Examining Associations Between Social and Emotional Loneliness and Drinking in a Clinical Sample with Alcohol Use Disorder (AUD): An Ecological Momentary Assessment Study

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Examining Associations Between Social and Emotional Loneliness and Drinking in a Clinical Sample with Alcohol Use Disorder (AUD): An Ecological Momentary Assessment Study

by

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts
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DEDICATION

To my parents and their unending support in all that I do.
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ABSTRACT

Loneliness, a negative affective state that arises when someone perceives a lack of social connectedness, is a predisposing and maintaining factor of alcohol use behavior. Several studies have linked loneliness to drinking at the daily level and elevated AUD risk using longitudinal designs; however, cross-sectional studies have identified inconsistent patterns. The current study applied a multidimensional framework of loneliness (i.e., emotional and social dimensions) to examine daily relations between loneliness and drinking in an AUD sample ($N = 60$), with consideration of drinking context (social vs. solitary) as a moderator. Results indicated that emotional loneliness (within-person) was associated with increased drinking likelihood ($OR = 1.09$) and quantity ($OR = 1.06$), while social loneliness was associated with decreases in both drinking likelihood ($IRR = .897$) and quantity ($IRR = .954$). The effects of loneliness dimensions on drinking quantity did not vary as a function of drinking context. Exploratory analyses showed that emotional loneliness (between-person) was associated with coping ($b = .042$) and loneliness alleviation ($b = .049$) drinking motives, while social loneliness (within-person) was associated with enhancement ($b = .053$) motives for a given drinking occasion. The differential findings for emotional and social loneliness may be ascribed to differences in their subjective manifestations, in that emotional loneliness is a more severe form of loneliness that overlaps significantly with negative affective states, while social loneliness may be readily alleviated by adaptive behavioral strategies and/or social withdrawal. These findings offer important insight for interventions aimed at reducing loneliness and alcohol use behavior. Limitations and areas for future research are discussed with the goal of maximizing translational potential.
CHAPTER ONE: INTRODUCTION

Social connection, which is a broad construct referring to the presence of positive relationships with people around you, is an integral aspect of healthy human functioning (Holt-Lunstad et al., 2017). Research has consistently demonstrated a strong link between social connectedness and health, whereby stronger social connection predicts better mental and physical health outcomes, as well as decreased risk of mortality (House et al., 1988). In fact, the magnitude of the effect of social connection deficits on mortality risk exceeds that of smoking, excessive drinking, and obesity (Holt-Lunstad et al., 2017). The World Health Organization’s (WHO) recent addition of “social support networks” as a determinant of health reinforces the importance of considering social relationship deficits as a risk indicator for a myriad of health-related consequences, especially alcohol use and misuse.

Seppala et al. (2013) conceptualized loneliness as the non-optimal negative affective state that arises when an individual’s social needs are not met, or when there is a perceived discrepancy between one’s desired and objective social relationships (i.e., cognitive discrepancy-attributional model; Perlman & Peplau, 1981). Therefore, although loneliness is moderately associated with deficiencies in social networks or objective isolation (e.g., lower frequency and quantity of social contact, increased isolation from others), the experience of loneliness is a subjective psychological state that is more heavily influenced by one’s emotional and/or cognitive appraisals of their social connectedness (Heinrich & Gullone, 2006). Correspondingly, extant research has often recognized two unique dimensions of loneliness: social (i.e., perceived deficits in one’s social network) and emotional (i.e., perceived lack of an intimate connection
with someone) (Dykstra & Fokkema, 2007; Gierveld & Tilburg, 2006; Weiss, 1973). Despite robust evidence that alcohol use disorder (AUD) severity is associated with higher levels of loneliness (Ingram, Kelly, Deane, et al., 2020), there are significant gaps and limitations in the current literature that need to be addressed. First, existing studies on loneliness and alcohol use typically take a unidimensional approach, lacking differentiation between the emotional and social dimensions of loneliness. Similarly, studies that have utilized an EMA framework to test loneliness-drinking associations 1) have been limited to college student or community samples, 2) lack the granularity required to properly understand the experiences driving consumption (i.e., use single-item measures of loneliness), and 3) often do not consider contextual factors related to drinking. The current study begins to address these gaps in the literature among an adult sample diagnosed with AUD.

**Loneliness as a Multi-Dimensional Construct**

Robert Weiss (1973) was the first to postulate that the construct of loneliness is made up of two distinct dimensions (social and emotional) that have unique psychological and behavioral correlates. Social loneliness is said to occur when an individual is lacking a broader network of meaningful social relationships (rooted in shared interests and common values), while emotional loneliness arises when a person is lacking an intimate connection to another person. According to Weiss (1973), a sense of emotional loneliness cultivates feelings of anxiety, depression, and isolation that can only be alleviated by seeking and developing a strong emotional attachment to someone (e.g., family, significant other). Conversely, social loneliness is less implicated in psychological distress and more related to feelings of boredom, aimlessness, or marginality that can be relieved by seeking a broader sense of social integration (e.g., friends or colleagues).
An early examination of Weiss’ theory found only a small correlation between ratings of social and emotional loneliness \((r = .17)\), as well as differential associations of loneliness dimensions with specific items on the UCLA Loneliness Scale (Russell et al., 1980, Russell et al., 1984). Ratings of emotional loneliness were more strongly related to feelings of there being no one to turn to, feelings of not being known well by others, and feelings of not being close to anyone, while ratings of social loneliness were more strongly related to not feeling in tune with others, not having a broader group of friends, and not having a lot in common with others (Russell et al., 1980; Russell et al., 1984). More recent research among college students and older adults indicates moderate overlap between measures of emotional and social loneliness (correlations between .41 and .65), further supporting the relative uniqueness of each dimension (Wolters, 2022). Additionally, intervention research shows that merely facilitating social connection (an intervention theorized to reduce social loneliness) does little to attenuate subjective feelings of loneliness (Ingram, Kelly, Haslam, et al., 2020). Taken together, social integration does not necessarily prevent an individual from feeling a sense of emptiness/lack of close attachment (i.e., emotional loneliness), so it is important to adopt multi-dimensional measures of loneliness to better understand the totality of the construct.

Although assessment of social and emotional loneliness among alcohol-dependent individuals is limited, findings from Ingram and colleagues (2018) suggest that the experience of emotional loneliness may be the most pertinent loneliness subtype for individuals with substance use disorders (SUDs) more broadly. Specifically, they administered the Social and Emotional Loneliness Scale for Adults – Short (SELSA-S; DiTommaso et al., 2004) to treatment-seeking individuals with an SUD and found that scores were highest on the romantic emotional loneliness subscale (e.g., *I wish I had a more satisfying romantic relationship*) as compared to
the familial emotional (e.g., *I feel close to my family*) and social (e.g., *I feel part of a group of friends*) subscales (Ingram et al., 2018). Despite poor model fit of the original three-factor SELSA-S in this sample (Factor 1 = social loneliness; Factor 2 = romantic emotional loneliness; Factor 3 = familial emotional loneliness), each subscale had high internal consistency, and the correlations between subscales were low (Ingram et al., 2018). These findings suggest that emotional and social loneliness may also be distinctive experiences for individuals struggling with substance dependence; however, each dimension’s unique associations with patterns of substance consumption is less clear.

**Loneliness, Alcohol Use, and Alcohol-Related Problems**

Loneliness is a pervasive issue for individuals with substance use problems; recent research shows that individuals with a SUD are 5 times more likely to experience problematic loneliness than the general population, with nearly 3 out of 4 individuals in substance-dependence treatment reporting loneliness as a serious problem for them (Ingram et al., 2018). However, these odds ratios and prevalence rates were compiled by asking participants to rate their endorsement of a single-item (e.g., *Loneliness has been a serious problem for me*) on a 5-point Likert scale, which disallows for a detailed understanding of how participants are subjectively experiencing loneliness. This lack of sufficient operationalization is ubiquitous across the literature and needs to be remedied to better assess the precise implications of social connection deficits for alcohol use and misuse. Early research has consistently posited that alcohol problems arise from feelings of loneliness (Åkerlind & Hörnquist, 1992; Mijuskovic, 1988), with some accounts even regarding alcoholism as “the lonely disease” (Orrok, 1989). When faced with deficits in social connection, a primary psychological need for healthy human
functioning (Maslow, 1943; Seppala et al., 2013), individuals may turn to alcohol and/or other substances to cope or to replace this innate human necessity (Åkerlind & Hörnquist, 1992).

Empirical examinations of associations between loneliness and alcohol use demonstrate that loneliness is related to alcohol use and alcohol-related problems. For example, among a large adult sample \( N = 8,635 \), Page & Cole (1991) showed that as frequency of past-year loneliness increased (measured by asking participants how often they felt lonely), participants reported higher AUD risk, especially late-adolescent females (age 18-20). Another study conducted by Sadava & Thompson (1986) assessed loneliness-drinking associations in young adults (age 18-25) across a 1-week period and found that loneliness (measured with the UCLA Loneliness Scale – Revised; Russell et al., 1980) was associated with alcohol-problem status indicators (e.g., detriments in overall functioning and drinking to cope with emotional distress), above and beyond levels of alcohol consumption (e.g., frequency and quantity). These findings support the possibility that individuals at greater risk for AUD drink in response to loneliness in contexts that may exacerbate alcohol-related problems, or to reduce negative self-evaluations that are characteristic of both alcohol dependence and loneliness (Hull, 1981).

More recently, Horigian and colleagues (2021) conducted a study on relations between loneliness, social connectedness, mental health, and alcohol use severity in a young adult (age 18-35) sample during the early stages of the COVID-19 pandemic. Results indicated general elevations in alcohol use and mental health symptomatology (e.g., anxiety and depression) during this period, as well as an indirect effect of both loneliness (i.e., measured via the UCLA-3; Russell, 1996) and social connectedness (i.e., subjective sense of belonging to a social network, measured via the Social Connectedness Scale; Lee & Robbins, 1995) on alcohol use severity through heightened anxiety. Although the cross-sectional nature of this research
precludes causal assumptions, these findings parallel with recent 2-wave longitudinal evidence from a college student sample showing that loneliness exerts its influence on alcohol consumption and alcohol-related problems (e.g., decreased school/work performance, concern/criticism from friends, etc.) indirectly through heightened stress (Segrin et al., 2018). Without considering levels of stress, loneliness did not concurrently or prospectively predict levels of alcohol consumption or alcohol-related problems (Segrin et al., 2018). These patterns indicate that subjective feelings of loneliness may be implicated in certain emotional responses (i.e., anxiety and distress) that potentially prompt alcohol consumption as a coping mechanism. However, none of these studies explicitly differentiated between the emotional and social dimensions of loneliness, so the influence of variations in participant’s subjective experience of loneliness remains unclear.

One study applied the emotional and social loneliness framework to a male college student sample ($N = 116$), finding that those referred to a substance use prevention program for marijuana and/or alcohol-related problems exhibited more substance-related negative consequences compared to control, as well as higher levels of emotional loneliness and lower levels of social loneliness (Yeh, 2002). The socially oriented nature of college student drinking may help explain the lower levels of social loneliness found in those referred to the substance use prevention program, which is supported by data showing that attending social gatherings more frequently is associated with lower levels of loneliness (Olmstead et al., 1991). These data also suggest that differentiation between loneliness subtypes may be important in the context of alcohol misuse and that the role of emotional loneliness warrants further attention. However, other cross-sectional research among college students implies an opposite pattern of loneliness-drinking associations; greater alcohol consumption was associated with lower levels of both
social and emotional loneliness (Diehl et al., 2018). Therefore, more intensive research methodology is essential to better understand the precise associations between loneliness (emotional and social) and drinking.

**Loneliness and Drinking at the Daily Level**

Ecological Momentary Assessment (EMA) is an intensive data collection process that involves assessment of complex behaviors in real-time, allowing for examination of prospective between- and within-person effects (Shiffman et al., 2009). This is particularly important when assessing loneliness-drinking associations because research indicates that feelings of loneliness can fluctuate daily depending on one’s environment or social context, and the effects of loneliness on drinking may look different when assessed cross-sectionally (Diehl et al., 2018; van Roekel et al., 2015). Further rationale for examining these associations at the daily level are rooted in motivational models of substance use and the multi-stage theory of addiction, which together posit that individuals drink for social, coping, and/or enhancement purposes, and that these motivations change as individuals progress in the addiction cycle (Cooper et al., 1992; Koob & Volkow, 2010). For instance, drinking to attenuate negative affect (i.e., coping motives) is more strongly predictive of alcohol-related problems than drinking to enhance positive affect or to facilitate social experiences (Cooper et al., 1992; Merrill & Read, 2010). A recent meta-analysis conducted by Dora et al. (2022) found no association between daily experiences of negative affect and drinking, highlighting the need for a more nuanced approach in assessing these relations (e.g., What kind of negative affect? In what contexts? For what populations?)

Several EMA studies have examined within- and between-person associations between loneliness and drinking, although definitive conclusions remain impossible due to differences in loneliness operationalization (i.e., all used unidimensional measures) and sample characteristics
(i.e., most used samples of non-dependent drinkers). Kuerbis et al. (2018) conducted an EMA study in treatment-seeking adult drinkers and showed that relations between loneliness (within-person) and drinking quantity did not differ by age, although they did not discuss or report a potential main effect for loneliness in the manuscript. Bragard et al. (2022) conducted a similar study among adult drinkers, demonstrating that within-person loneliness (controlling for between-person loneliness) was negatively associated with drinking quantity when a linear model was fit; however, they also reported a quadratic effect of loneliness, such that extremely low and high loneliness scores both predicted subsequent elevations in drinking quantity. To my knowledge, the only study to demonstrate positive associations between loneliness and drinking at the daily level was conducted by Arpin et al. (2015).

Arpin et al. (2015) found that loneliness predicted increases in solitary consumption (especially for women), decreases in social consumption, and overall decreases in social interactions later in the day (Arpin et al., 2015). Path analyses indicated that the effect of loneliness on solitary consumption was not attributable to reductions in social interactions, while the effect of loneliness on social consumption was better explained by reductions in social interactions. These patterns are consistent with a sad passivity response to loneliness, through which feelings of loneliness precipitate general social withdrawal and drinking alone, which in turn reduces socially oriented alcohol consumption (Heinrich & Gullone, 2006). Results are also in accordance with the cognitive discrepancy-attributional model of loneliness, in that individuals with a stronger sense of social support were particularly prone to solitary consumption when faced with transient experiences of loneliness (Perlman & Peplau, 1981).

Arpin et al. (2015) provide important insights into the daily dynamics of loneliness-drinking patterns; however, further research is needed to increase its translational potential. For
instance, loneliness was assessed using a single item (i.e., how lonely do you feel at this moment?), which begs the question whether participants were responding to feelings of emotional or social loneliness (Gierveld & Tilburg, 2006; Weiss, 1973). Although Arpin et al.'s (2015) inclusion of perceived social support as a moderator (measured by the Interpersonal Support Evaluation List; ISEL; Cohen et al., 1985) assesses both emotional and social aspects of support, their analyses did not examine the unique predictive utility of items assessing emotional versus less intimate forms of social support. These distinctions are vital in the context of alcohol misuse, as neurobiological and behavioral evidence indicates alterations in both social cognition and reward sensitivity, which can have significant implications for one’s ability to maintain a deeper sense of human connection, even when social networks remain relatively intact.

Social Cognition and Reward Alterations: Implications for AUD

Impairment in reward sensitivity and social cognition are two common features of alcohol dependence with shared behavioral correlates that may underly subjective experiences of loneliness and alcohol consumption. Reward sensitivity, which refers to the degree to which an individual can derive pleasure from daily experiences, is often hijacked when an individual becomes dependent on alcohol (Volkow et al., 2010). Specifically, chronic alcohol users experience reward-system adaptations that may limit their willingness to seek and their ability to experience reward from non-substance-related behaviors (e.g., socialization) (Koob & Le Moal, 2008). Although initial alcohol use is often characterized by positive reinforcement motives and drinking in social settings, later stages of addiction often entail compulsive alcohol consumption to alleviate negative affective experiences associated with substance craving and withdrawal, which may occur more often in solitary settings (Galandra et al., 2018; Keough et al., 2018; Koob & Le Moal, 2008). This premise is supported by Arpin et al's. (2015) finding that
associations between loneliness and solitary drinking were not explained by reductions in social interaction for moderate-heavy drinkers. Given decreased sensitivity to non-substance related reward during dependence, it is plausible that experiencing emotional loneliness, regardless of how socially integrated a person feels, may motivate solitary consumption in those with an AUD. Individuals with an AUD also report deficits in social cognition (e.g., expressing emotions and experiencing empathy), which may further contribute to avoidance of social interaction, and subsequent decreases in social consumption and increases in solitary consumption (Le Berre, 2019). Nevertheless, research is needed to parse out the differential predictive utility of emotional versus social loneliness on context-specific alcohol consumption (social versus solitary) with consideration of people’s self-reported motivations for alcohol consumption.

**Present Study**

This study was designed to expand upon the current literature by examining loneliness-drinking associations using an EMA framework over a 2-week period in a clinical sample diagnosed with AUD. Participants completed measures of loneliness (emotional and social), alcohol consumption, and drinking motives twice per day for 14 days.

*Aim 1*

Examine the between- and within-person effects of emotional and social loneliness on alcohol consumption (likelihood and quantity) across the 2-week monitoring period.

Hypothesis 1: Within-person elevations in social and emotional loneliness will prospectively predict greater likelihood and quantity of alcohol consumption. In line with previous research suggesting that emotional loneliness is more pervasive for individuals who misuse alcohol, it is expected that emotional loneliness will be a stronger predictor (Yeh, 2002).
Hypothesis 2: It is also expected that those who are more emotionally and socially lonely on average across the two-week monitoring period (i.e., between-person differences) will have higher levels of alcohol consumption, with stronger associations for emotional loneliness (Yeh, 2002).

Aim 2
Examine whether associations between social and emotional loneliness and drinking differ as a function of drinking context (social versus solitary).

Hypothesis 3: Given evidence of diminished emotional expression and social withdrawal during AUD, associations between emotional loneliness and drinking will be strongest for drinking in solitary settings (Arpin et al., 2015; Le Berre, 2019). Conversely, associations between social loneliness and drinking will be strongest for drinking in social settings.

Aim 3 (Exploratory)
Examine relations between experiences of social and emotional loneliness and drinking motives (i.e., social, enhancement, coping, loneliness alleviation, and conformity), with assessment of how these patterns may differ by drinking context (social versus solitary).
CHAPTER TWO: METHOD

Participants

A sample of non-treatment seeking individuals \(n = 60\) participated in the current study. They were recruited using online advertisements (e.g., Craigslist, Facebook, Instagram) to participate in a 2-week online EMA study. Inclusion criteria were: a) being at least 18 years old, b) having a personal smartphone with text messaging capabilities and access to the internet, c) English speaking, d) living within commuting distance to the research site, and e) meeting DSM-5-TR diagnostic criteria for a current AUD diagnosis (i.e., initial screening with AUDIT > 8, confirmed with MINI semi-structured interview). To limit confounds, people were excluded from participating in the study if they a) were currently in treatment for AUD, b) if they reported current use of other substances aside from tobacco or marijuana, and/or c) if they were extremely cognitively impaired (e.g., Mini-Mental State Exam < 23).

A total of 150 interested individuals were screened via telephone or an online pre-screening survey, with 95 scheduled for a full screening/intake appointment. Of the 95 scheduled, 64 attended their appointment and 60 were enrolled and completed at least one day of assessments. Thus, the final sample analyzed was \(n = 60\) (see Figure 1 for Participant Flowchart).

Participants \((n = 60)\) had a mean age of 30.43 \(\text{(SD} = 12.9; \text{range 18 – 67)}\) and were predominantly female (58.33%) and heterosexual (81.67%; 18.33% bisexual). More than two-thirds of participants identified as White (70%; 11.67% Black; 10% Multiracial; 8.33% Asian), with approximately 27% identifying as Hispanic (26.67%; 73.33% Non-Hispanic). Additionally, the sample was nearly half college students (45%) and half non-college students (55%), with
Figure 1. Participant Flowchart

41.67% working full-time (15% job-seeking; 10% not working/not seeking work; 28.33% working part-time; 5% retired). Most of the sample was single/never married (61.67%; 16.67% partnered; 10% married; 10% divorced; 1.67% widowed). See Table 1 for a summary of demographic information for the final sample.
Table 1. Summary of Participant Demographics ($n = 60$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>$n$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>35 (58.33)</td>
</tr>
<tr>
<td>Male</td>
<td>25 (41.67)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>42 (70.00)</td>
</tr>
<tr>
<td>Black/African American</td>
<td>7 (11.67)</td>
</tr>
<tr>
<td>Asian</td>
<td>5 (8.33)</td>
</tr>
<tr>
<td>Multiracial</td>
<td>6 (10.00)</td>
</tr>
<tr>
<td>Sexual Orientation</td>
<td></td>
</tr>
<tr>
<td>Heterosexual</td>
<td>49 (81.67)</td>
</tr>
<tr>
<td>Bisexual</td>
<td>11 (18.33)</td>
</tr>
<tr>
<td>College Student Status</td>
<td></td>
</tr>
<tr>
<td>Not in College</td>
<td>33 (55)</td>
</tr>
<tr>
<td>Freshman</td>
<td>1 (1.67)</td>
</tr>
<tr>
<td>Sophomore</td>
<td>2 (3.33)</td>
</tr>
<tr>
<td>Junior</td>
<td>4 (6.67)</td>
</tr>
<tr>
<td>Senior</td>
<td>12 (20.00)</td>
</tr>
<tr>
<td>5th Year and Beyond</td>
<td>2 (3.33)</td>
</tr>
<tr>
<td>Graduate Student</td>
<td>6 (10.00)</td>
</tr>
<tr>
<td>Relationship Status</td>
<td></td>
</tr>
<tr>
<td>Single/Never Married</td>
<td>37 (61.67)</td>
</tr>
<tr>
<td>Partnered, not living with partner</td>
<td>6 (10.00)</td>
</tr>
<tr>
<td>Partnered, living with partner/married</td>
<td>10 (16.67)</td>
</tr>
<tr>
<td>Divorced</td>
<td>6 (10.00)</td>
</tr>
<tr>
<td>Widowed</td>
<td>1 (1.67)</td>
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<tr>
<td>Employment Status</td>
<td></td>
</tr>
<tr>
<td>Employed Full Time</td>
<td>25 (41.67)</td>
</tr>
<tr>
<td>Employed Part Time</td>
<td>17 (28.33)</td>
</tr>
<tr>
<td>Job Seeking</td>
<td>9 (15.00)</td>
</tr>
<tr>
<td>Not Working/Not Seeking Work</td>
<td>6 (10.00)</td>
</tr>
<tr>
<td>Retired</td>
<td>3 (5.00)</td>
</tr>
</tbody>
</table>

**Measures: Phone/Online Screening**

Interested participants who responded to the online advertisement underwent a screening (either via phone or Qualtrics) to determine initial eligibility for the study. Direct questions were
asked to assess inclusion and exclusion criteria. Participants were deemed ineligible if they did not meet all inclusion criteria and/or if they endorsed any of the exclusion criteria.

**Alcohol Use Disorders Identification Test (AUDIT)**

This measure was administered to initially screen for AUD (Saunders, et al., 1993). The AUDIT is a 10-item self-report measure of typical past-year alcohol consumption and related consequences. Research among the general population suggests an optimal cut-off score of 8 for maximizing sensitivity and specificity in detecting the presence of an AUD (Lundin et al., 2015). Hence, participants scoring \( \geq 8 \) were invited in for an in-person screening to determine final eligibility.

**Measures: In-Person Screening**

**Mini-Mental State Exam (MMSE)**

This 19-item instrument assesses current overall cognitive functioning (Folstein et al., 1983). A score of less than 23 out of 30 is indicative of severe cognitive impairment, so individuals who did not score at least 23 were deemed ineligible to participate.

**Mini International Neuropsychiatric Interview (MINI; Alcohol Use Disorder Module)**

The MINI is a semi-structured diagnostic interview for DSM-5 psychiatric disorders that is widely used to detect the presence of an AUD (Sheehan et al., 1998). This interview also allowed for consideration of AUD severity based on the number of symptoms endorsed (i.e., mild = 2-3, moderate 4-5, severe = 6+). Participants who did not meet diagnostic criteria for AUD were deemed ineligible to participate in the study. During this interview, 4 individuals did not meet diagnostic criteria for an AUD and were deemed ineligible.
Measures: In-Person Baseline Assessment

Demographics

Demographic information was gathered including gender, age, race, ethnicity, sexual orientation, employment status, and college student status.

Positive and Negative Affect Scale (PANAS)

The PANAS is a 20-item self-report scale that assesses the extent to which individuals experience various forms of positive and negative affect (Watson et al., 1988). There are two 10-item subscales for positive and negative affect, and participants ranked the extent to which they generally feel that way for each item on a 5-point scale. This measure was administered for the purpose of future secondary data analyses.

Alcohol Dependence Scale (ADS)

The ADS is a 25-item measure of alcohol dependence symptomatology that taps into three important domains: loss of behavioral control (LBC), obsessive-compulsive drinking (OCD), and psychophysical and psychoperceptual withdrawal (PPW) (Doyle & Donovan, 2009). This measure was administered for the purpose of secondary and sensitivity analyses.

Readiness to Change Questionnaire (RCQ)

The RCQ is a 12-item measure that assesses the stage of change an individual has reached regarding their drinking behavior (Heather et al., 1993). This scale is based on the work of Prochaska & Diclemente (1986) that describes how individuals transition through the following stages of changes: precontemplation, contemplation, and action. This measure was administered for the purpose of post-hoc exploratory analyses.
Emotional/Social Loneliness Inventory (ESLI)

The ESLI is a 15-item multi-dimensional measure of loneliness and isolation, with items corresponding to Weiss’ (1973) distinction between emotional and social dimensions (Vincenzi & Grabosky, 1987). Two forms of the measure with differential item wording permits assessment of 1) objective isolation and 2) subjective experiences of loneliness, and each form consists of two subscales specifically related to emotional and social aspects. At baseline, participants completed the objective isolation form. Participants were asked to respond to each item by picking the response that best describes them using a 4-point scale (Strongly Disagree – Strongly Agree). The items on the objective isolation form (both social and emotional) ask participants to respond based on what is true in their life at this time. The objective isolation form of this measure was administered for the purpose of exploratory analyses.

The ESLI was developed and validated in college students, high school students, and adults within a group psychotherapy program who endorsed current problems with loneliness and isolation. Original factor analysis of the loneliness form using a varimax rotation indicated a two-factor solution, with both factors accounting for 53% of the total covariance. These findings were cross-validated in a second sample, with results also suggesting a two-factor solution accounting for 52% of the total covariance. These results, as well as results from group comparisons (i.e., adults with known loneliness difficulties scored significantly higher on both subscales than college and high school students) support the ESLI’s construct validity. See Appendix A for the full measure.

UCLA Loneliness Scale-3 (UCLA-3)

The UCLA-3 is a 20-item unidimensional measure of subjective feelings of loneliness and social isolation (Russell, 1996). Participants indicated how often they feel the way described
in each statement on a 4-point scale. This measure was used to examine convergent validity of
the primary loneliness measure (i.e., Emotional/Social Loneliness Inventory).

**Depression, Anxiety, and Stress Scale-21 (DASS-21)**

The DASS-21 contains three self-report subscales designed to measure the degree of
current depression, anxiety, and stress (Lovibond & Lovibond, 1995). This measure is based on a
dimensional conception of psychological disorders and was administered for the purpose of post-
hoc exploratory analyses.

**Substance Use Risk Profile Scale (SURPS)**

The SURPS is a 23-item scale with four subscales assessing different personality
domains that are theoretically implicated in substance use and misuse (Woicik et al., 2009). This
measure was administered for the purpose of post-hoc exploratory analyses.

**Drinking Motives Questionnaire-Revised (DMQ-R)**

The DMQ-R is a 20-item measure containing reasons why people may be motivated to
consume beverages containing alcohol. Participants indicated on a 5-point scale how frequently
each of the reasons motivate them to drink alcohol. Scores on this measure are divided into 4
subscales that represent common motivations for alcohol consumption (Social, Coping,
Enhancement, Conformity). This measure was administered for the purpose of post-hoc
exploratory analyses (Cooper et al., 1992).

**Measures: Two-Week Follow-Up**

The measures for the two-week follow-up were the same as those administered during the
in-person baseline assessment. They were re-administered to allow for exploratory analyses.
Measures: Daily Assessment

Alcohol consumption, drinking context and motives, and other substance use since the previous prompt was assessed at each timepoint (i.e., morning and afternoon). Current experiences of loneliness, affect, and intentions to drink were also measured at each timepoint. The exact questions that participants were asked at each timepoint are listed below. Question wording differed slightly for morning and afternoon surveys. The language used for the afternoon surveys is included below in brackets directly next to the wording used for the morning surveys.

1. How many STANDARD DRINKS of alcohol did you consume SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT? Enter “0” if you did not drink since last night’s [THIS MORNING’S] prompt.
   a. If ≥1 standard drink consumed since last night’s [THIS MORNING’S] prompt:
      Below is a list of common reasons for drinking. For each reason, please indicate how important it was when you decided to drink SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT? Responses for each motive were ranked on a 5-point scale (Very Unimportant – Very Important). This measure was used to operationalize drinking motives for Aim 3 of the current study.
      Social Motives: To enjoy a social gathering.
      Coping Motives: To cope with negative emotions.
      Enhancement Motives: To increase positive emotions.
      Conformity Motives: To fit in with a group.
      Loneliness Alleviation Motives: To feel less lonely.
2. *Approximately what time did you have your first drink SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT?*

3. *Approximately what time did you have your last drink SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT?*
   
   i. *What was the location of the drinking event SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT?* (response options included: home, friend’s house, bar/restaurant, club, and other_____).

   ii. *Approximately how many people (not counting yourself) were with you when you were drinking SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT?* (response options included: 0, 1, 2-3, 4-8, 9-15, more than 15). This item was used to establish whether it was a solitary (response = 0) or social (response > 0) drinking event.

   iii. *Who else were you drinking with SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT? Select all that apply.* (response options included: friend, co-worker, family member, someone I just met, significant other, other_____).

   NOTE: If participants reported 0 drinks consumed since the previous prompt, then they completed filler questions.

4. *Do you plan on consuming alcohol between now and the next prompt?*
   
   a. If Yes:

      i. *How many drinks do you plan on consuming between now and the next prompt?*
5. Which of these substances (if any) did you use SINCE LAST NIGHT’S [THIS MORNING’S] PROMPT? Select all that apply (Response options included: tobacco, cannabis, and neither). Mode of consumption for tobacco and cannabis was also assessed for the purpose of post-hoc exploratory analyses.

6. Single-item Loneliness Assessment. “How lonely do you feel at this moment?” (response options on a 5-point scale; 1 = very slightly or not at all, 5 = extremely). This item was administered for the purpose of post-hoc exploratory analyses.

7. PANAS-Brief. Current positive and negative affect was assessed using a brief 8-item version of the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). Negative affect was assessed with the following items: embarrassed, disappointed, anxious, and sad. Positive affect was assessed with the following items: enthusiastic, happy, satisfied, and excited. Each item was rated on a 5-point scale ranging from 1 (Very Slightly or Not at All) to 5 (Extremely) indicating the extent to which the respondent was experiencing different affective states.

8. AAAQ-Brief. Current alcohol approach and avoidance inclinations were assessed using a brief 6-item version of the Approach and Avoidance of Alcohol Questionnaire (Levine et al., 2019). Participants rated how much they agreed with each statement on a scale of 1 (Agree Not At All) to 9 (Agree Very Strongly).

9. Emotional/Social Loneliness Inventory (Subjective Loneliness Form; Vincenzi & Grabosky, 1987) was used to assess current feelings of emotional and social loneliness. Scores on this measure were used as a proxy for experiences of emotional and social loneliness at each timepoint.
**Psychometric Examination of the ESLI**

Internal consistency (within- and between-person) was calculated for each subscale (emotional and social loneliness), as well as for total ESLI scores. The emotional loneliness subscale had a within-person internal consistency of .81 and between-person estimate of .96. The social loneliness subscale had a within-person internal consistency of .74 and between-person estimate of .97. Scores on the total ESLI scale had an internal consistency of .86 (within) and .98 (between). These internal consistency estimates are consistent with good to excellent reliability in the current study.

To assess convergent validity of the ESLI, correlations between the UCLA-3 (measured at baseline) and average scores on the ESLI’s emotional and social loneliness subscales were examined. Participant means on emotional \( r = .78 \) and social \( r = .71 \) loneliness across the monitoring period were strongly correlated with UCLA-3 scores at baseline, indicating that each subscale of the ESLI successfully tapped into the construct of loneliness. In addition, within-(i.e., repeated measures) and between-person correlations between the subscales were examined to assess the extent to which emotional and social loneliness overlapped on a single dimension of loneliness. Between-person correlations showed very little discrimination between average experiences of emotional and social loneliness across the monitoring period \( r = .93 \); however, within-person emotional and social loneliness (accounting for the non-independence of observations via repeated measures correlational analysis) showed only moderate overlap \( r = .63 \). These patterns are consistent with conceptualizing emotional and social loneliness as distinct (albeit overlapping) subjective experiences.
**Procedure**

Potential participants were recruited for the study using online advertisements (Craigslist, Facebook, Instagram). The advertisements included a brief description of the study, and interested participants viewed a full description by clicking on the embedded Qualtrics link.

*Phone/Online Screening*

Those who were interested in the study underwent a phone (or online) screening to determine initial eligibility for the study. During the early stages of data collection, interested participants were asked to provide their contact information and were called by a trained research assistant to complete a phone screening. To reduce participant burden, the phone screening was eventually moved entirely online. Hence, only participants who met inclusion/exclusion criteria provided their contact information. For both the phone and online screening, participants were provided detailed information about the study and the purpose of the screening. If participants met initial study criteria, they were invited for an in-person baseline screening/assessment to confirm eligibility.

*In-Person Baseline Screening/Assessment*

First, verbal consent to undergo further screening for study eligibility was obtained. Then, participants completed a breath alcohol test to ensure zero blood alcohol concentration, and further screening for study eligibility was conducted (e.g., MMSE and MINI for AUD). Informed consent was obtained for participants who were eligible and interested in the study, and enrolled participants completed a series of self-report measures on a computer (see *Measures* above). Lastly, enrolled participants were 1) provided instructions for completing the daily assessments via Qualtrics, 2) given an overview of the payment schedule (see *Compensation* above).
below), and 3) scheduled for their two-week follow-up appointment. The in-person baseline session lasted roughly 60 minutes.

*Two-Week EMA Monitoring Period*

Surveys were completed twice per day via Qualtrics (Morning: between 10:00 – 1:00 PM; Afternoon: between 4:00 and 7:00 PM). At each timepoint during the two-week monitoring period, participants received a text message prompt with a hyperlink directing them to the corresponding survey. The hyperlink for the morning survey was sent at 10:00AM and participants were given until 1:15PM to complete the survey before the window closed. The hyperlink for the afternoon survey was sent at 4:00PM and participants were given until 7:15 PM to complete the survey before the window closed. Each survey was expected to take roughly 3-5 minutes to complete, and median completion time for both morning ($m = 3.37; IQR = 2.78$) and afternoon ($m = 2.72; IQR = 2.48$) surveys were within this estimate. Total completion time for the daily surveys was roughly 1.5 hours.

*EMA Compliance*

To maximize daily survey compliance, participants who did not complete the corresponding survey 1 hour prior to the window closing received a text message reminder to complete the survey. Additionally, participants who did not complete the corresponding survey 15 minutes prior to the window closing received another text message reminder to complete the survey.

*Two-Week Follow-Up*

Participants were reminded of their follow-up appointment with an email the day before. Participants traveled back to the research site to complete a final set of self-report measures,
undergo debriefing, and receive the rest of their compensation. The duration of this appointment was approximately 30 minutes.

**Compensation**

Eligible participants who attended and completed the baseline assessment were compensated $15 for their time. Participants then earned up to $50 across the 14-day monitoring period, receiving $1 for each completed survey, an additional $11 bonus for 75% compliance (i.e., 21 out of the 28 total surveys), or an additional $22 for 85% compliance (i.e., 24 out of the 28 total surveys). Payment for the 14-day monitoring period was provided at the follow-up session, where participants also earned an additional $10 for completing additional self-report measures. In total, participants earned up to $75 for participating in the study, which equates to roughly $15 per hour and is in line with prior studies of similar structure (Martino et al., 2016).

**Data Analytic Strategy**

**Preliminary Analyses**

All variables were examined for outliers and violations of normality prior to analyses. An outlier analysis was conducted for normally distributed variables (i.e., within-person emotional and social loneliness) to identify cases where values fell outside of the median ± two interquartile ranges (IQRs); however, no such cases were identified, so all original data from these variables were retained.

Since drinking quantity was positively skewed and all daily reports fell into a range reasonably expected for an AUD sample (range = 0 – 12), all drinking data were retained. Descriptive and EMA compliance statistics were computed to characterize the sample, including mean comparisons of relevant variables between college and non-college students using linear regressions.
Analytic Strategy Overview

To test study hypotheses, time-lagged multilevel regression models (Schwartz & Stone, 1998) were estimated using the glmmTMB (Brooks et al., 2017) and lme4 (Bates et al., 2015) packages within R Statistical Software (v4.2.1; R Core Team 2022). Multilevel regression accommodates the two levels of nesting in the current study; time points (level 1) nested within persons (level 2), allowing for estimation of both within- and between-person effects simultaneously. Models involving drinking outcomes (Aims 1 and 2) were tested using a hurdle proxy model, whereby drinking likelihood (i.e., Y/N) was modeled with a binomial logistic regression, followed by a zero-truncated negative binomial model if the participant cleared the hurdle (i.e., if they drank). Although these models can be estimated simultaneously, Long & Freese (2014) demonstrated that running the model in two parts is equivalent to the former approach. Models involving continuous outcomes (Aim 3) were built using traditional linear mixed effect models.

All models included a random intercept component, with inclusion of random slopes determined on a case-by-case basis with consideration of 1) changes in model deviance, 2) significant changes in fixed-effect coefficients, and/or 3) model parsimony. All effects were estimated using maximum likelihood estimation (MLE), which is appropriate considering that the distribution of residuals for all variables were relatively normal. Missing data in all analyses were handled using pairwise deletion.

Aim 1: Loneliness-Drinking Associations

To examine relations between loneliness (emotional and social) and drinking, drinking likelihood and quantity were modeled separately using a hurdle proxy model as outlined above, and scores on the corresponding subscales of the ESLI were disaggregated into within-person
(i.e., scores at each timepoint) and between-person (i.e., average score across all timepoints) effects. Within-person social and emotional loneliness scores (level 1) were person-centered and time-lagged to test associations between loneliness and subsequent drinking. Between-person scores of emotional and social loneliness (level 2) were grand-mean centered to aid coefficient interpretation.

Sensitivity analyses for both parts of the hurdle proxy model were conducted, including age, college student status (Y/N), relationship status (single/in relationship), day-of-week (weekday or weekend), alcohol dependence severity (scores on the Alcohol Dependence Scale), and previous timepoint drinking (Y/N) as covariates due to their theoretical relevance to loneliness and drinking behavior. For both the logistic and count models, changes in model deviance and changes in pseudo r-squared from the unconditional models (i.e., intercept only) were examined for purposes of optimal model selection.

**Aim 2: Moderation of Loneliness-Drinking Associations by Context**

To examine whether loneliness-drinking associations differed across drinking contexts, a dichotomous drinking context variable (0 = solitary, 1 = social) was entered as a time-varying predictor at level 1, including a level 1 interaction term with loneliness dimensions (within-person) for the final count model outlined in Aim 1.

**Aim 3 (Exploratory): Relations Between Loneliness and Drinking Motives**

To examine relations between emotional and social loneliness and drinking motives, each motive (social, coping, enhancement, loneliness alleviation, and conformity) was modeled separately as continuous level 1 outcomes. Model specification and variable-centering was the same as outlined in Aim 1. To test for a moderating effect of drinking context, the dichotomous
drinking context variable (0 = solitary, 1 = social) was entered as a time-varying predictor, including an interaction term with level 1 emotional and social loneliness for each model.

*Power*

Estimating power to detect significant effects in MLM requires consideration of both level 1 and level 2 sample size, such that as the number of level 1 observations increases, the size of the level 2 sample needed to detect an effect decreases (Hox, 2010). According to simulation studies, 50 groups (level 2) with 30 individuals in each group (level 1) is sufficient to produce reliable parameter estimates for linear multilevel regression models (Maas & Hox, 2005). Other studies using simulated data have suggested having at least 50 groups (level 2) and 40 individuals in each group (level 1) to detect a small fixed effect (Schoeneberger, 2016). A level 2 sample size of 65 (level 2) with 28 level 1 observations per individual was reasonable to estimate a medium-sized fixed effect in the current study, as previous studies with similar sample sizes and analyses have been adequately powered to do so (Dvorak et al., 2016).
CHAPTER THREE: RESULTS

Descriptive Statistics

Daily Survey Compliance

A total of 1566 surveys were completed out of 1680 possible surveys, corresponding to a compliance rate of 93.21%. However, due to technical glitches with Qualtrics, 5 morning surveys and 18 afternoon surveys were never distributed, so true compliance rates are likely slightly higher than reported. Compliance rates were very similar across timepoint (morning = 93.45%; afternoon = 92.98%) and day of week (range: 90.83 – 95%) and are much higher than typically seen in clinical samples (Jones et al., 2019).

Baseline Sample Characteristics

A total of 60 participants meeting AUD criteria completed the study, with a relatively even split between college (55%) and non-college (45%) students. College students were significantly younger than non-college students ($b = -13.71$, $p < .001$). The gender split for non-college students was nearly equal (51.5% female), while college students were predominantly female (66.7%). Given the sample split between college and non-college students, mean comparisons for all relevant variables were conducted, and college student status was controlled for in all analyses (see Table 2).

The average AUDIT score for participants enrolled in the study was 15.18 ($SD = 6.11$). College students had significantly lower AUDIT scores than non-college students ($b = -2.49$, $p < .001$). Most enrolled participants met criteria for either moderate (38.33%) or severe AUD (36.92%), with only 22% (21.67%) endorsing mild AUD symptomatology. When compared to
non-college students, college students had less intense AUD symptomatology \((b = -0.249, p < .001)\). No participants exhibited extreme cognitive impairment, and the average MMSE score of enrolled participants was indicative of healthy cognitive functioning \((M = 29.25; SD = 1.22)\).

Table 2. Mean Comparisons by College Student Status

<table>
<thead>
<tr>
<th>Measure</th>
<th>Total Sample</th>
<th>Non-College Students</th>
<th>College Students</th>
<th>b</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>30.43</td>
<td>36.61</td>
<td>22.89</td>
<td>13.71</td>
<td>&lt; .001</td>
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<tr>
<td><strong>Drinking Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUDIT</td>
<td>15.18</td>
<td>16.30</td>
<td>13.81</td>
<td>-2.49</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>AUD Severity</td>
<td>2.18</td>
<td>2.36</td>
<td>1.96</td>
<td>-0.40</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Number of Drinking Days</td>
<td>6.25</td>
<td>6.88</td>
<td>5.48</td>
<td>-1.40</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Number of Heavy Drinking Days</td>
<td>3.33</td>
<td>3.70</td>
<td>2.89</td>
<td>-0.81</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Number of Drinks Per Drinking Day</td>
<td>4.61</td>
<td>4.49</td>
<td>4.57</td>
<td>0.08</td>
<td>0.521</td>
</tr>
<tr>
<td><strong>Drinking Motives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coping</td>
<td>2.27</td>
<td>2.50</td>
<td>1.99</td>
<td>-0.51</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Enhancement</td>
<td>3.15</td>
<td>3.23</td>
<td>3.05</td>
<td>-0.18</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Loneliness Alleviation</td>
<td>2.05</td>
<td>2.14</td>
<td>1.95</td>
<td>-0.18</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Conformity</td>
<td>2.02</td>
<td>2.12</td>
<td>1.89</td>
<td>-0.24</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Social</td>
<td>2.85</td>
<td>2.76</td>
<td>2.95</td>
<td>0.19</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Loneliness Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Emotional Loneliness</td>
<td>8.02</td>
<td>8.37</td>
<td>7.59</td>
<td>-0.77</td>
<td>0.008</td>
</tr>
<tr>
<td>Social Loneliness</td>
<td>6.62</td>
<td>6.66</td>
<td>6.57</td>
<td>-0.09</td>
<td>0.719</td>
</tr>
<tr>
<td>Total Loneliness</td>
<td>14.64</td>
<td>15.03</td>
<td>14.16</td>
<td>-0.87</td>
<td>0.111</td>
</tr>
</tbody>
</table>

*Note.* Non-college students were reference group (0) in linear regressions. \(b = \) unstandardized beta coefficient; \(p = \) p-value.

**EMA Drinking Descriptives**

To calculate drinking descriptives for the 14-day monitoring period, all relevant variables were time-led by one timepoint to ensure that participant’s responses to drinking questions aligned with the correct day/time of the drinking event in question. Given that drinking questions on each survey asked about drinking that occurred since the previous timepoint, time-leading
drinking data allowed for a precise understanding of the day and time-of-day of reported drinking events, while excluding drinking data that was not relevant to the 14-day monitoring period (i.e., drinking that occurred prior the start of the study, as assessed on the Day 1 Morning Survey). After time leading the variables, descriptive statistics were calculated by study day and timepoint (i.e., morning and afternoon).

On average, participants drank alcohol on 6.25 days ($SD = 3.65$) or 44.64% ($SD = 26.09$) of the two-week monitoring period, although one participant did not engage in any alcohol use during the study. Participants consumed an average of 4.61 ($SD = 2.48$) drinks per drinking day and engaged in roughly 3.33 ($SD = 3.32$) heavy drinking days (i.e., 4+ drinks for women, 5+ drinks for men). College students engaged in significantly fewer drinking days ($b = -1.40$, $p < .001$) and heavy drinking days ($b = -.81$, $p < .001$) compared to non-college students, although they did not differ in average number of drinks consumed on drinking days ($b = -.06$, $p = .614$).

Drinking rates were discordant across timepoints, with participants consuming alcohol on an average of 2.72 ($SD = 3.16$) occasions between the morning and afternoon surveys (i.e., during the day/early afternoon) and an average of 5.35 ($SD = 3.35$) occasions between the afternoon and morning (i.e., late afternoon/night). Excluding missing data, this corresponds to an average drinking rate of 20.75% ($SD = 23.60$) during the day/early afternoons and 43.71% ($SD = 26.57$) during late afternoon/nights. Drinking quantity also varied across timepoints, with participants consuming an average of .61 ($SD = .84$) drinks between morning and afternoon surveys, and an average of 1.73 ($SD = 1.10$) drinks between the afternoon and morning surveys.

Drinking occasions were predominantly social (i.e., drinking with at least one other person), with only 27.61% of morning and 22.11% of evening drinking occurring alone (i.e., solitary). Roughly a quarter (26.47%) of total drinking events for non-college students were
solitary, compared to 19.67% for college students. When accounting for the nested nature of the data, college students and non-college students did not differ significantly in likelihood of engaging in social compared to solitary drinking ($b = 1.70, p = .11$).

**EMA Loneliness Descriptives**

The mean scores across participants for emotional and social loneliness were 8.02 ($SD = 1.85$) and 6.62 ($SD = 1.69$), respectively, which both fall into the average range as specified by the original measure development paper (Vincenzi & Grabosky, 1987; see Measures section for more details). The mean total ESLI score was 14.62 ($SD = 3.17$), with one participant not endorsing any emotional or social loneliness across the monitoring period. College students had a significantly lower average emotional loneliness score compared to non-college students ($b = - .87, p < .001$), while average social and total loneliness did not differ by college student status. Average emotional ($b = -.17, p = .575$), social ($b = -.44, p = .09$), and total loneliness scores ($b = -.61, p = .26$) did not differ significantly by timepoint.

**EMA Drinking Motive Descriptives**

Average daily scores on individual items assessing drinking motives are as follows: social ($M = 2.85, SD = .92$), coping ($M = 2.27, SD = 1.09$), enhancement ($M = 3.15, SD = .98$), conformity ($M = 2.02, SD = .85$), and loneliness alleviation ($M = 1.78, SD = .76$). College students exhibited higher scores on social ($b = .19, p < .001$), but lower scores on enhancement ($b = -.18, p < .01$), coping ($b = -.51, p < .001$), conformity ($b = -.24, p < .001$), and loneliness alleviation ($b = -.18, p < .001$) motives as compared to non-college students. See Table 2 for mean comparisons between college and non-college students for drinking behavior, drinking motives, loneliness, and age.
Aim 1: Emotional and Social Loneliness Predicting Drinking Likelihood (Part 1 of the Hurdle Proxy Model)

A series of models were fit examining relations between loneliness and drinking likelihood (i.e., the first part of the hurdle model). Models including varying combinations of emotional and social loneliness (i.e., a combined model with a total composite loneliness score, a model including both emotional and social loneliness subtypes separately) and inclusion/exclusion of theoretically important covariates (age, gender, college student status, relationship status, alcohol dependence severity, day-of-week, and drinking at previous timepoint) were fit and compared. Additionally, random slopes for time-varying predictors at level 1 (i.e., within-person emotional and social loneliness, previous timepoint drinking) were considered to examine variation in effects across participants and its potential impact on fixed effect coefficients and overall model fit. Results from the final model, which included fixed effects for emotional and social loneliness (within- and between-person) and fixed effects for all covariates, are reported below due to maximization of model parsimony. Notably, fixed effect coefficients for emotional and social loneliness remained largely consistent with and without the inclusion of covariates, so all covariates were included in the final model to maximize variance accounted for compared to the intercept-only model (pseudo $r^2 = .13$).\(^1\)

The final model had significant variance at the intercept ($\sigma^2 = 1.21$), with results indicating that weekends ($OR = 2.72, p < .001$), age ($OR = 1.05, p = .002$), and alcohol dependence severity ($OR = 1.07, p = .004$) were all significantly associated with elevated likelihood of drinking. Gender, college student and relationship status, and drinking at the

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\(^1\) Due to concern with multicollinearity of between-person loneliness variables (VIFs > 5), the model was refit with a between-person total loneliness (i.e., total ESLI) score only. Results remained consistent, so the original model with between-person emotional and social loneliness was retained.
previous timepoint were unrelated to drinking likelihood. Within-person emotional loneliness was associated with increased likelihood of drinking \((OR = 1.09, p = .03)\), such that a one unit increase in emotional loneliness above an individual’s average corresponded to a 9% increase in likelihood of drinking. Conversely, social loneliness was negatively associated with drinking likelihood \((OR = .897, p = .02)\), whereby a one unit increase in social loneliness above an individual’s average corresponded to a 10.3% decrease in drinking likelihood. Between-person emotional and social loneliness were unrelated to drinking likelihood in the final model.

**Aim 1: Emotional and Social Loneliness Predicting Drinking Quantity (Part 2 of the Hurdle Proxy Model)**

A similar series of models were fitted with drinking quantity as the outcome. Results from the final model indicated significant intercept variability \((\sigma^2 = .151)\). Inclusion of random slopes for within-person social and emotional loneliness yielded model convergence issues, so they were removed. Inclusion of random slopes for previous timepoint drinking resulted in only marginally improved model fit, so the model was refitted with fixed effects only for all predictors. The final model with fixed effects for all predictors and covariates is presented and discussed in this section (pseudo \(r^2 = .12\)). Notably, fixed effect coefficients for emotional and social loneliness remained largely consistent regardless of inclusion/exclusion of covariates.\(^2\)

Gender \((IRR = 1.52, p = .002)\) and weekends \((IRR = 1.22, p < .001)\) were both significantly associated with an increased drinking rate, such that males had a 52% higher drinking rate than females and participants drank 22% more on weekends compared to weekdays. Within-person emotional loneliness was positively associated with drinking rate \((IRR \quad 2\) Multicollinearity of between-person emotional and social loneliness was also noted in the count portion of the hurdle proxy model (VIFs > 10); however, inclusion of a between-person total loneliness (i.e., total ESLI) score did not significantly change results, so the original model was also retained.
= 1.06, *p* < .001), while within-person social loneliness was negatively associated with drinking rate (IRR = .954, *p* < .001). Specifically, a one-unit increase in emotional and social loneliness above an individual’s mean corresponded to a ~ 6% increase and ~ 5% decrease in drinking rate, respectively. Between-person emotional and social loneliness were both unrelated to drinking rate. See Table 3 for a summary of results from the final hurdle proxy model (both parts).

**Aim 2: Drinking Context as a Moderator of Loneliness-Drinking Associations**

An additional model was fit examining the main effect of drinking context (social or solitary) on drinking quantity, as well as separate level 1 interactions between drinking context and within-person emotional and social loneliness. This model was otherwise identical to the final count model described in Aim 1. A random intercept was specified (σ² = .137), while all slopes were entered as fixed effects only due to limited variance in effects across participants. Both within-person emotional loneliness (*b* = -.002, *p* = .95) and social loneliness interactions (*b* = -.034, *p* = .48) with drinking context were non-significant and were removed.

Results from the final model indicated that drinking context was positively associated with number of drinks consumed (IRR = 1.21, *p* = .03), such that social drinking was characterized by a ~21% higher rate of consumption as compared to solitary drinking. Other coefficients remained relatively consistent to those of the final count model from Aim 1, with only marginal changes. Weekends (IRR = 1.21, *p* < .001), gender (IRR = 1.54, *p* = .001), and within-person emotional (IRR = 1.06, *p* < .001) remained positively associated with number of drinks consumed, while social loneliness (IRR = .957, *p* = .02) remained negatively associated with number of drinks consumed. See Table 4 for final model results from Aim 2.³

³The potential impact of multicollinearity of between-person emotional and social loneliness was also examined in this model. Results from the model with between-person emotional and social loneliness were highly consistent compared to the model that included one between-person total loneliness score, so the original model was retained.
Table 3. Summary of Final Hurdle Proxy Model Results for Aim 1

<table>
<thead>
<tr>
<th>Within-Person</th>
<th>Drinking Day (Yes/No)</th>
<th>Number of Drinks Per Drinking Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
</tr>
<tr>
<td>Social Loneliness</td>
<td>-.109</td>
<td>.046</td>
</tr>
<tr>
<td>Emotional Loneliness</td>
<td>.087</td>
<td>.041</td>
</tr>
<tr>
<td>Weekend</td>
<td>.999</td>
<td>.137</td>
</tr>
<tr>
<td>Previous Timepoint Drinking</td>
<td>-.204</td>
<td>.156</td>
</tr>
</tbody>
</table>

| Between-Person                       |                                      |                                    |
| Gender                               | .019      | .309    | .949 | 1.019 ( .557, 1.869) | .421      | .134    | .002  | 1.524 (1.172, 1.982)         |
| College Student Status               | .123      | .366    | .736 | 1.131 ( .552, 2.317) | .167      | .164    | .310  | 1.181 ( .856, 1.630)         |
| Age                                  | .045      | .015    | .002 | 1.046 (1.017, 1.077) | .002      | .007    | .746  | 1.002 ( .989, 1.015)         |
| ADS Score                            | .068      | .024    | .004 | 1.070 (1.021, 1.121) | .015      | .010    | .122  | 1.015 ( .996, 1.035)         |
| Relationship Status                  | .060      | .351    | .863 | 1.062 ( .534, 2.112) | -.142     | .150    | .345  | .868 ( .647, 1.164)          |
| Social Loneliness                    | .094      | .083    | .258 | 1.098 ( .934, 1.292) | .021      | .036    | .560  | 1.021 ( .952, 1.095)         |
| Emotional Loneliness                 | -.068     | .075    | .363 | .934 ( .807, 1.081)   | -.009     | .032    | .774  | .991 ( .931, 1.054)          |
| Intercept                            | -3.653    | .661    | .001 | 0.507 (.007, .095)    | .562      | .33     | .087  | 1.474 (1.336, 1.684)         |

Note. $b =$ unstandardized estimate; $SE =$ standard error; $p =$ p-value; $CI =$ confidence interval. $^1n =$ 60 participants; 1421 observations. $^2n =$ 58 participants; 456 observations.
Table 4. Summary of Final Model Results for Aim 2

<table>
<thead>
<tr>
<th></th>
<th>Number of Drinks per Drinking Day</th>
<th></th>
<th></th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Within-Person</td>
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<td></td>
</tr>
<tr>
<td>Social Loneliness</td>
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<td>.018</td>
<td>.016</td>
<td>.957</td>
</tr>
<tr>
<td>Emotional Loneliness</td>
<td>.061</td>
<td>.018</td>
<td>&lt; .001</td>
<td>1.063</td>
</tr>
<tr>
<td>Weekend</td>
<td>.195</td>
<td>.058</td>
<td>&lt; .001</td>
<td>1.215</td>
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<td>Previous Timepoint Drinking</td>
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<td>.064</td>
<td>.339</td>
<td>.941</td>
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<tr>
<td>Drinking Context</td>
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<td>1.211</td>
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<td>Between-Person</td>
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<td>Gender</td>
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<td>.006</td>
<td>.608</td>
<td>1.003</td>
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<td>ADS Score</td>
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<td>.009</td>
<td>.127</td>
<td>1.015</td>
</tr>
<tr>
<td>Relationship Status</td>
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<td>.402</td>
<td>.885</td>
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<tr>
<td>Social Loneliness</td>
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<td>.036</td>
<td>.671</td>
<td>1.015</td>
</tr>
<tr>
<td>Emotional Loneliness</td>
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<td>.033</td>
<td>.947</td>
<td>.998</td>
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<tr>
<td>Intercept</td>
<td>.798</td>
<td>.294</td>
<td>.007</td>
<td>2.221</td>
</tr>
</tbody>
</table>

Note. b = unstandardized estimate; SE = standard error; p = p-value; CI = confidence interval. n = 58 participants; 456 observations.

Aim 3 (Exploratory): Relations Between Emotional and Social Loneliness and Drinking Motives

Although the residuals of all drinking motives were non-normal, the effects were examined using linear mixed effects models, per Schielzeth et al.'s (2020) observation that these models are relatively robust to violations of residual normality. Each drinking motive was modeled separately with fixed effects for all covariates (see above), including a main effect for drinking context and separate interaction terms for level 1 social and emotional loneliness with drinking context. Due to concern with multicollinearity of between-person emotional and social loneliness (VIFs > 5) and its impact on coefficient estimates, these variables were replaced with a total composite loneliness score at the between-person level in each model.
**Loneliness Alleviation Motives**

Results from the initial model for loneliness alleviation motives had a significant social loneliness X drinking context interaction \( (b = -0.12, p = .04) \) and a non-significant emotional loneliness X drinking context interaction \( (b = 0.09, p = .06) \). Removal of the non-significant emotional loneliness X drinking context interaction term resulted in the social loneliness X drinking context interaction term becoming nonsignificant, which is likely attributable to multicollinearity \( (VIFs > 5) \). Inclusion of the social loneliness X drinking context interaction term did not significantly improve model fit and did not account for additional variance in loneliness alleviation motives \( (\text{pseudo } r^2 = 0.12) \), so it was removed.

The final model included a random intercept component \( (\sigma^2 = 0.53) \). Results indicated a significant effect of between-person total loneliness scores on loneliness alleviation motives \( (b = 0.05, p < .001) \), such that higher loneliness across the monitoring period was associated with elevated loneliness alleviation motives on a given drinking occasion. No other effects in the model were statistically significant. Final model results are presented in Table 5.

**Coping Motives**

Results from the initial model for coping motives showed a significant emotional loneliness X drinking context interaction \( (b = 0.12, p = .03) \) and a non-significant social loneliness X drinking context interaction \( (b = -0.07, p = .29) \). Both interaction terms were removed before refitting due to 1) multicollinearity, 2) non-significant improvement in model fit, 3) no differences in variance accounted for \( (\text{pseudo } r^2 = 0.13) \), and 4) model parsimony.

The final model had significant variance at the intercept \( (\sigma^2 = 0.45) \). Between-person total loneliness scores were significantly associated with coping motives \( (b = 0.04, p < .001) \), in that individuals with higher average loneliness across the monitoring period endorsed greater coping
motives for a given drinking occasion. Main effects for college student status ($b = -.57, p = .03$) and drinking context ($b = -.298, p = .02$) were negatively significant, in that being a college student and engaging in a social drinking episode were both associated with lower coping motives for a given drinking event. Alcohol dependence was positively associated with drinking to cope ($b = .04, p = .01$), such that higher levels of alcohol dependence predicted a marginal increase in coping motives on a given drinking occasion. See Table 6 for final model results.

Social Motives

Results from the initial model indicated that both interaction terms were non-significant, so they were removed from the model to allow for main effect interpretation. The final model included a random variance component at the intercept ($\sigma^2 = .32$). Weekends ($b = .32, p = .002$) and social drinking context ($b = 1.34, p < .001$) were both associated with higher levels of social drinking motives for a given drinking occasion. No other effects reached statistical significance. See Table 7 for final model results.

Enhancement Motives

Results from the initial model indicated that both interaction terms were non-significant, so the model was refitted after removing the interaction terms to examine main effects. The final model had a significant random intercept component ($\sigma^2 = .61$). Within-person social loneliness was positively associated with enhancement motives ($b = .05, p = .03$), such that higher levels of social loneliness were associated with higher enhancement motives for a given drinking occasion. No other effects reached statistical significance. See Table 8 for final model results.

Conformity Motives

Results from the initial model indicated a significant drinking context X within-person social loneliness interaction ($b = -.18, p = .007$) and a non-significant drinking context X within-
person emotional loneliness interaction ($b = .02, p = .72$). The non-significant interaction term was removed, and the model was refitted. The drinking context X within-person social loneliness interaction remained significant ($b = -.17, p = .003$); however, 1) the results of this interaction are misaligned with theory (e.g., social loneliness predicted higher conformity motives only when individuals are drinking alone) and 2) the interaction term and main effect terms were highly collinear (VIFs > 5), which can contribute to unreliable hypothesis testing and biased coefficient estimates. Because of these concerns, both interaction terms were removed, and the model was refitted. Results from the final model showed significant random variance at the intercept ($\sigma^2 = .42$). The only significant fixed effect in the final model was drinking context ($b = .669, p < .001$), in that social drinking was associated with higher conformity motives on a given drinking occasion (compared to drinking alone). The final model results are presented in Table 9.

### Table 5. Summary of Model Results for Loneliness Alleviation Motives

<table>
<thead>
<tr>
<th></th>
<th>Loneliness Alleviation Motives</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$b$</td>
<td>95% CI</td>
<td>$SE$</td>
<td>$p$</td>
</tr>
<tr>
<td><strong>Within-Person</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Loneliness</td>
<td></td>
<td>.013</td>
<td>(-.034, .061)</td>
<td>.024</td>
<td>.579</td>
</tr>
<tr>
<td>Emotional Loneliness</td>
<td></td>
<td>.006</td>
<td>(-.039, .050)</td>
<td>.023</td>
<td>.802</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
<td>.067</td>
<td>(-.081, .216)</td>
<td>.075</td>
<td>.371</td>
</tr>
<tr>
<td>Previous Timepoint Drinking</td>
<td></td>
<td>-.037</td>
<td>(-.209, .133)</td>
<td>.087</td>
<td>.666</td>
</tr>
<tr>
<td>Drinking Context</td>
<td></td>
<td>-.148</td>
<td>(-.371, .074)</td>
<td>.113</td>
<td>.191</td>
</tr>
<tr>
<td><strong>Between-Person</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>.152</td>
<td>(-.302, .603)</td>
<td>.227</td>
<td>.505</td>
</tr>
<tr>
<td>College Student Status</td>
<td></td>
<td>-.026</td>
<td>(-.560, .510)</td>
<td>.269</td>
<td>.922</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>.013</td>
<td>(-.008, .035)</td>
<td>.011</td>
<td>.226</td>
</tr>
<tr>
<td>ADS Score</td>
<td></td>
<td>.015</td>
<td>(-.018, .049)</td>
<td>.017</td>
<td>.369</td>
</tr>
<tr>
<td>Relationship Status</td>
<td></td>
<td>.101</td>
<td>(-.385, .585)</td>
<td>.244</td>
<td>.681</td>
</tr>
<tr>
<td>Total Loneliness</td>
<td></td>
<td>.049</td>
<td>(.028, .070)</td>
<td>.010</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Intercept</td>
<td></td>
<td>1.45</td>
<td>(.471, 2.43)</td>
<td>.494</td>
<td>.004</td>
</tr>
</tbody>
</table>

*Note. $b =$ unstandardized estimate; $SE =$ standard error; $p =$ p-value; $CI =$ confidence interval. $n =$ 58 participants; 456 observations.*
### Table 6. Summary of Model Results for Coping Motives

<table>
<thead>
<tr>
<th></th>
<th>Coping Motives</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$b$</td>
<td>95% CI</td>
<td>$SE$</td>
<td>$p$</td>
</tr>
<tr>
<td><strong>Within-Person</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Loneliness</td>
<td>.045</td>
<td>(.011, .010)</td>
<td>.028</td>
<td>.113</td>
<td></td>
</tr>
<tr>
<td>Emotional Loneliness</td>
<td>.000</td>
<td>(.052, .052)</td>
<td>.003</td>
<td>.995</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>-.066</td>
<td>(-.238, .106)</td>
<td>.088</td>
<td>.449</td>
<td></td>
</tr>
<tr>
<td>Previous Timepoint Drinking</td>
<td>.116</td>
<td>(-.081, .313)</td>
<td>.100</td>
<td>.248</td>
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</tr>
<tr>
<td>Drinking Context</td>
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<td>(-.554, -.039)</td>
<td>.129</td>
<td>.022</td>
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</tr>
<tr>
<td><strong>Between-Person</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
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<td>.265</td>
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<tr>
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<td>(-1.09, -.048)</td>
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<tr>
<td>Age</td>
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<td>(-.027, .015)</td>
<td>.001</td>
<td>.555</td>
<td></td>
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<tr>
<td>ADS Score</td>
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<td>(.013, .078)</td>
<td>.016</td>
<td>.007</td>
<td></td>
</tr>
<tr>
<td>Relationship Status</td>
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<td>(-.340, .601)</td>
<td>.236</td>
<td>.582</td>
<td></td>
</tr>
<tr>
<td>Total Loneliness</td>
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<td>(.023, .062)</td>
<td>.010</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td><strong>Intercept</strong></td>
<td>2.23</td>
<td>(1.255, 3.185)</td>
<td>.485</td>
<td>&lt;.001</td>
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</tbody>
</table>

*Note. $b$ = unstandardized estimate; $SE$ = standard error; $p$ = p-value; $CI$ = confidence interval. n = 58 participants; 456 observations.*

### Table 7. Summary of Model Results for Social Motives

<table>
<thead>
<tr>
<th></th>
<th>Social Motives</th>
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<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
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<td></td>
<td></td>
<td>$b$</td>
<td>95% CI</td>
<td>$SE$</td>
<td>$p$</td>
</tr>
<tr>
<td><strong>Within-Person</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Loneliness</td>
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<td>(-.116, .010)</td>
<td>.032</td>
<td>.102</td>
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<tr>
<td>Emotional Loneliness</td>
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<td>Weekend</td>
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<td>(-.028, .008)</td>
<td>.009</td>
<td>.273</td>
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*Note. $b$ = unstandardized estimate; $SE$ = standard error; $p$ = p-value; $CI$ = confidence interval. n = 58 participants; 456 observations.*
Table 8. Summary of Model Results for Enhancement Motives

<table>
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<td>SE</td>
<td>p</td>
</tr>
<tr>
<td>Within-Person</td>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>Social Loneliness</td>
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<td>(.005, .101)</td>
<td>.023</td>
<td>.030</td>
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<tr>
<td>Emotional Loneliness</td>
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<td>(-.114, .183)</td>
<td>.076</td>
<td>.650</td>
</tr>
<tr>
<td>Previous Timepoint Drinking</td>
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<td>(-.109, .234)</td>
<td>.087</td>
<td>.470</td>
</tr>
<tr>
<td>Drinking Context</td>
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<td>(-.212, .238)</td>
<td>.114</td>
<td>.908</td>
</tr>
<tr>
<td>Between-Person</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
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<td>(-.653, .336)</td>
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<tr>
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<td>(1.340, 3.474)</td>
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<td>&lt; .001</td>
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</table>

Note. b = unstandardized estimate; SE = standard error; p = p-value; CI = confidence interval. n = 58 participants; 456 observations.

Table 9. Summary of Model Results for Conformity Motives

<table>
<thead>
<tr>
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<th>Conformity Motives</th>
<th></th>
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<tr>
<td></td>
<td>b</td>
<td>95% CI</td>
<td>SE</td>
<td>p</td>
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<td>Emotional Loneliness</td>
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<td>Intercept</td>
<td>1.348</td>
<td>(.425, 2.29)</td>
<td>.469</td>
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Note. b = unstandardized estimate; SE = standard error; p = p-value; CI = confidence interval. n = 58 participants; 456 observations.
CHAPTER FOUR: DISCUSSION

Theoretical (e.g., Åkerlind & Hörnquist, 1992; Mijuskovic, 1988; Orrok, 1989) and empirical (e.g., Arpin et al., 2015; Diehl et al., 2018; Horigian et al., 2021; Hull, 1981; Page & Cole, 1991; Sadava & Thompson, 1986; Segrin et al., 2018; Yeh, 2002) discussions have consistently highlighted loneliness as a contributing and maintaining factor of problematic alcohol use; however, the precise nature of these relations remains largely unknown, with most examinations measuring loneliness as a unidimensional construct among individuals who are non-dependent on alcohol. By applying a multidimensional conceptualization of loneliness (i.e., tapping into emotional and social components) the current study examined 1) how individuals with AUD subjectively experience loneliness, 2) how these experiences fluctuate within-participants, 3) how these within-participant fluctuations relate to subsequent drinking behavior, and 4) how loneliness-drinking associations may vary as a function of drinking context (social vs. solitary) and loneliness dimension (emotional or social). Results indicated significant within-person associations between emotional and social loneliness and subsequent drinking, although the effects were positive for emotional and negative for social loneliness. Additionally, there was no evidence for differences in these patterns as a function of drinking context (social vs. solitary). These findings, as well as results from exploratory analyses assessing relations between loneliness and various drinking motives, are discussed in the context of relevant psychological theories and gaps in the literature.
Loneliness: Importance of Disaggregating Within- and Between-Person Experiences

In line with Weiss' (1973) assertion that emotional and social loneliness are overlapping but distinct constructs, momentary (within-person) experiences of emotional and social loneliness were only moderately correlated, although mean-level (between-person) scores were nearly inseparable. These patterns highlight important differences in the experience of loneliness that occur within- and between-persons, reinforcing the need to apply daily process methodology to disaggregate the unique influence of average (between-person) and daily (within-person) experiences of emotional and social loneliness on drinking behavior. This lack of distinction is a broader issue in the literature that has likely contributed to inconsistent findings on loneliness-drinking associations. To exemplify, several studies examining between-participant relations between loneliness and drinking (e.g., frequency and quantity) have reported null results (Bragard et al., 2022; Rhew et al., 2021; Shank, 2022; Yeh, 2002), with one study even reporting negative associations (Hofman et al., 2022). Taking these findings at face value may lead to erroneous conclusions on how loneliness is related to alcohol use, as other studies that have focused on drinking consequences and drinking at the daily level have found opposite patterns (i.e., positive associations; Arpin et al., 2015; Horigian et al., 2021; Segrin et al., 2018).

Aim 1: Daily and Mean-Level Associations Between Loneliness and Drinking

Examination of associations between emotional and social loneliness showed that within-person elevations in emotional loneliness predicted subsequent increases in drinking likelihood and rates of consumption, while within-person elevations in social loneliness predicted subsequent decreases in drinking likelihood and rates of consumption. These effects were relatively large, such that a one unit increase in emotional loneliness above a person’s mean corresponded to an increased drinking likelihood of ~9% and an increased drinking rate of ~6%.
For social loneliness, a one unit increase above a person’s mean corresponded to a decreased drinking likelihood of ~10% and decreased drinking rate of ~5%. Notably, and in line with several previous studies, between-person (e.g., average levels across the monitoring period) emotional and social loneliness were unrelated to drinking, suggesting that transient experiences of loneliness (as compared to dispositional levels) are most relevant to drinking behavior.

Perlman and Peplau's (1981) cognitive discrepancy-attributioinal model may offer some insight into these different patterns by emphasizing that transient loneliness arises when one’s desired and achieved degree of social relations become misaligned. Although this model defines discrepancies more objectively in terms of “desired” versus “achieved” social relations/contact, it is possible that subjective discrepancies between “typical” (e.g., dispositional levels) and “actual” (i.e., transient experiences) levels of loneliness are equally important. To explain, it may be that an individual’s in-the-moment sense of loneliness is always compared to their average levels of loneliness, whereby deviations from that average are what constitute how lonely an individual feels at any given time, as well as the potential influence of that experience on subsequent behavior. Heinrich and Gullone (2006) provide direct support for this premise by demonstrating that individuals with a more robust sense of social support had accentuated relations between transient loneliness and solitary drinking, suggesting that the effect of subjective loneliness on drinking behavior may be greatest when it is highly discrepant from one’s typical experience. Notably, this line of reasoning does not preclude an individual from feeling lonely if the discrepancy is small, as the cognitive-discrepancy attributional model stresses the importance of the individual’s subjective interpretation (i.e., cognitive attribution) of a given discrepancy. Although it is indiscernible whether participants were engaging in
cognitive-attributional processes when reporting on their current loneliness, the within-person findings suggest that deviations in loneliness are temporally related to drinking behavior.

Although findings for emotional loneliness were consistent with our prediction, the inverse pattern identified for social loneliness was unexpected. Weiss' (1973) original theory characterized emotional loneliness as a more acutely painful form of loneliness, emphasizing its considerable overlap with other negative affective states (e.g., anxiety and depression), while social loneliness is much less implicated in psychological distress, and more so an indicator of boredom, aimlessness, or marginality. Indeed, higher emotional, but not social, loneliness is associated with lower levels of psychological well-being and higher levels of depression and anxiety (Hyland et al., 2019; Wolters, 2022). It is possible that experiencing elevated levels of emotional loneliness is more indicative of an internalized negative affective state, whereas elevated levels of social loneliness is more a response to the current perceived presence/absence of social connection. The internalized nature of emotional loneliness and the potentially significant overlap with depressive symptomatology might also explain why interventions aimed at merely facilitating social contact do little to attenuate subjective experiences of loneliness (Ingram, Kelly, Haslam, et al., 2020). In line with the multistage theory of addiction and motivational models of substance use, it is possible that drinking in response to emotional loneliness reflects a coping or self-medicating response, where alcohol consumption serves to alleviate the negative affective state an individual is experiencing (Cooper et al., 1995; Koob et al., 2004).

Unlike emotional loneliness-drinking patterns, the negative association noted for social loneliness and drinking may reflect how individuals respond to perceived deficits in their social relationships, rather than perceived emotional disconnection. Given that social loneliness has
been demonstrated to be more strongly related to social isolation than emotional loneliness (Wolters, 2022), and that social loneliness is generally less implicated in psychological dysfunction (Hyland et al., 2019), it may be that transient social loneliness can be more readily alleviated via adaptive behavioral strategies. Indeed, Weiss (1973) and Russell et al. (1984) postulate that relieving social loneliness involves seeking out social contact and integration, which is likely more achievable than fostering a deeper emotional connection with another individual. The degree to which individuals engaged in other adaptive behavioral responses in response to social loneliness, however, is unanswerable within the current study. It is equally plausible that decreases in alcohol consumption following social loneliness can be ascribed to general social withdrawal. To this point, Arpin et al. (2015) found negative temporal relations between loneliness and social drinking that were mediated by degree of social contact, such that transient loneliness predicted decreases in social interactions, which in turn decreased social consumption. There is also EMA research suggesting that the burden of loneliness (i.e., its influence on psychological well-being) remains the same (or may even be exacerbated) when people are with others compared to being alone, which suggests that the mere presence of others is not enough to decrease the effects of loneliness (Stavrova & Ren, 2023). Given that drinking in our society is typically socially oriented, it is possible that elevated social loneliness precipitates general social withdrawal, making social drinking (and maybe general drinking) opportunities relatively unlikely. Nevertheless, it is important to consider that other variables implicated in socio-affective processes (e.g., one’s current social context and the immediate accessibility of other social contexts) may play an important role in loneliness-drinking associations. Hence, Aim 2 explored whether the effect of emotional and social loneliness on drinking rates varied across drinking contexts (social vs. solitary).
Aim 2: Influence of Context on Loneliness-Drinking Associations

Contradictory to original study hypotheses, associations between emotional and social loneliness and drinking did not vary across drinking contexts, although there was a direct effect for drinking context in that drinking rates were significantly higher (~22%) in social compared to solitary settings. These findings were unexpected for several reasons: 1) theory and empirical data suggest that negative-affect related drinking typically occurs in solitary settings (Arpin et al., 2015; Keough et al., 2018; Mohr et al., 2001), 2) AUD and elevated loneliness are both associated with deficits in social cognition and decreases in reward sensitivity, which may contribute to social withdrawal (Le Berre, 2019; Russell et al., 1984; Volkow et al., 2010), and 3) social and emotional loneliness are posited to promote unique behavioral responses aimed at alleviation (Arpin et al., 2015; Weiss, 1973). Hence, it was expected that emotional loneliness-drinking associations would be stronger when drinking occurred in solitary settings, while social loneliness-drinking associations would be stronger when individuals were drinking with others.

One possible explanation for the null findings, which likely influences any conclusions that can be made, is that moderation by social context was only tested for drinking rate (not drinking likelihood). Indeed, one’s social environment prior to deciding to drink (i.e., presence or absence of others) is a practical limitation that likely affects one’s ability to engage in social versus solitary drinking, as well as the likelihood that one is experiencing emotional or social loneliness at any given time. Indeed, Arpin et al. (2015) demonstrated that reductions in social contact provided additional explanatory power in predicting decreased likelihood of social drinking, so failing to consider general social interactions prior to, during, and leading up to drinking may obscure the true nature of loneliness-drinking patterns. If social loneliness is less indicative of internalized negative affective states (Hyland et al., 2019; Wolters, 2022) and can
be promptly alleviated by social contact (Weiss, 1973), then the true effect of social loneliness can only be understood if we also consider social interactions around the time of consumption. Similarly, emotional loneliness may be indicative of an internalized negative affective state that would trigger a coping response and (more often than not) solitary drinking (Arpin et al., 2015; Stavrova & Ren, 2023; Van Buskirk & Duke, 1991); however, one’s current social circumstances (e.g., being surrounded by other people) can confound true associations that would otherwise be uncovered.

A final explanation of the null loneliness X drinking context interaction effects is related to the omission of reasons why people are engaging in consumption. Although the analyses established temporal relations among loneliness, drinking, and drinking context, people’s motivations for engaging in alcohol consumption are not explicitly considered in these analyses. It is probable that individual differences in drinking motives are implicated in drinking as well as the context in which drinking is taking place. For instance, loneliness may not necessarily be the mechanism driving consumption for all individuals; some people may endorse enhancement, coping, or social motives as the cognitive factors that are responsible for their drinking on any given occasion. Similarly, people’s drinking motives may differ as a function of drinking context. Aim 3 began to address this limitation by considering differential relations between emotional and social loneliness and subsequent drinking motives, which is a solid first step toward testing multilevel mediation.

**Aim 3 (Exploratory): Relations Between Loneliness and Drinking Motives Across Contexts**

Although temporal relations between emotional and social loneliness and subsequent drinking behavior were established in the previous aims of the study, it is also important to examine how these subjective experiences are prospectively associated with self-reported...
motivations for drinking. This is a great first step toward furthering our understanding of potential mechanisms driving loneliness-drinking relations. Results from this exploration indicated that higher mean levels of loneliness (between-person) were associated with elevated loneliness alleviation and coping motives on a given occasion, while within-person social loneliness was associated with elevated enhancement motives on a given occasion. Within-person emotional loneliness was not associated with subsequent drinking motives in any of the specified models. Importantly, it remains unclear how drinking motives are implicated in actual consumption; multilevel mediation was not examined due to limited statistical power.

While no specific hypotheses for these analyses were outlined, it is interesting that within-person emotional loneliness was unrelated to coping and loneliness alleviation motives, particularly given the theoretical assertion that drinking often occurs in response to negative affective experience in those who are dependent on alcohol (Koob et al., 2004). Nevertheless, null findings for relations between experiences (e.g., emotional loneliness) and motivations for behavior (e.g., coping and loneliness alleviation drinking motives) does not necessarily mean that these motives were not implicated in an individual’s decision to drink. Indeed, Nisbett and Wilson (1977) provide compelling evidence that individuals may have limited insight into the cognitive processes mediating the influence of stimuli on responses, which often leads to erroneous conclusions or post-hoc explanations that are inconsistent with actual behavioral patterns. Given that participants in the current study were asked to report on their drinking motives after they had already engaged in a drinking episode, it is possible that a priori implicit causal theories of their typical behavior are confounding the objectivity of their self-reports. To exemplify, some participants may attribute their typical alcohol use to enhancement purposes, which may bias post-hoc descriptions of their decisions on a given occasion (Dora et al., 2022).
Relatedly, it is possible that associations between subjective affective experiences and drinking motives better explain individual differences, rather than intraindividual processes. Our findings that mean total loneliness (between-person) was associated with elevated coping and loneliness alleviation motives on a given occasion is consistent with cross-sectional evidence showing that individuals who are more lonely tend to endorse higher coping motives, which accentuates frequency of alcohol consumption (Mohr et al., 2021). Several other studies have consistently highlighted positive associations between drinking motives and substance use between participants; however, momentary assessments of affective experiences and subsequent drinking are often inconsistent with such notions (e.g., positive affect not predicting consumption among individuals higher on enhancement motives; Dora et al., 2022, 2023). Discrepant patterns between loneliness and self-reported drinking motives across levels of analysis in the current study further highlight issues with understanding how and when negative affective experiences may influence self-reported drinking motives, and (potentially) alcohol consumption. It is relatively clear that individuals who experience more negative affect on average report greater coping motives and consumption, but future research is needed to understand how this maps on to intraindividual drinking patterns.

Further, the current study provides evidence that within-person social loneliness predicted subsequent elevations in enhancement motives on a given drinking occasion. Although the same limitations in post-hoc self-reports of behavioral motives outlined by Nisbett & Wilson (1977) remain relevant, these findings are in line with theory suggesting that social loneliness is a less severe form of loneliness that is more implicated in boredom, aimlessness, and marginality (Weiss, 1973). Under this assumption, it makes sense that social loneliness may accentuate a desire to enhance positive emotionality, rather than a need to alleviate a negative affective
experience. Colder et al. (2010) report that individuals who primarily drink for reasons related to positive reinforcement are more likely to focus on reward-relevant stimuli (e.g., a positive attentional bias), which may maintain a priori causal theories that focus primarily on the internal positive reinforcement mechanisms of consumption. Firm conclusions on this possibility cannot be offered given the current study design; however, future research should examine 1) the circumstances in which global (i.e., between-person) and momentary drinking motives converge and 2) whether momentary (or global) drinking motives mediate relations between affective experiences and subsequent consumption.

**Clinical Implications**

Findings from the current study suggest that loneliness consists of two relatively unique subjective experiences (e.g., emotional and social) with each subtype being differentially implicated in patterns of alcohol consumption. Without considering these important differences, implementation of interventions for alcohol misuse that target social processes may lead to null effects (Ingram, Kelly, Haslam et al., 2020), as emotional and social loneliness likely require unique treatment components. Since emotional loneliness is consistently recognized as a more severe form of loneliness that significantly overlaps with other negative affective experiences (e.g., anxiety and depression), a greater focus on cognitive restructuring and development of deeper social connection may be warranted. Indeed, Alcoholics Anonymous (AA; Orrok, 1989) is an effective intervention for alcohol use that inherently involves the development of supportive social networks, with some evidence even proposing that social support processes mediate the impact of AA on abstinence (Groh et al., 2008). Other loneliness-oriented interventions have identified meaningful relationship development and cognitive restructuring (e.g., reappraisal of one’s self and others within relationships) as the most important factors in
reducing subjective experiences of loneliness (Masi et al., 2011). Additionally, research has consistently shown that development of a strong therapeutic alliance predicts improved treatment outcomes during psychotherapy, as well as reductions in drinking between sessions (Connors et al., 2016). These interventions are most consistent with alleviating an emotional loneliness typology, and future research should consider the role of developing and strengthening deeper social connections in reducing emotional versus social loneliness, as well as prospective changes in drinking behavior.

On the other hand, it is possible that experiences of social loneliness are more normative, requiring less consideration in the development and implementation of alcohol use interventions. In fact, Yeh (2002) demonstrated that individuals with problematic substance use patterns exhibited lower levels of social loneliness than did controls, and several others have noted that social loneliness is less implicated in psychological distress (Hyland et al., 2019; Weiss, 1973; Wolters, 2022). Therefore, cognitive biases may be much less important for subjective experiences of social loneliness. Instead, therapies implementing behavioral activation techniques (e.g., engaging in alternative coping strategies, seeking out general social contact) may offer an effective resolution for individuals who are dealing with social loneliness. Van Buskirk & Duke (1991) found that individuals who endorsed lower levels of loneliness were more likely to engage in adaptive coping strategies when faced with loneliness compared to individuals with more intense loneliness symptomatology. Given that transient experiences of social loneliness were inversely associated with alcohol consumption in the current study, it is possible that the less severe nature of social loneliness prompted more adaptive behavioral strategies (e.g., pursuing social contact outside the context of alcohol consumption). Nonetheless, future research is required to examine the effectiveness of behavioral activation, development of
more adaptive coping strategies, and cognitive restructuring on subjective experiences of emotional and social loneliness among individuals with AUD to better understand any potential differences in mechanistic processes.

**Strengths and Limitations**

The current study is benefited by many strengths, including 1) a large number of observations \((n = 1566)\), 2) superb compliance rates, 3) robust analytical procedures that allowed for disaggregation of within- and between-person effects (i.e., multilevel modeling), 4) consideration of distinct loneliness subtypes (i.e., emotional and social), 5) consideration of theoretically relevant covariates (e.g., relationship status, college student status, alcohol dependence symptomatology, autoregressive influence of drinking, day-of-week), 6) both theory and data driven analytical approaches, and 7) increased focus on effect sizes over statistical significance. Nevertheless, several limitations must be acknowledged.

First, psychometric properties of the primary loneliness measure (ESLI) have yet to be examined in individuals diagnosed with AUD and in a repeated measures modality. Preliminary analyses in the current study indicate that both emotional and social loneliness map on to well-established unidimensional measures of loneliness and offer multidimensional discrimination at the daily level. Additionally, the inter-item reliabilities of both the emotional and loneliness subscales were excellent across levels of analyses (i.e., within- and between-person). Although other scales have been validated for use in substance using samples (e.g., 6-Item De Jong Loneliness Scale; Gierveld & Tilburg, 2006), the item wording on this scale only permits assessment of trait-like emotional and social loneliness, which would disallow for examination of within-person processes. Future research on psychometric properties of the ESLI (as well as other measures) and replication of findings are encouraged to strengthen validity.
Second, the study was limited in its assessment of momentary experiences of subjective loneliness to two timepoints per day (i.e., morning and afternoon). Loneliness is likely to fluctuate at an even tighter timescale, which may influence conclusions that can be made about the temporal influence of loneliness on drinking behavior in the current study. Nevertheless, similar EMA designs (and results from the current study) have showed low rates of consumption during the daytime (Arpin et al., 2015), so adding extra assessments may not provide much more information into prospective loneliness-drinking associations.

Additionally, the current study did not consider baseline levels of social isolation and objective social network size in analyses. Loneliness is a subjective experience that is distinct from social isolation; however, individuals who are more socially isolated do tend to have higher levels of loneliness (Heinrich & Gullone, 2006). Although relationship status (e.g., single vs. in a relationship) was controlled for in all analyses, other details about people’s relationships are likely implicated in both loneliness and alcohol consumption (e.g., presence of a roommate and/or living with a partner, number of friendships available). Future research should consider the differential predictive utility of social isolation and loneliness on consumption to maximize our understanding of how these two constructs predict similar or dissimilar outcomes.

Lastly, temporal associations identified in the current study do not necessarily represent causal processes. Exploratory analyses testing associations between emotional and social loneliness and subsequent motivations for engaging in alcohol use are only partly consistent with a causal sequence (e.g., between-person total loneliness predicted coping and loneliness alleviation motives; within-person social loneliness predicted enhancement motives). Motivational and multi-stage models of addiction would posit that loneliness predicts drinking through drinking motives (Cooper et al., 1995; Koob et al., 2004); however, there is limited
evidence for this proposition in the current study. Given that individuals drink for myriad reasons (i.e., combinations of coping, social, enhancement, and conformity), future research should apply more robust analytical techniques (e.g., structural equation modeling) that allows examination of 1) unique influence of each loneliness subtype on each drinking motive and 2) indirect effects of loneliness on drinking through each drinking motive. Additionally, experimental designs may be particularly useful in manipulating subjective experiences of loneliness and examining subsequent changes in drinking behavior; however, there is no existing research to inform how to best operationalize such a manipulation.

**Conclusion**

Results from the current study provide evidence that emotional and social loneliness may have unique implications for alcohol use behavior among individuals with AUD, in that transient emotional loneliness predicted increases and transient social loneliness predicted decreases in drinking behavior. Results are highly consistent with multidimensional models of loneliness that describe emotional loneliness as a more severe form that overlaps considerably with negative affective states, while social loneliness may be a more normative experience that promotes more adaptive coping responses and/or social withdrawal. No differences in effects of emotional and social loneliness were noted as a function of drinking context (social versus solitary), and limited convergence between affective experiences and subsequent drinking motives were observed. These findings reiterate the importance of adopting a multidimensional framework of loneliness, as each typology (emotional versus social) may demand different components when developing interventions for AUD. Replication of findings are encouraged, and future research should continue parsing out the underlying mechanisms of loneliness-drinking associations.
REFERENCES


Shank, F. A. (2022). *Drinking Motives as Potential Mediators of Associations Between Loneliness and Alcohol Use and Consequences Among College Students* [M.A., Rowan University]. https://www.proquest.com/docview/2679681434/abstract/A6604EA00C9D4B7EPQ/1


APPENDIX A: EMOTIONAL/SOCIAL LONELINESS INVENTORY

The purpose of this questionnaire is to help you explore what is “TRUE” in your life versus how you “FEEL” at this time. For example, you may have a mate, but due to a poor relationship, you don’t feel like you have a mate Please respond to each question by circling the response that best describes you. Please respond to both categories for each question. Response options are Strongly Agree = 3, Agree = 2, Disagree = 1, Strongly Disagree = 0.

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<th>WHAT I FEEL IN MY LIFE AT THIS TIME.</th>
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<tbody>
<tr>
<td>1. I don’t have a close friend.</td>
<td>1. I don’t feel like I have a close friend.</td>
</tr>
<tr>
<td>2. People take advantage of me when I’m involved with them.</td>
<td>2. I am afraid to trust others.</td>
</tr>
<tr>
<td>3. I don’t have a significant other.</td>
<td>3. I don’t feel like I have a significant other.</td>
</tr>
<tr>
<td>4. I don’t want to burden others with my problems.</td>
<td>4. Those close to me feel burdened by me when I share my problems.</td>
</tr>
<tr>
<td>5. There is nobody in my life who depends on me.</td>
<td>5. I don’t feel needed or important to others.</td>
</tr>
<tr>
<td>6. I don’t have any relationships that involve sharing personal thoughts.</td>
<td>6. I don’t feel I can share personal thoughts with anyone.</td>
</tr>
<tr>
<td>7. There is no one in my life that tried to understand me.</td>
<td>7. I don’t feel understood.</td>
</tr>
<tr>
<td>8. Nobody in my life really wants to be involved with me.</td>
<td>8. I don’t feel safe to reach out to others.</td>
</tr>
<tr>
<td>9. I spend a lot of time alone.</td>
<td>9. I feel lonely.</td>
</tr>
<tr>
<td>10. I am not part of any social group or organization.</td>
<td>10. I don’t feel part of any social group or organization.</td>
</tr>
<tr>
<td>11. I haven’t spoken to anyone today.</td>
<td>11. I don’t feel like I made contact with anyone today.</td>
</tr>
<tr>
<td>12. I don’t have much in common to talk about with those around me</td>
<td>12. I don’t feel I have anything to say to people.</td>
</tr>
<tr>
<td>13. When I’m with others I don’t disclose much about myself.</td>
<td>13. I don’t feel I’m being myself with others.</td>
</tr>
<tr>
<td>15. People don’t see me as an interesting person.</td>
<td>15. I don’t feel I am interesting.</td>
</tr>
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Citation for original measure: Vincenzi & Graboski (1987)
APPENDIX B: IRB APPROVAL LETTER

December 19, 2022

Brendan Walsh
4202 E Fowler Ave
Tampa, FL 33620

Dear Brendan Walsh:

On 12/17/2022, the IRB reviewed and approved the following protocol:

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<tr>
<td>Review Type:</td>
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<tr>
<td>Title:</td>
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<td>Approved Protocol and Consent(s):</td>
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  • Walsh IRB Protocol SS Drinking Study (12-14); 
  • Verbal Consent for Baseline Screening (12-14); 
  • Verbal Consent for Phone Screening (12-14); 
  • Written Informed Consent (12-14); 

Approved study documents can be found under the ‘Document’ tab in the main study workspace. Use the stumped consent found under the ‘Last Finalized’ column under the ‘Documents’ tab.

Within 30 days of the anniversary date of study approval, confirm your research is ongoing by clicking Confirm Ongoing Research in BullsIRB, or if your research is complete, submit a study closure request in BullsIRB by clicking Create Modification/CR.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Your study qualifies for a waiver of the requirements for the documentation of informed consent for online research activities as outlined in the federal regulations at 45 CFR 46.117(c).

Sincerely,

Blupinder Sain
IRB Research Compliance Administrator

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Institutional Review Boards / Research Integrity & Compliance
FWA No. 00001569
University of South Florida / 3702 Spectrum Blvd., Suite 165 / Tampa, FL 33612 / 813-974-5638