, and ideas rather than on external stimulation (Baumeister & Finkel, 2010). Although extraverts can be thought of as gaining energy from external, and frequently social, stimulation, introverts more often find this stimuli to instead be energy draining. For this reason, more introverted individuals tend to prefer solitary, or small group, experiences quite independent of their individual level of social ease (De Raad, 2000). As with all of the Big Five traits, however, one should acknowledge the continuum at play here, with the vast majority of people being neither pure extraverts nor pure introverts, but rather having aspects of both (Baumeister & Finkel, 2010). Because the vast majority of people possess both needs for solitude and social stimulation, this trait more so describes the individual balance of these two opposing needs.

Agreeableness. A third of the Big Five traits, agreeableness, relates to individuals' tendencies towards, or lack thereof, prosocial behavior (De Raad, 2000). Highly agreeable individuals tend to be people-oriented and are often willing to prioritize others' needs above their own needs. High degrees of agreeableness often goes hand-in-hand with having a comprehensive social perspective in which one is able to take on the perspectives of others and consider others' needs, rather than viewing situations from a more egocentric perspective (Baumeister & Finkel, 2010). Resultantly, people who score high in agreeableness are often viewed to possessing traits of high empathy, helpfulness, warmth, social tact, generosity, and consideration for others (De Raad, 2000). Those high in this trait also often show an optimistic view of humanity in general;

often viewing others are decent, likable, and worthy of trust, and thus behaving accordingly (Baumeister & Finkel, 2010). Individuals high in this trait tend to be concerned with minimizing conflict and maintaining positive relationships. Relatedly, research has found that highly agreeable people tend to get less angry about others' transgressions than do less agreeable people, and show higher abilities to moderate and control their own anger (Baumeister & Finkel, 2010). For these reasons, this trait can be viewed as helping these individuals with inhibiting aggressive responses and being adaptive at helping to maintain relationships and pro-social behavior. Alternatively, those who are particularly low in agreeableness tend to show more egocentric qualities and frequently may be seen to prioritize their own needs and interests above those of others (Baumeister & Finkel, 2010). As such, others may view these individuals as being unfriendly, uncooperative, selfish and distant. In contrast to the optimistic view of humanity that those who score highly in agreeableness often show, people who score low in agreeableness tend to show skepticism about others' motives and may often view unknown people as untrustworthy (Mattarozzi, et al., 2015).

Openness. The trait openness to experience, often simply called openness, refers to individuals' level of preference for venturing outside of their existing comfort zone. Individuals high in this trait show more willingness and enjoyment of immersing themselves in unfamiliar experiences, such as traveling to new locations, considering diverse viewpoints, embracing cultures that are different from their own, and experimentation with new activities generally (Baumeister & Finkel, 2010). These individuals tend to also show high amounts of curiosity, flexibility and open-mindedness and tend to be imaginative more so than literal or practical (De Raad, 2000). Research has found that individuals high in openness tend to hold more favorable interracial attitudes (Flynn, 2005), as well as to show higher engagement with the existential

challenges of life (Keyes, Shmotkin, & Ryff, 2002). In contrast, individuals who score lower on the trait of openness to experience, tend to be more comfortable sticking to their existing routines and tend to be more resistant to change (Baumeister & Finkel, 2010). They typically experience less desire to seek out new experiences and instead gain comfort from familiarity and predictability.

Neuroticism. The last of the Big Five traits, neuroticism, relates to an individual's level of tolerance for stress and distress (Jeronimus, et al., 2014). Those scoring highly on measures of neuroticism tend to experience a high vulnerability to stress, anxiety, depression, and other types of general distress (De Raad, 2000). These individuals typically focus on the more negative sides of situations rather than the positive ones (Jeronimus, et al., 2014). As such, these people are more likely to subjectively interpret various situations as more difficult or threatening than those individuals scoring lower on measures of neuroticism. Indeed, people with higher levels of neuroticism have been found to report more frequent negative life events than their lower scoring counterparts report (Jeronimus, et al., 2014). Research has found that neuroticism is associated negatively with social problem-solving skills, referring to the skills with which people cope with challenging situations in their lives (Koruklu, 2015). Conversely, those who score lower on measures of neuroticism are considered to be less vulnerable to stressors and are able to sustain a more balanced perspective on life events (Baumeister & Finkel, 2010). As such, this is hypothesized to allow these lower-scorers to remain calmer and more collected in the face of stressful events than may be seen in their higher-scoring counterparts. Of important note, however, one's level of neuroticism is not always stable throughout life, as research has found that scores for neuroticism tend

to gradually decrease as a person ages (Scollon & Diener, 2007).

Sleep Quality and Personality

Due to the significant potential for negative consequences associated with sleep-related problems, it is unsurprising that researchers have attempted to distinguish factors that can predict sleeping difficulties. One promising area related to this is the study of personality, specifically the attempt to match specific personality traits to sleeping patterns and dysfunctions. Most of the current research in this area has used the Big Five model of personality. Among the domains making up this model, most research in this area has shown conscientiousness and neuroticism to be most clearly connected to sleep-related traits, with low conscientiousness and high neuroticism being correlated with poor sleep hygiene, poor sleep quality, and high levels of daytime sleepiness (Calkins, et al., 2013; Duggan, et al., 2014). For example, Duggan et al. (2014) found that roughly 17% of the variance in sleep hygiene was explained by low conscientiousness, high neuroticism, and low agreeableness. In the same study, high levels of neuroticism and low scores on conscientiousness were found to explain roughly 19% of the variance in sleep quality. High levels of agreeableness have been found to be associated with longer sleep duration, while lower levels of agreeableness have been associated with deficient sleep (Hintsanen, et al., 2014). The role of extraversion has been more mixed in the literature, with some studies suggesting more positive associations with sleep and others suggesting more negative ones. For instance, high levels of extraversion have been associated with lower rates of restful sleep (Raynor & Levine, 2009), while extraversion has also been associated with better sleep quality (Gray & Watson, 2002; Hintsanen, et al., 2014) and shorter sleep latency (Williams & Moroz, 2009). In this small literature, significant associations between sleep and openness have not been reported (Duggan, et al., 2014; Gray & Watson, 2002; Hintsanen, et al., 2014).

Though still a nascent area of study, a number of associations between sleep and personality have been reported and show promise to be useful in understanding factors relating to sleep quality.

Alcohol Use and Personality

Just as with sleep quality, the Big Five personality domains have also been found to have associations with alcohol consumption and use. Similar to poor sleep quality, extraversion and neuroticism have been found to be correlated with increased alcohol consumption and alcohol-related problems (Lemos-Giráldez & Fidalgo-Aliste, 1997; Livingston, et al., 2015; Raynor & Levine, 2009). Extraversion specifically has been found to be correlated positively with binge drinking (Raynor & Levine, 2009), whereas higher conscientiousness and agreeableness have been found to correlate with higher alcohol-related harm reduction behaviors (Raynor & Levine, 2009), more healthy attitudes and behaviors (Lemos-Giráldez & Fidalgo-Aliste, 1997), and lower levels of binge drinking (Raynor & Levine, 2009). Higher conscientiousness has also been associated with lower alcohol use (Raynor & Levine, 2009). Similar to studies of sleep and personality interactions, studies examining alcohol use and personality types do not consistently find openness to be clearly associated with alcohol use patterns in either direction (Hong & Paunonen, 2009; Livingston, et al., 2015). Because high levels of openness have been found to predict some types of risky behavior (Markey, Markey, & Tinsley, 2003; Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005), relations between openness, sleep problems, and alcohol still warrant further exploration.

As is apparent, many of the associations found between high or low alcohol consumption or use patterns and personality have also been found when looking at sleep quality and personality. That is, many of the same personality types that are associated with high sleep

quality (i.e., high conscientiousness and high agreeableness) also seem to be associated with low alcohol use issues, as well as similar personality features that are correlated with sleep disturbance (i.e. high neuroticism) tend to also be correlated with problematic or increased alcohol use patterns. These personality patterns may help in further understanding how alcohol use problems and sleep problems are related.

Latent Profile Analysis Background

Thus far, few studies have used LPA to examine sleep and alcohol together or the combination of alcohol and personality. Furthermore, there are no known studies to have used this statistical approach to examine these three variables together at one time. Despite the scarcity of research in this area, LPA has significant potential to produce novel findings and novel ways to look at relationships among these variables. As a form of mixture modeling, LPA is still a fairly new type of analysis that is currently building in popularity (Berlin, Williams, & Parra, 2014). Similar in some ways to cluster analysis, LPA allows researchers to group continuous variables into latent/unobserved classes, which are based on observed response patterns in the individual's data (Berlin, et al., 2014). One feature that distinguishes LPA from cluster analysis, however, is LPA's ability to distinguish the most ideal number of classes based on established fit statistics (Nylund, Asparouhov, & Muthén, 2007; Nylund, Bellmore, Nishina, & Graham, 2007). This feature is considered to be an important advantage over traditional cluster analysis, which lacks clear ways to determine the best number of classes, at times resulting in arbitrary or subjective class enumeration (DeMartini & Fucito, 2014). By using LPA, one can be more confident that the number of classes ultimately chosen are grounded in, and are most representative of, actual latent groupings present in the data.

Although using this methodology to examine relationships between sleep, alcohol, and personality is still very much a nascent field, some research among these areas have begun to emerge. DeMartini and Fucito (2014) used a sample of college students ($N = 312$) who were identified as being at-risk alcohol drinkers and used LPA to delineate class membership based on the students' sleep patterns. This study found a four-class solution, in which the classes were labeled as follows: a "sleepiness" class that made up 11% of the total sample, a "sleepiness & late bedtimes" class that was 42% of the sample, a "sleepiness & late bedtimes with consequences" class making up 28% of the sample, and lastly a "sleepiness, late bedtimes, & sleep disturbance with consequences" class, which was the remaining 19% of the total sample. For the latter two classes, "consequences" referred to negative effects related to problematic sleep patterns (e.g., falling asleep in class, arriving late to class due to oversleeping). Of particular note was the finding that of at-risk college drinkers, the entire sample showed some form of sleep distress, which speaks to the relationship between alcohol and sleep issues in college students. For DeMartini and Fucito's study sleep distress was measured using the Sleep/Wake Behavior Problems Scale (SWPS), a 10-item measure that includes concerns related to being late to class because of oversleeping, needing multiple reminders to get up, difficulty falling asleep, and late bedtimes (DeMartini & Fucito, 2014). Furthermore, these classes of sleep patterns were found to relate differently to patterns of alcohol consumption. The class with the greatest number of sleep-related problems ("Sleepiness, late bedtimes, & sleep disturbance with consequences") was found to also report the most frequent alcohol consumption and binge drinking, as well as receive higher scores on the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler, Strong, & Read, 2005), than any of the other classes. Similarly, the class with the lowest number of sleep-related issues ("Sleepiness") was found to

report the lowest frequency of alcohol consumption, binge drinking, and alcohol-related consequences (DeMartini & Fucito, 2014).

Another study used latent class analysis (which is another form of mixture modeling that uses categorical, as opposed to continuous latent variables; Berlin et al. 2014) to determine latent subgroupings within morning-types and evening-types in college students ($N = 780$), before comparing these subgroups on alcohol consumption, intrapersonal adjustment, and academics (Tavernier & Willoughby, 2013). This study found two classes for the morning-type participants. The first one comprised 70.2% of the morning-type sample and showed fewer sleep-related problems. This class was labeled "Morning-good," while the second class (29.8% of the morning-type sample) had more sleep-related problems and were resultantly labeled "Morning-poor." When looking specifically at the evening-type participants, a three-class solution was found in which the classes were as follows; the "Evening-good" class made up 38.4% of the sample, another "Evening-moderate" class comprised 48.2% of the sample, and lastly an "Evening-poor" class made up 13.5% of the sample. Results from this study found that the evening-types tended to consume more alcohol than the morning-types. However, the two poor groups (morning-poor and evening-poor) did not differ in their alcohol consumption (Tavernier & Willoughby, 2013). This finding potentially suggests that amount of alcohol consumption, for college students with poor sleep quality, is not differentiated between those who are a morning or evening type person.

Similarly, there has so far been very little research looking at relationships between alcohol consumption and the Big Five personality domains using LPA. The only study found on this topic used a sample of adolescents and grouped them based on their mean scores on each of the Big Five personality domains (Zhang, Bray, Zhang, & Lanza, 2015). This study used a five-

class solution, in which the largest class was labeled the "Ordinary" class and represented participants who scored closest to the mean on all personality domains, making up 45.1% of the total sample. Next a "Rigid" class (9.5% of the sample) was made up of people who scored the highest on neuroticism while scoring the lowest on the rest of the domains. A "Confident" class (28.5% of the sample) had low scores for neuroticism and high scores for extraversion, openness, and agreeableness. The remaining two classes were a "Reserved" class (6.9% of the sample) that had the highest scores in conscientiousness while showing fairly low scores for all other domains, and lastly a "Resilient" class (10.1% of the sample) was characterized by having the highest scores on extraversion, openness, and agreeableness, relatively high scores for conscientiousness, and the lowest scores for neuroticism. Results from this study showed that the Resilient and Reserved classes each had higher rates of frequent binge drinking in comparison to those in the Ordinary class (Zhang, et al., 2015). This finding, related to the Resilient class, fits well with prior research due to this group scoring the highest in extraversion, a trait found to predict frequent binge drinking (Raynor & Levine, 2009). However, findings regarding the Reserved class are a bit more counterintuitive, since most studies find that high conscientiousness tends to negatively predict harmful drinking behaviors (Lemos-Giráldez & Fidalgo-Aliste, 1997; Raynor & Levine, 2009). Thus, one might expect this class, characterized by high conscientiousness, to refrain from frequent binge drinking. The authors suggest, however, that because the Reserved class were also characterized by low openness scores, results may represent a combined effect from this personality configuration. In this case they suggest that these participants' low scores for openness may lead them to crave familiarity and shun change, the status quo in adolescent environments often being high frequencies of binge drinking, while the influence from their high conscientiousness scores may leave them more

inclined to adhere to these social rules and norms encountered in their daily life, leaving them unlikely to break conformity (Zhang, et al., 2015). Overall, because various personality profiles were found to be significant predictors of binge drinking there is need for additional research to clarify these associations.

The Present Study

The purpose of the present study was to investigate relationships between alcohol consumption, sleep disturbance, and the Big Five personality domains in college students. LPA was used to group participants into distinct classes based on their patterns of alcohol consumption. These groupings allow for a deeper investigation of how alcohol use relates to sleep patterns in college students by exploring differences in how students in each latent class compare to each other based on their sleep. Furthermore another goal of the present study was to investigate whether the Big Five personality domains could be used to make meaningful predictions about which students would end up in which class based on their personality domain scores. Meaning that while the alcohol use measures were solely used to form the latent classes, I also examined whether these classes were comprised of individuals with distinct personality traits (e.g., perhaps the highest drinking class will have the greatest number of individuals high in neuroticism). These three distinct areas of sleep, alcohol, and personality traits were chosen based on previous research findings that have served to highlight significant interrelationships among these constructs. Apart from previous research, this study was designed to extend the field in a number of ways. The first of these was by examining these three important areas together using LPA, something that has not previously been done. Additionally this study extended the previous literature in this field by using alcohol consumption as the latent class indicator variable, while all identified previous research in this area has used sleep as the latent

class indicator variable instead (e.g., DeMartini & Fucito, 2014; Tavernier & Willoughby, 2013). This distinction is particularly important because differing drinking classes may present with distinct sleep patterns that may not show up delineated in the same way in previous statistical configurations. In other words, it is likely that membership in a certain alcohol group may more commonly drive sleep behaviors, rather than the reverse. For instance, if an individual frequently engages in problematic alcohol usage characterized by frequent heavy alcohol consumption, then they are highly likely to experience negative effects on their sleep (e.g., passing out, fragmented sleep, reduced REM sleep). In contrast an individual who independently experiences sleep difficulties may or may not also be engaging in heavy alcohol usage. This is not to say that this study can determine causation: it cannot. However, it does provide valuable insight to examine findings from the opposite direction than has previous research, which allows one to compare and contrast differences revealed.

Hypotheses

In constructing this study, a number of specific hypotheses were developed, which draw on the available previous literature and empirical evidence.

1. It was expected that an LPA would find a four-class solution, representing two lower and two higher alcohol consumption patterns, in which one class of each has low rates of alcohol-related consequences, and the other has high rates of such consequences.
2. It was expected that higher alcohol use would correlate with higher sleep disturbance.
3. It was expected that scores on the Big Five personality domains would be significantly predictive of class assignment. It was hypothesized that those higher in conscientiousness and/or agreeableness would show an increased likelihood of being in classes marked by better sleep quality and lower alcohol use. Furthermore, those higher in neuroticism

and/or extraversion were expected to show an increased likelihood of being in classes marked by higher alcohol consumption and sleep disturbance. No specific hypotheses were made about the trait openness due to mixed prior literature.

III. Method

Participants

Participants for this research were undergraduate students attending Auburn University. All individuals in the sample were age 18 or older and any subjects who indicated being less than 18 years of age were excluded from participation. The only criteria for inclusion in this study were that participants be undergraduate students attending college at Auburn University and that they be eligible to participate in the College of Education SONA system for research participation. Because this study expected to look at all ranges of sleep quality ranging from high sleep quality to very poor sleep quality, as well as nonexistent or minimal, ranging to high, levels of alcohol consumption this allowed for a greatly unrestricted participant selection process. Keeping the selection criteria this open and unrestrictive was expected to improve the chances of attaining a larger sample size. Based on existing LPA research investigating similar alcohol-related concepts it was determined that approximately 250-400 individuals would be adequate for achieving sufficient power in this study. While previous examples of research about alcohol-related concepts using LPA have utilized both smaller (e.g., Prince, Connors, Maisto, & Dearing, 2016; Schlauch, Rice, Connors, & Lang, 2015) and larger samples (e.g., Haas et al., 2015; Tavernier & Willoughby, 2013), the majority of identified prior research in this area had samples within this range (e.g., Abar, Turrisi, & Mallett, 2014; DeMartini & Fucito, 2014; Varvil-Weld, Marzell, Turrisi, Mallett, & Cleveland, 2013).

Of the final participant sample (N = 305) for the study, participants were predominantly female (63%) and White (79%), African American (9.5%), or Asian (6.6%). The majority of the sample identified as heterosexual (91.8%) or bisexual (5.2%), with ages ranging from 18 to 32 years old (M = 20.6, SD = 1.54). The majority of the final sample was made up of 3rd year

students (33.1%), followed by 2nd years (28.9%), 4th year students (18.7%) and 1st year students (12.5%), with small numbers of later year students (7%).

Procedures

Participants were recruited through the SONA-system in Auburn University, where a brief description of the study was available to potential study participants. Students who chose to participate received SONA credit for their participation, which can be applied as extra credit in many participating courses, at the discretion of the course instructor. The awarding and documentation of SONA credit happened independently through the SONA website and was not in any way related to, or contingent upon, students' responses during their participation in this research. After viewing the brief description for this study online on the SONA-System website, students who chose to participate were directed to click a link on the website that automatically directed them to the first page of this study on Qualtrics, a web-based survey software. The first webpage that participants saw was the information letter for this study. This information letter apprised participants of information relating to participation in this study, such as what they would be asked to do as a participant (i.e., filling out various survey questions), any anticipated risks or benefits involved in participating, as well as what compensation they could expect to receive from participating, namely the extra credit hours they were awarded on the SONA-System. Furthermore, participants were informed that at any point during the survey they could choose to stop participating simply by closing the website and that choosing to do so would not lead to any negative consequences for them. Participants were informed that they would still receive the previously described compensation regardless of whether or not they completed the entire survey. On this page participants were also reminded that no personally identifying information would be collected linking their identity to their survey responses. After reading

through the information letter, participants were able to indicate their consent to participate by clicking on a box to confirm that they had read the information letter and voluntarily wished to participate in the study, before accessing the rest of the survey.

Participants were then directed to the rest of the study starting with a page of demographic questions. Next, participants completed each of the remaining survey measures, which asked a variety of questions relating to the participants' sleep quality and alcohol consumption, as well as questions designed to determine the participant's Big Five personality type. These measures appeared in a randomized order so as to minimize potential item order effects. Following these surveys, the last page of the study was a note thanking participants for their time spent completing the survey. This page also included contact information for the principal investigator of the study, to whom any questions could be directed. Last, this page also included the telephone number and address of Student Counseling Services on Auburn University's campus, which could be contacted in the unlikely event that the participant had experienced any unanticipated distress or discomfort while completing the survey. It was conservatively anticipated that the entire survey would take approximately 30 minutes for participants to complete.

Measures

Each of the measures that participants completed for this study is described with additional detail below.

Demographics. Demographics for this study included questions asking the participant to indicate their current age, current year in college, biological sex, gender identity, sexual orientation, and ethnicity.

Alcohol consumption. A modified version of the *Daily Drinking Questionnaire* (DDQ; Collins, Parks, & Marlatt, 1985) was used to collect information relating to the average quantity and frequency of alcohol consumed by participants on each day of a typical week occurring in the past 30 days. While completing this measure, participants saw a one-week calendar with boxes representing each day of the week. In each box participants were instructed to fill in the average number of alcoholic drinks he or she consumes on that day in a typical week. While taking this measure, participants were also shown a standard drink conversion table that included a definition of a standard drink, which is a standard procedure as part of administration of the DDQ. This enabled participants to more accurately estimate their typical alcohol consumption. Participants also provided quantitative estimates related to their drinking behaviors from the previous month, (including how many days they drank alcohol, how often they were drunk, how often they engaged in binge drinking etc.) such that higher scores indicate more severe drinking behaviors. Past research has found it to show sufficient reliability and validity (Baer et al., 1992). When correlated with responses from two other measures of alcohol use across two administrations, 12-month and 24-month follow up administrations, results were found to be reliable ranging from .66 to .75 (Baer et al., 1992). Moreover the DDQ has been shown to have good convergent validity with longer measures of quantity, frequency, and volume of alcohol consumption (Cahalan, Cisin, & Crossley, 1969; Collins, et al., 1985). While participants for the present study completed this measure in its entirety, only a select handful of items from the measure were used in the final analysis, with these specific items described below under Analytic Procedure. The number of items selected as latent class indicator variables was limited in this way in order to maintain fidelity of the analysis. Selectively minimizing the items used in this way helped to limit the number of indicator variables for more parsimony.

Alcohol consequences. *The Brief Young Adult Alcohol Consequences Questionnaire (*B-YAACQ; Kahler, et al., 2005) is a 24-item self-report measure that has been specifically created for use with an undergraduate population. This measure is used to assess the presence of alcohol-related consequences (e.g., passing out, neglecting obligations, etc.) that have occurred over the previous month. While completing this measure, participants answer either "yes" or "no" to each of a variety of statements, which all ask about whether the participant has experienced various alcohol-related consequences over the previous month (Kahler, et al., 2005). For this measure the total score, ranging from 0 to 24, is the sum of all confirmatory (yes) answers to the statements with higher scores representing a greater quantity of alcohol-related negative consequences. Scores from the B-YAACQ are highly correlated with scores from other previously validated instruments, such as the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989).The B-YAACQ has also demonstrated good internal consistency of .83 (Kahler, et al., 2005). Lastly, scores from the B-YAACQ have been shown to be reliable at .89 over a six week time period (Kahler, Hustad, Barnett, Strong, & Borsari, 2008).

Sleep disturbance. *The Pittsburgh Sleep Quality Index* (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a widely used measure that consists of 19 items. These items create seven component scores, measuring subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, use of sleeping medications, sleep disturbances, and daytime dysfunction. When these composite scores are combined, one total score is produced, ranging from 0 to 21, with higher scores indicating more sleep disturbance (Buysse, et al, 1989). For this study, this measure was used to assess sleep quality in participants over the previous month, with a score of 5 or less indicating good sleep quality, and a global score of greater than 5 indicating poor sleep quality or sleep disturbance. The PSQI is generally considered to have good

psychometric qualities, with a recent meta-analysis of 37 studies finding the measure to have strong reliability, ranging from .70 to .83, in a variety of samples, as well as moderate structural validity (Mollayeva, et al., 2016).

Personality types. *The Big Five Inventory* (BFI; John & Srivastava, 1999) uses 44 items to determine an individual's score for each of the Big Five personality traits; extraversion, conscientiousness, neuroticism, agreeableness, and openness to experience. Each of these items has the structure of a short statement to finish the sentence "I see Myself as Someone Who…" While responding to this measure, participants selected an answer ranging from 1 "Disagree Strongly" to 5 "Agree Strongly" to represent how much each sentence describes how they view themselves. This widely used measure has good psychometric qualities and clear factor structure, and has been translated into 29 separate languages for widespread accessible use (Chiorri, Marsh, Ubbiali, & Donati, 2016). More specifically, the BFI has been found to have 3-month test-retest reliabilities ranging from .80 to .90 and shows good validity coefficients with the Neuroticism-Extraversion-Openness Five Factor Inventory (NEO-FFI) that ranged from .83 to .91 for each of the five personality domains (John & Srivastava, 1999).

Sleep regularity. Lastly a self-created measure of sleep regularity was constructed for the present study. While completing this measure participants saw a one-week calendar with two boxes representing each day of the week. In each box participants were instructed to fill in the time that they most often wake up for each day of the week from the previous month, as well as the time that they most often fall asleep for each day of the week over the previous month. However, ultimately this measure was not included in the final study analysis due to excessive ambiguity in the format of question answers. Because the measure neglected to specify whether participants were expected to include AM and PM descriptions in their answers much of the data

received was highly ambiguous, potentially introducing excessive subjectivity in the scoring of this measure. For this reason this measure was excluded from the final analysis.

Analytic Procedure

Latent class indicators. Of the previously described measures, scores from the B-YAACQ and several questions, described below, from the modified DDQ were used as latent class indicator variables. As such, the classes that were formed were based upon response patterns, representing alcohol use, as measured by these instruments. From the DDQ, question 1: *On how many days did you use alcohol in the last 28 days?*, 6: *During the last 28 days, on how many days have you been drunk?*, 7: *During the last 28 days, on how many days did you have 5* (or 4 for female participants) *or more standard drinks?*, and 8: *During the last 28 days, what is the largest number of standard drinks you consumed in one night?*, were included as latent class indicator variables. Scores from these questions were not combined, but rather each kept as a unique latent class indicator variable. These specific items were ones that assessed alcohol use overall, as opposed to other items assessing more specific information related to alcohol use, such as information about the type of alcohol consumed, or ones assessing traits about the participant themselves, such as their height or weight.

Class correlates. Apart from the indicator variables used to form the latent profile classes, other variables called auxiliary variables provided further support for group membership (Asparouhov & Muthén, 2014). Such variables customarily have a background research base establishing them to correlate with the class indicator variables, while still being separate constructs. For instance, for this study both quality of sleep and Big Five personality type were treated as auxiliary variables, and each of these can be seen to correlate with various alcohol use patterns, however, neither personality type nor sleep quality are inherently or definitively known

to be a part of any specific alcohol usage pattern. The utility of examining these auxiliary variables is to lend additional support to the class structure because auxiliary variables can create more distinct delineations among the classes.

Furthermore, auxiliary variables come as either of two separate types, consisting of either distal or predictor variables (Asparouhov & Muthén, 2014). One of the primary purposes of distal variables is to help highlight some of the implications related to specific class membership. This concept is related to the question of why it matters to differentiate classes. For instance, distal variables can let us know whether one class has significantly better or worse levels of the distal variable. For the current study, level of sleep quality served as a distal variable; hypothetically if the results of the analysis were to find that one specific class (e.g., the highest drinking class) also was correlated to the lowest level of sleep quality this would create more support for the idea that it matters to distinguish between the classes. This is due to the finding that there are now observable and potentially important differences in outcomes between the classes. Alternatively, predictor auxiliary variables can be used to determine retroactively whether specific factors can be used to predict which individuals will end up in which classes (Asparouhov & Muthén, 2014). For this study, scores from each of the Big Five personality domains were used as predictor variables and were examined to evaluate whether personality type can be used to determine which alcohol use group an individual belongs in.

Analytic Strategy. All analyses for this project were conducted using Mplus Version 8. Basic descriptive statistics were computed and examined for all relevant variables. Any non-normality present in the data were addressed and accounted for using maximum likelihood estimation with robust standard errors (Muthén & Muthén, 1998-2012). Furthermore any missing data were handled using full information maximum likelihood, since this procedure

allows researchers to salvage more data than other methods of dealing with missing data (Kline, 2016). This method produced very good covariate coverage (95.4 to 97.7) for the present study. An LPA was carried out using scores from the measures of alcohol consumption, the DDQ and the B-YAACQ, as the latent class indicator variables. This allows for examination of relationships between the latent class variable, alcohol consumption, and other auxiliary variables, such as sleep quality and Big Five personality types. To do this, the "3-step approach" was utilized (see Asparouhov & Muthén, 2013). In using this approach, latent class indicator variables were first used to determine a best class solution for the latent class model. Secondly, the latent class posterior distribution was used to generate a most likely class variable. Finally, using the auxiliary option in Mplus, relationships between the most likely class variable and the predictor (personality domains) and distal (sleep) variables were examined. Using the analytic strategies just described, results were examined for their congruence or incongruence to the previously stated research hypotheses.

IV. Results

Correlations

Upon initial examination of correlations between the various sleep, personality, and alcohol related items, a number of significant correlations were observed (see table 1). As might be expected, many of the alcohol related items were found to be significantly correlated with each other. Positive significant correlations were found between the number of negative alcohol related consequences participants reported experiencing and the number of days that participants drank, reported being drunk, engaged in binge drinking, and largest number of drinks they reported consuming. Number of days that participants engaged in alcohol use was also found to be significantly correlated, in a positive direction, with days participants reported being drunk, engaging in binge drinking, and number of drinks consumed. The number of days participants reported being drunk was found to be significantly positively correlated with binge drinking and highest number of drinks. Furthermore, binge drinking was found to be positively correlated with the largest number of drinks participants reported consuming.

Similarly, significant correlations were observed among the big five personality traits. Positive significant correlations were shown between extraversion and agreeableness, as well as between extraversion and conscientiousness. Additionally, a significant negative correlation was found between extraversion and neuroticism. A significant positive correlation was found between agreeableness and conscientiousness, as well as between agreeableness and openness. However, a significant negative correlation was found to exist between agreeableness and neuroticism. Similarly a significant negative correlation was found between neuroticism and conscientiousness.

A number of significant correlations were also observed between differing domains of variables. For instance, among the personality variables, agreeableness was found to be positively significantly correlated with number of alcohol consequences participant's reported experiencing, as well as being negatively correlated with frequency of binge drinking. The trait neuroticism was found to be positively correlated with number of negative alcohol consequences participants reported, as well as with overall sleep disturbance. Meanwhile, sleep disturbance was significantly positively correlated with number of alcohol related consequences participants reported. Participant's scores for extraversion were shown to be significantly positively correlated with both the number of days they reported engaging in alcohol use, as well as the number of days they reported being drunk. Finally, participant's scores in the area of conscientiousness were shown to be significantly correlated with a number of other variables. Sleep disturbance was suggested to be negatively correlated with conscientiousness. Conscientiousness was also shown to be negatively correlated with a number of alcohol related variables, such as number of negative alcohol consequences, binge drinking, largest number of drinks participants consumed, and the number of days participants reported being drunk.

Table 1. *Descriptive Statistics*

	Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1	Alcohol Consequences	4.50	4.94	1										
2	Days Drank	5.93	6.08	.521**	1									
3	Days Drunk	3.00	3.82	.636**	.757**	1								
4	Binge Drinking	2.74	3.95	.582**	.742**	.832**	1							
5	Most Drinks	4.67	4.36	.577**	.713**	.684**	.781**	1						
6	Sleep Disturbance	7.23	4.10	.329**	.082	.112	.076	.014	1					
7	Extraversion	26.55	6.49	.084	.174**	.156**	.087	.072	-.095	1				
8	Agreeableness	34.54	5.98	-.192**	-.050	-.082	-.138*	-.087	-.136	.155**	1			
9	Conscientiousness	29.55	5.26	-.315**	-.097	-.141*	-.190**	-.172**	-.301**	.201**	.323**	1		
10	Neuroticism	23.79	6.03	.143*	-.031	-.008	-.025	-.045	.304**	-.313**	-.241**	-.130*	1	
11	Openness	30.31	5.52	.067	.047	.019	.035	.121*	.086	.048	.197**	-.090	-.078	1

Note: * p < .05; ** p < .001

Latent Class Model

In analyzing the results for this study, 2- to 6-class models were run and appraised in order to determine the best-fitting model for the data (see Table 2). The best loglikelihood value converged and replicated for all models, and each model was re-run to reduce the chance of having inadvertently identified any local maxima (for details see Asparouhov & Muthén, 2014; Muthén, & Muthén, 1998-2012). When initially compared to the 2-class model, each successive model was found to have a lower Bayesian Information Criterion (BIC) value compared to the previous model, which typically indicates a better fitting model as this score becomes lower. This is important since the BIC is considered to be the most robust fit statistic for differentiating best-fitting solutions; however, it should also be noted that the BIC at times can tend to overestimate the correct number of classes (Nylund, Asparouhov, & Muthén, 2007). Since successive models each showed a lower BIC, this suggested a more complex solution than the initial 2-class model. Additionally, another fit statistic, the bootstrap likelihood ratio test (BLRT) was found to be significant for each class, making it unhelpful in differentiating between the classes, since a significant *p*-value for this statistic indicates that this class has better fit than the previous model. However, when examining the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR-A), the 4-class solution was the first class to show a non-significant *p*-value on this measure, which indicates that one should stop increasing the number of classes at this point (Nylund, et al., 2007). As per background literature, once this criterion has been met, one can feel confident that this is the largest number of classes, particularly since the LMR-A has been found to identify the correct number of classes "over 90% of the time" (Nylund, et al., 2007, p. 560). Furthermore, upon closer examination of the 5 and 6-class solutions it was found that each of these models contained at least one class with minimal participants in it; the 5-class solution

had one class with only 5 participants and the 6-class solution had one class with only 4 participants. Considering the small participant numbers in some of these classes introduces the possibility that these classes may have appeared based on chance rather than actual latent grouping, and may not have appeared with a larger sample size. For this reason, along with the fact that each of these classes had a non-significant LMR-A p-value, these two classes were rejected. Since the 4-class solution was the first solution to show a non-significant LMR-A, while also having a lower BIC value than any of the previous solutions, it was selected as the best-fitting model for this data set.

Table 2. *Fit indices for LPA models with 2-6 Classes*

No. of classes	2	3	4	5	6
No. of free parameters	16	22	28	34	40
log likelihood	-1660.351	-1532.786	-1463.968	-1409.436	-1372.939
BIC	3412.069	3191.202	3087.827	3013.027	2974.294
ABIC	3361.326	3121.430	2999.027	2905.197	2847.436
BLRT (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000
VLMR (p-value)	0.0057	0.0114	0.5966	0.2104	0.6652
LMR-A (p-value)	0.0064	0.0127	0.6076	0.2152	0.6701
Entropy	0.934	0.948	0.908	0.918	0.911

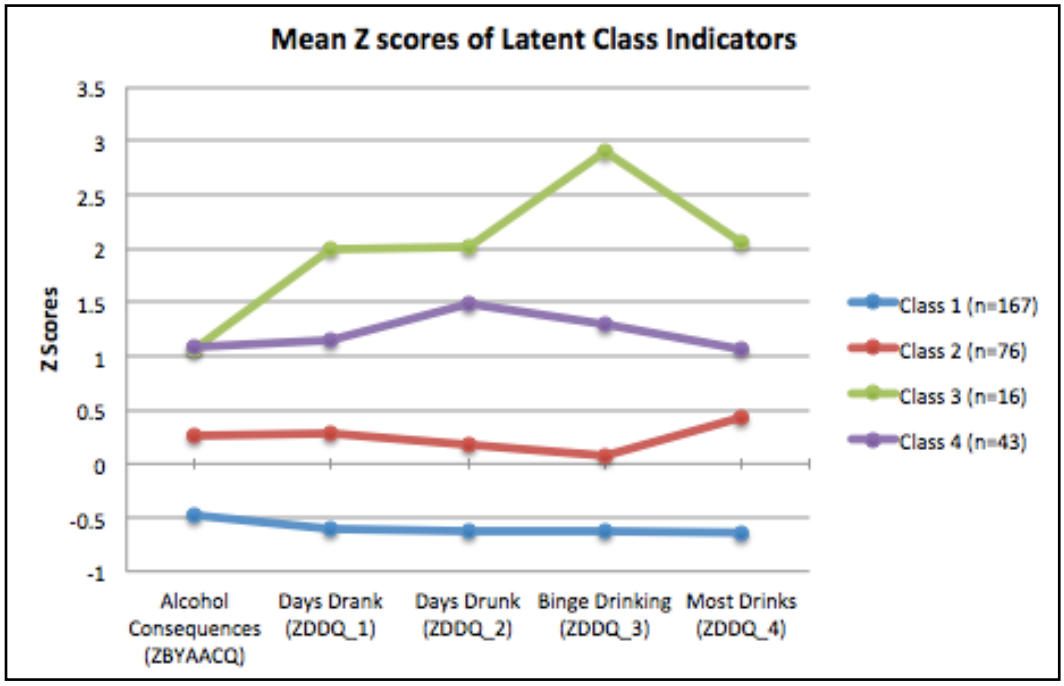
Note. BIC = Bayesian information criterion; ABIC = adjusted BIC; BLRT = bootstrap likelihood ratio test; VLMR = Voung-Lo-Mendell-Rubin; LMR-A = Lo-Mendell-Rubin adjusted likelihood ratio test.

Latent Class Indicator Variables

In order to examine the 4 classes in this model, a graph of each class's means (transformed into *z*-scores) for each of the latent class indicator variables was constructed and is represented in Figure 1. It appears likely, when comparing the classes, that the four classes can be interpreted as representing four differing levels of alcohol use, based on amount of alcohol consumed, frequency of consumption, amount of binge drinking, and severity of alcohol use behaviors. Class 1 was differentiated from other classes by representing the lowest levels of all latent class indicator variables; this class accounted for the largest portion of the sample (n = 167) and was labeled the Low Drinkers. Class 2 (n = 76) and Class 4 (n = 43) seem to represent successively higher levels of alcohol use, which seem to evenly demonstrate both frequency and severity of drinking behaviors rising in cohesion with each other. These classes were labeled the Moderate Drinkers (Class 2) and the High Drinkers (Class 4) respectively. A partial exception to this trend, of frequency rising in conjunction with severity, appears to be Class 3 (n = 16), which represents the class with the most severe level of drinking behaviors, and was thus labeled the Severe Drinkers. This class appears to represent students who, in addition to overall high alcohol use, also appear to show a particularly higher frequency of binge drinking behaviors compared to all other classes. Notable also, is that despite having the highest alcohol use among the classes, the Severe Drinkers appear to experience no higher amount of negative consequences associated with alcohol use than the High Drinkers experience. While this appears counterintuitive, since progressively higher drinking behaviors appear to coincide with a higher number of negative consequences related to drinking in all other groups, it is possible that the Severe Drinkers represents a subset of individuals who have developed a higher level of alcohol tolerance, which

wards against further negative consequences, due to their heightened amount and frequency of drinking compared to all other classes.

Figure 1


Mean Z scores of Latent Class Indicators
Z Scores
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
Alcohol Consequences (ZBYAACQ)
Days Drank (ZDDQ_1)
Days Drunk (ZDDQ_2)
Binge Drinking (ZDDQ_3)
Most Drinks (ZDDQ_4)
Class 1 (n=167)
Class 2 (n=76)
Class 3 (n=16)
Class 4 (n=43)

Class Differences by Sleep Disturbance; Distal Variables

Sleep disturbance was compared across the four classes with the purpose of determining if notable differences between the classes related to their level of sleep disturbance was found. Table 3 presents means across classes. Overall results indicate that sleep disturbance was found in all classes, with each class mean being higher than a score of 5 (which indicates poor sleep quality on this measure). For the entire sample, an overall mean of 7.24 was found. While the two classes with the highest alcohol use did show marginally higher means, compared to the two classes with lower alcohol use, for sleep disturbance, no significant differences were found between any of the classes on their mean level of sleep disturbance. As presented in Table 3, the overall χ^2 test was not found to be significant at $p > .05$.

Table 3: *Mean Differences in Sleep Disturbance Among the Four Latent Classes*

	Class 1 (n = 167)	Class 2 (n = 76)	Class 3 (n = 16)	Class 4 (n = 43)	
Variable	M (SD)	M (SD)	M (SD)	M (SD)	$\chi^2(3)$
PSQI Global Score	7.12 (4.91)	7.05 (5.66)	7.21 (5.10)	8.68 (7.28)	1.87

* $p < .05$. (No significant findings)

Class Differences in Personality; Predictor Variables

For this study, the 5 scales from the BFI, representing extraversion, agreeableness, conscientiousness, neuroticism, and openness, were used as predictor variables. This allowed for examination of differences across the LPA classes based on these personality traits. These relationships are represented in Table 4. In order to compare classes based on these personality types, one class was needed to represent a normative comparison group, with which to compare the other classes to. For this purpose the low drinkers class was chosen. Subsequently three kinds of comparisons were made, representing first the likelihood of participants being in the low drinkers class compared to the moderate drinkers class, second the likelihood of participants being in the low drinkers class compared to the severe drinkers class, and finally the likelihood of participants being in the low drinkers class compared to the high drinkers class. Among these comparisons, significant findings are outlined as follows, using the logistic regression coefficient (logit) for each finding. The extraversion logit for both the moderate drinkers (logit = 0.06, p = .03) and the high drinkers (logit = 0.08, p = .02) indicate that, extraversion was related to increased odds of membership in the high drinker class, relative to the reference low drinkers class. Conversely when looking at conscientiousness, both the two highest drinking classes (Class 3; logit = -0.14, p = .01; and Class 4; logit = -0.10, p < .01) suggest that when compared to the low drinkers class, participants with higher levels of conscientiousness were more likely than participants with lower levels of conscientiousness to be in the reference group rather than the higher drinking classes. When comparing the moderate drinkers (logit = 0.07, p = .03) with the low drinkers, those with higher levels of neuroticism were found to be more likely than those with lower levels of neuroticism to be in higher drinking class rather than the reference group. Similarly between these two classes, an additional finding was that participants with higher

levels of openness were found to be more likely than those with lower levels of openness to be in the moderate drinkers class (logit = 0.08, p = .01) rather than the reference group.

Table 4:
Log odds coefficients and odds ratio for four-class model with extraversion, agreeableness, conscientiousness, neuroticism, and openness as covariates.

Class	Effect	Logit	SE	t	OR
2	Extraversion	0.06	0.03	2.240*	1.06
	Agreeableness	0.04	0.03	1.107	1.04
	Conscientiousness	-0.05	0.04	-1.432	1.00
	Neuroticism	0.07	0.03	2.124*	1.07
	Openness	0.08	0.03	2.550*	1.08
3	Extraversion	0.07	0.05	1.395	1.07
	Agreeableness	-0.09	0.05	-1.791	0.91
	Conscientiousness	-0.14	0.05	-2.541*	0.90
	Neuroticism	-0.03	0.06	-0.552	1.00
	Openness	0.04	0.06	0.613	1.04
4	Extraversion	0.08	0.03	2.384*	1.08
	Agreeableness	0.01	0.03	0.281	1.01
	Conscientiousness	-0.10	0.03	-3.070**	0.90
	Neuroticism	0.02	0.03	0.668	1.02
	Openness	0.01	0.03	0.445	1.01

Note. Class 1 was used as the comparison group.
* $p < .05$.
** $p < .01$.

V. Discussion

Previous research has indicated that alcohol usage and sleep disturbance frequently correlate with each other. Moreover, while most frequently studied separately, previous studies have suggested that similar Big Five personality domains correlate to patterns of high alcohol consumption and sleep disturbance, as well as with low alcohol consumption and high sleep quality. The purpose of the present study was to build upon and deepen this research base relating to the relationships and interconnections between alcohol consumption, sleep quality, and the Big Five personality domains in a college student population. To date, this is the first known study to combine these three constructs using LPA as the analytic strategy. Another way this study extended previous research was by using alcohol consumption and negative drinking consequences as latent class indicator variables, while all identified previous research in this area instead used sleep as the latent class indicator variable instead (e.g. DeMartini & Fucito, 2014; Tavernier & Willoughby, 2013). The purpose of this research paradigm was to allow for investigation into how alcohol use relates to sleep patterns by exploring whether there are distinct differences in how students in each latent class compare to each other based on their sleep. Additionally, the present research study attempted to investigate whether Big Five personality traits could be used to make meaningful predictions about class placement based on personality domain scores.

When evaluating the previously proposed hypotheses for the present study, a number of both expected and unexpected results emerged. The first hypothesis for the present study was partially supported; as expected, a four-class model was selected as the best fitting model for the data. While the number of classes aligned with prior expectations, the actual classes found appear to be differentiated based upon four distinct levels of alcohol usage rather than the

expected two levels of alcohol consumption with high or low numbers of negative consequences of alcohol. Instead, for the most part, numbers of alcohol consequences appear to successively rise in conjunction with higher levels of alcohol consumption. An exception to this pattern was observed in the severe drinkers class, which was represented by having the highest level of alcohol consumption and the most frequent binge drinking behaviors, while also showing no higher mean numbers of negative alcohol consequences than the class below it, with regard to levels of alcohol consumption. This exception might be explained through this class potentially representing a distinct cluster of participants who might have developed a higher level of alcohol tolerance, due to their heightened amount and frequency of drinking compared to all other classes.

In contrast to hypothesis two, sleep quality was not found to correspond differently across classes, which were differentiated based on alcohol usage. Instead, the entire participant sample, making up each of the classes, was found to experience sleep disturbance, which did not vary significantly among the classes. Part of this finding aligns with prior research findings that suggest undergraduate students in general have poor sleep quality (Carter, Chopak-Foss & Punungwe, 2016; Lund, Reider, Whiting, & Prichard, 2010). However, this finding also differs from research that has suggested that sleep quality correlates with alcohol use in a predictable pattern, particularly that as alcohol use increases, sleep quality tends to decrease (Singleton & Wolfson, 2009). Instead, for the present sample, each of the four classes was found to all have highly similar mean scores for sleep disturbance.

A number of potential reasons for this difference are suggested as follows. First, it is possible that the sample characteristics associated with this college student population impacted the study's ability to provide adequate coverage of the full range of possible levels of sleep

quality. Thus, it is possible that had the present study been done with a different sample, such as a non-college student population, differences in sleep quality across alcohol usage groups may have been observed more readily. Additionally, it should be noted that sleep quality was measured using only one self-report measure based on participants' recollection, thus this portion of the study may have been influenced by recall bias leading to potential confounds. It is also notable that some of the particular components of sleep quality that previous research suggest correlates with alcohol usage, for example that higher levels of alcohol consumption can decrease REM sleep (Ebrahim, Shapiro, Williams, & Fenwick, 2013) were not measured in the present study.

The last hypothesis that was previously delineated suggested that certain personality traits would be found to help predict class assignments. This hypothesis was supported, most clearly with the traits of extraversion, conscientiousness, and neuroticism. As hypothesized, those with higher levels of neuroticism as well as those higher in extraversion were found to be more likely to be placed in higher drinking classes rather than the lowest drinking class. Additionally, as hypothesized, participants who were higher in conscientiousness were more likely to be in the lowest drinking class compared to those who were lower in conscientiousness. Contradictory to initial hypotheses, the personality domain of agreeableness was not found to be significantly predictive of class assignment in any direction. Additionally, while previous research has not consistently established any trend for how levels of openness relate to alcohol usage, the present study found that those participants with higher scores for openness were more likely to be placed in higher drinking classes rather than the lowest drinking class. Such findings warrant further study in order to establish the reliability of these trends. Overall it appears that the present study partially replicated some of the findings from previous research relating to which personality

types correspond to higher or lower patterns of alcohol consumption. These findings lend further support for the idea that certain personality types, particularly those with higher levels of neuroticism and extraversion, may be particularly prone to higher or more problematic alcohol usage, while those who are higher in conscientiousness tend to be lower consumers of alcohol.

The present study thus both replicated some aspects of previous literature and found divergent results in a number of other notable areas. It is also worth noting that this study is, to date, the first known study to combine these three unique areas of research (alcohol usage, sleep quality, and Big Five personality types) into an LPA model, as well as being the first known LPA study dealing with alcohol usage and sleep quality to use alcohol usage as latent class indicator variables, rather than using sleep quality in the role. It is possible, therefore, that some of the divergent results stem back to the novelty of this area, and likely warrant further study and replication in order to better evaluate the present results. Clearly the intricate relationships between the content areas studied, still warrant future investigation and while this area remains relatively nascent, studies such as the present one serve an important role in attempting to evaluate and broaden the current understanding in the area.

Implications

Findings gleaned from the present study suggest a number of important implications, particularly for use in clinical contexts. First, the general finding that, for the most part, numbers of alcohol related negative consequences successively rise in conjunction with higher levels of alcohol consumption, leads to treatment related implications. One such implication related to this overall pattern suggests that it is important for clinicians to be mindful and intentional about repeatedly assessing the presence, and amount, of negative alcohol related consequences that their clients experience, as amount of alcohol consumption fluctuates, rather than at any one

level of drinking. For instance, rather than merely assessing alcohol consumption and the presence of these consequences only once at intake, it is likely important to periodically assess these concerns throughout treatment as well. This is important because, as suggested by the results of this study, as peoples' alcohol consumption fluctuates, so too may the amount of negative alcohol related consequences that they experience. Thus, if a clinician was to only assess for these concerns at intake and then subsequently the client significantly changes their alcohol consumption later on, the clinician may not have an accurate understanding of the amount or severity of the alcohol related negative consequences that the client may be experiencing.

Similarly, another clinical implication of the present study's finding related to personality characteristic may help clue clinicians in on which clients may face more difficulties with problematic alcohol usage. This could be important for giving clinicians another metric with which to help determine which clients may subsequently warrant more assessment of substance use or simply more psychoeducation related to problematic alcohol use. Implications like this may lend support for potentially increasing administration of measures of personality factors, such as the Big Five, within routine clinical contexts. Procedures like this may have potential dual benefits for both clinicians and their clients. In addition to helping in indicating to clinicians which clients may warrant additional substance assessment, such procedures could provide another avenue for important psychoeducation with clients, relating to ways that their individual constellation of personality traits may impact their substance use. Such psychoeducation could furthermore help get clients more involved with their treatment and serve to potentially demystify traits that may correlate with increased substance usage difficulties.

Limitations and Future Directions

In evaluating the present study a number of methodological limitations become apparent, resolution of which would greatly enhance future research in this area. First, it should be noted that the present participant sample was highly homogeneous, representing a very limited scope of human diversity. As such, results from this data should not be applied to populations that were not adequately represented, including sexual orientation and gender identity minorities, non-traditionally aged college students, or racial and ethnic minorities. Similarly, the present sample also had a somewhat low representation of 1st year students, who only made up 12.5% of the total population. Future research would be enhanced by inclusion of more aspects of human diversity, making results applicable to a wider number of populations. Additionally, this would be useful in evaluating whether the research constructs studied affect different populations in similar or differing ways.

As noted previously, another limitation impacting the present study relates to the measurement of sleep disturbance, or more specifically the lack of inclusion of a number of important aspects contributing to overall sleep quality. Among these is the construct of sleep regularity, as well as specific types of sleep, such as REM sleep, which were not included in the present study. As discussed previously, an attempt was initially made to include the construct of sleep regularity, however, due to unforeseen measurement issues in the novel assessment that was created for this study, this data was ultimately excluded from the analysis. Future research could correct this issue by utilizing previously constructed and standardized measures of these other components of sleep quality, including sleep regularity.

Additionally an important direction for future research aimed at elucidating complex relationships between these constructs would be to broaden and diversify the measures used,

particularly since another limitation of the present study was that it relied exclusively on the use of self-report measures. In doing so, this study may have been impacted by excessive subjectivity in participant responses as well as potential recall bias. Furthermore, it may be important to note the potentially stigmatized topic of some of the survey questions, particularly in relation to alcohol usage and negative consequences of alcohol use, which could possibly cause participants to misrepresent or under-endorse their alcohol usage or related behaviors. Future research would benefit by incorporating the use of more objective measures of study constructs, including both sleep quality, for instance through the use of sleep trackers, as well as for tracking alcohol usage and associated consequences.

A final limitation that should be noted is that one of the classes found in the present study, the Severe Drinkers, had fairly low participant numbers (n = 16). Due to the small number of people identified to be in this class one may be less confident that this class represents a truly distinct subset of the population. Thus results from this class may be less stable than the other classes. It is possible that this class is truly distinct, as this study interprets it to be, and these associated behaviors occur more infrequently than behaviors represented by other classes, however, there is also the potential that a 3 class solution could instead be chosen to represent the data, dissolving this class. Further replication will be important to determine whether this class is consistently found.

Despite these limitations, the present study nonetheless made significant contributions to research in the areas of sleep, alcohol and personality in a number of important ways. As the first known study to combine these three distinct areas of research in an LPA model, the present study helped contribute support for many prior research findings through a novel methodology. Amongst these were findings that certain personality types not only correlate with certain

drinking behaviors, but were also found to help predict class membership as previously described, leading to important implications for clinical practice. Notably, higher levels of extraversion and neuroticism were more likely to exist in higher drinking classes, while the reverse was found for the personality type conscientiousness. Similarly helping to inform clinical choices, is the finding that as alcohol consumption increases, so too does the frequency of alcohol-related negative consequences. Supporting prior findings, the present study found prevalent sleep disturbance amongst the undergraduate sample, however, the study did not find that sleep disturbance significantly differed amongst the differing drinking classes, as prior finding would suggest it to. While a number of potential explanations are suggested for this discrepancy, further research is needed to more definitively elucidate relationships between these constructs. Overall, this study dealt with a unique combination of constructs that has a nascent research base at present, but which nonetheless shows clinical promise, making it deserving of further investigation.

VI. References

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