Summer 2019

The Bidirectionality of Impulsivity and Alcohol Use: An Ecological Momentary Examination Among Emerging Adults

Amy L. Stamates
Old Dominion University, stamatesa1@gmail.com

THE BIDIRECTIONALITY OF IMPULSIVITY AND ALCOHOL USE: AN ECOLOGICAL MOMENTARY EXAMINATION AMONG EMERGING ADULTS

by

Amy L. Stamates
B.S. December 2010, Northern Kentucky University
M.S. May 2016, Old Dominion University

A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

PSYCHOLOGY

OLD DOMINION UNIVERSITY
August 2019

Approved by:

Cathy Lau-Barraco (Director)

Michelle L. Kelley (Member)

Shana L. Pribesh (Member)

ABSTRACT

THE BIDIRECTIONALITY OF IMPULSIVITY AND ALCOHOL USE: AN ECOLOGICAL MOMENTARY EXAMINATION AMONG EMERGING ADULTS

Amy L. Stamates
Old Dominion University, 2019
Director: Dr. Cathy Lau-Barraco

Impulsivity is a robust risk factor for alcohol use among emerging adults (i.e., 18 to 25), but significant gaps remain in our understanding of the way that impulsivity relates to alcohol harms. Most prior research has been limited to between-level differences; thus, within-person variability in impulsivity at the momentary level and its bidirectional association with alcohol use has not been examined. Consequently, the present research used a 14-day ecological momentary assessment (EMA) design to: (1) determine momentary impulsivity as a predictor of subsequent alcohol use and problems; (2) examine the influence of alcohol use on subsequent impulsivity; (3) test socio-cognitive mechanisms (motives, expectancies, and norms) as real-time mediators explaining the link between momentary impulsivity and alcohol use; and (4) test context and sex as moderators of the relationship between momentary impulsivity and alcohol use. Participants were 96 (63 women) heavy drinking, college students. The mean age was 19.80 (*SD* = 1.76) years. Participants completed a baseline questionnaire and 14 consecutive days of momentary reports sent in the morning, afternoon, and evening; participants also completed two user-initiated reports during a drinking occasion (i.e., at the beginning and the end of their drinking). Multilevel modeling results indicated that greater levels of impulsivity experienced during the day was not associated with alcohol use or problems experienced that night. For bidirectional effects, alcohol use was associated with greater impulsivity reported at

the end of the drinking occasion and greater alcohol use predicted greater impulsivity the next morning. Multilevel structural equation modeling revealed significant within-person mediation, such that on days when individuals reported greater than usual impulsivity, they also reported greater enhancement motives, positive expectancies, and negative expectancies, which in turn, was associated with greater alcohol consumption. Coping motives and norms did not mediate the association between impulsivity and alcohol use. A peer drinking context and sex were not significant moderators of the link between impulsivity and alcohol use. Overall, this study was the first to examine the bidirectional relationship between impulsivity and alcohol use as well as mechanisms and moderators using an EMA methodology. Findings supported impulsivity's conceptualization as a state construct, and fluctuations in momentary states of impulsivity may coincide with alcohol use behaviors. Thus, findings from the present study contributed to conceptual daily process models of drinking by identifying how alcohol behaviors unfold in the real world. Future research is needed to examine other potential within-person mechanisms that may underlie or factors that may impact the examined relationships.

This dissertation is dedicated to my parents for their unwavering love and support.

ACKNOWLEDGEMENTS

There are several individuals I must acknowledge who contributed to the successful completion of my dissertation. First, I want to express my gratitude to my advisor, Dr. Cathy Lau-Barraco. Her guidance has been instrumental to my graduate career, and I could not have asked for a better mentor. I am so grateful for the feedback and her constant probing towards understanding theory and implications of our research. She has made me a better researcher, and I would not be where I am today without her advice and friendship. In addition, I would like to thank my committee members, Drs. Michelle Kelley and Shana Pribesh, for their feedback and encouragement throughout this project. I also want to thank Old Dominion University and the American Psychological Association for funding this research. Beyond my committee, I must acknowledge others in my department who contributed to this project. For example, I would like to thank Dr. Abby Braitman for her support, collaboration, and stats-consulting; she is always willing to answer my many, many data questions. In addition, I would like to thank the undergraduate research assistants who contributed hours to participant screening, data collection, and data entry. This process would have undoubtedly been longer without their help! I also want to thank other graduate students (former and current), Ashley Linden-Carmichael, Peter Preonas, and Sarah Ehlke, for their support and always lending an ear. I am grateful for their encouragement and moments of needed distraction. I also want to share my deepest gratitude to my family for their support throughout my entire life. My appreciation for my parents cannot be described. Thank you teaching me the work ethic, confidence, and humor needed to get through these years. Last but not least, I want to thank my husband, Marcus, for selflessly moving with me to Norfolk, VA. I am incredibly thankful for your unwavering love, support, and partnership.

TABLE OF CONTENTS

Page

LIST OF TABLES ix

LIST OF FIGURES x

Chapter

I. INTRODUCTION 1
- CONCEPTUALIZATION OF IMPULSIVITY AS A STATE VARIABLE 2
- IMPULSIVITY'S ASSOCIATION WITH ALCOHOL USE 8
- THEORETICAL MECHANISMS 16
- MODERATORS 22
- EMA RESEARCH DESIGN 25
- STUDY PURPOSE 26

II. METHOD 30
- PARTICIPANTS 30
- PROCEDURE 32
- MEASURES 39

III. RESULTS 46
- POWER ANALYSIS 46
- DATA CLEANING 46
- PARTICIPANT REACTIVITY 49
- VARIABILITY IN STUDY OUTCOMES 49
- STATISTICAL ANALYSES FOR STUDY AIMS 52

IV. DISCUSSION 77
- IMPULSIVITY'S ASSOCIATION WITH ALCOHOL USE/PROBLEMS 77
- BIDIRECTIONAL EFFECTS 80
- MECHANISMS EXPLAINING IMPULSIVITY AND ALCOHOL 82
- MODERATORS IMPACTING IMPULSIVITY AND ALCOHOL 89
- GENERAL DISCUSSION 91
- FUTURE DIRECTIONS 95
- LIMITATIONS 99

V. CONCLUSIONS 101

REFERENCES 102

APPENDICES
- A. STUDY MEASURES SUMMARY 121

Page

B. UPPS-P SCALE 122
C. TIMELINE FOLLOWBACK 124
D. YOUNG ADULT ALCOHOL CONSEQUENCES QUESTIONNAIRE 127
E. DRINKING MOTIVES QUESTIONNAIRE 129
F. DRINKING NORMS RATING FORM 130
G. COMPREHENSIVE EFFECTS OF ALCOHOL 131
H. GENERAL BACKGROUND QUESTIONNAIRE 133
I. CONTEXT 135
J. MOMENTARY IMPULSIVITY SCALE 136
K. DRINKING MOTIVES 137
L. POSITIVE AND NEGATIVE ALCOHOL EXPECTANCIES 138
M. NORMS 139
N. ALCOHOL USE 140
P. DAILY POSITIVE AND NEGATIVE CONSEQUENCES 141
Q. REASONS FOR NOT DRINKING 142

VITA 143

LIST OF TABLES

Page

Table

1. Summary of Measures for Each Type of Report 37

2. Example of Surveys on Drinking Days 38

3. Intraclass Correlation Coefficients for Momentary Variables 51

4. Multilevel Models of Impulsivity Predicting Total Number of Drinks Consumed that Day 54

5. Multilevel Models of Impulsivity Predicting Alcohol-related Problems and Positive Consequences that Day 58

6. Daily Mediation of Impulsivity to Problems through Alcohol Use 60

7. Multilevel Models of Alcohol Use Predicting Impulsivity During the Drinking Occasion 63

8. Multilevel Models Predicting Impulsivity After Alcohol Use 64

9. Indirect Effects from Impulsivity to Alcohol Use through Socio-Cognitions ...70

10. Multilevel Models of Context on Momentary Impulsivity and Alcohol Use ..74

11. Multilevel Models of Sex on Momentary Impulsivity and Alcohol Use 76

LIST OF FIGURES

Page

Figure
1. Conceptual Model for Aims 1 and 2 55

2. The Influence of Impulsivity on Number of Drinks Consumed through Socio-cognitions 69

CHAPTER I

INTRODUCTION

Alcohol use is a major public health hazard among individuals between ages 18 and 25 (i.e., emerging adults; Substance Abuse and Mental Health Services Administration [SAMHSA], 2016). Although significant research has attempted to reduce alcohol-related harms during this developmental period, it remains that one in nine emerging adults meet criteria for an alcohol use disorder (SAMHSA, 2016). Given the consistent rates of problem drinking in this population, investigations on factors contributing to alcohol-related harms are needed to improve existing interventions. Impulsivity refers to a predisposition toward rapid, unplanned reactions without regard of negative consequences (The International Society for Research on Impulsivity, 2016) and is a robust predictor of alcohol use (King, Patock-Peckham, Dager, Thimm, & Gates, 2014; Stautz & Cooper, 2013). Traditional perspectives of impulsivity have argued that it is a trait, and thus, generally stable throughout life (Dick et al., 2010; King et al., 2014). As such, the literature on impulsivity's association with alcohol use has been primarily limited to cross-sectional studies and between-subject designs that may lack ecological validity. Recent research supports that impulsivity varies in-the-moment (Ansell, Laws, Roche, & Sinha, 2015; Tomko et al., 2014), but scant research has examined how momentary states of impulsivity manifest before and after alcohol use. Further, research lacks on factors that may explain or impact the association between impulsivity and alcohol use. Thus, there is still much information about impulsivity's role in alcohol behaviors that remains unknown. Consequently, this research aimed to address a significant gap regarding the role that state impulsivity has on drinking by using a 14-day ecological momentary assessment (EMA) study to examine momentary levels of impulsivity and alcohol use in a sample of emerging adult college drinkers.

Conceptualization of Impulsivity as a State Variable

Impulsivity has been consistently argued as a multi-dimensional risk factor for psychopathology, particularly substance use disorders (e.g., King et al., 2014; Loree, Lundahl, & Ledgerwood, 2015). Traditional theories regarding impulsivity have considered it to be a personality trait, and as such, much of the information known about impulsivity is rooted in the personality literature (e.g., Loree et al., 2015; Stamates & Lau-Barraco, 2017). The idea of impulsivity as a personality trait suggests that impulsiveness is an enduring characteristic that determines behavior across a variety of situations. Further, this notion indicates that impulsivity is relatively stable throughout the life course (e.g., McCrae & Costa, 1994; Stamates & Lau-Barraco, 2017), as this conceptualization characterizes traits as unchanging within a person. Given this long held view of impulsivity, and personality in general, most research on impulsivity's role in various behaviors has been primarily focused on differences between individuals rather than how impulsivity may change within a person. However, previous research has captured states of impulsivity (e.g., Dick et al., 2010; King et al., 2014), and further, recent strides in the personality trait literature provide support that individuals also may differ from themselves (i.e., within) across contexts and over time (e.g., Fleeson, 2012). Thus, a burgeoning literature supports that personality characteristics such as impulsivity may be best conceptualized as a set of transient states rather than fixed trait scores (e.g., Fleeson, 2007). Indeed, research supports impulsivity as a concept that can vary from moment-to-moment within-individuals (Tomko et al., 2014).

Traditional state impulsivity theories. State conceptualizations of impulsivity have primarily focused on two theories of behavior that occur in the moment: impulsive action and impulsive choice.

Impulsive action. Impulsive action (can be referred to as rapid-response impulsivity, behavioral inhibition, or inhibitory control) refers to the inability to suppress an impulse to engage in inappropriate behavior, and this occurs with a lack of forethought (Hamilton et al., 2015a). An inappropriate behavior is defined as a behavior that is out of context with the present environment (e.g., shouting at your boss, driving after drinking; Hamilton et al., 2015a). Thus, impulsive action proposes that one may have diminished control over their behavior. This state theory uses a theoretical foundation of behavioral control, whereby there are two distinct processes that control one's behavior. These two processes include activation (or "go" process) and inhibition (or "stop" process) mechanisms (e.g., Clay, Allen, & Parran, 2008; Gray, 1977). The activation and inhibition mechanisms are in constant opposition towards each other, and thus, "the relative strength of each determine behavioral control" (Howard & Marczinski, 2010). Inhibition processes help regulate behavior or allow one to withhold or suppress a response (Fillmore, 2003). Thus, if the inhibition mechanism dominates over the activation mechanism within the behavioral control model, then the response is successfully suppressed. However, if activation dominates, then this failure in the inhibition process can lead to an impulsive or inappropriate response (e.g., Fillmore, 2003; Howard & Marczinski, 2010). In sum, individuals who are able to suppress behaviors process the environmental information *before* reacting; however, individuals who cannot inhibit their response are argued to have less control, and as such, are considered more impulsive.

Impulsive choice. Impulsive choice (also referred to as delay discounting, temporal discounting, or impulsive decision making) is a form of decision making that reflects a tendency to prefer smaller immediate rewards over larger delayed rewards, or at the expense of negative consequences (e.g., de Wit, 2009). Thus, impulsive choice highlights the process of self-control

in decision-making, which may change depending on the environmental context. For example, an impulsive individual may prefer to receive $10 today rather than $20 a week from now. Theoretical assertions of impulsive choice indicate that individuals who may prefer the $10 today have difficulties in delayed gratification or exerting self-control (Fineberg et al., 2010). There has been considerable research and debate on the theoretical foundation of impulsive choice, but researchers agree that it encompasses a complexity of processes related to decision-making, behavioral economics theory, and reflection (Hamilton et al., 2015b). A key theoretical component of impulsive choice is the automatic attribution of value (Hamilton et al., 2015b). An individual's value is subjective, but choice is determined by the strength of value an individual places on an immediate reward versus delaying the reward. The level of value placed on a reward depends on the type of reward itself, the context, and the probability of earning that reward. A reward can rapidly lose its value based on its temporal distance, or how long it is delayed in time (i.e., discounting; Hamilton et al., 2015b). In sum, impulsive choice refers to the process of delaying gratification, and more impulsive individuals have difficulty in this domain.

Current measurement of state impulsivity. Considerable research has examined impulsivity's conceptualization and how that translates to assessment (Dick et al., 2010; King et al., 2014; Stautz & Cooper, 2013), and researchers have attempted to capture states of impulsivity, primarily in laboratory-based settings. The primary goal of these tasks is to capture "behavioral snapshots" of impulsive behavior (Cyders & Coskunpinar, 2011). It is important to note that scores of impulsive action and impulsive choice are unrelated (see Stamates & Lau-Barraco, 2017 for review) suggesting that these states represent different types of impulsive behavior.

Impulsive action is objectively measured via computerized behavioral tasks, such as go/no-go or stop-signal paradigms (e.g., Dick et al., 2010; Hamilton et al., 2015a). Thus, performance on these tasks capture real-time impulsive responding. On impulsive action tasks, researchers are typically interested in response inhibition (i.e., responding when told to inhibit a response). *Impulsive choice* is objectively assessed by delay discounting paradigms, which may be computerized or in a questionnaire-format (i.e., the Monetary Choice Questionnaire; Kirby, Petry, & Bickel, 1999). On these tasks, participants' make choices between immediate versus delayed rewards that are manipulated by size and when the reward will be received (e.g., 1 day versus 2 days). Individuals who are more impulsive tend to select smaller, immediate rewards because they prefer immediate gain or gratification (e.g., Hamilton et al., 2015b).

Limitations of impulsive action and impulsive choice tasks. Although impulsive action and impulsive choice tasks have been widely used in the literature, particularly in the context of addiction (e.g., Dick et al., 2010; King et al., 2014), researchers also note limitations of these types of tasks. First, behavioral tasks are argued to provide "behavioral snapshots" (Cyders & Coskunpinar, 2011), but the behavior exhibited on these tasks is behavior resulting from a specific set of conditions. For instance, behavioral tasks are often administered at one time in a laboratory-based setting with specific instructions on what to do and what not to do on the task. Thus, a primary and valid criticism of measurement of traditional state models is their ecological validity (Cyders & Coskunpinar, 2011; Coskunpinar, Dir, & Cyders, 2013). That is, it is unclear whether impulsive behavior displayed on tasks is generalizable to a real-world representation of impulsivity that may be subject to variation depending on the context. Second, it may be difficult to administer these types of behavioral tasks repeatedly over time. These tasks are generally time-consuming (e.g., at least 30 minutes) and require expensive

laboratory equipment to administer (e.g., King et al., 2014). Consequently, behavioral tasks are not best suited to capture changes in state impulsivity over time due to fatigue effects (e.g., King et al., 2014). Thus, researchers are limited in examining within-person changes in impulsive behavior when only using behavioral tasks. Third, behavioral tasks appear to measure multiple cognitive processes (e.g., motor coordination, attention, memory, etc.), and as such, researchers often disagree on which process is primarily being measured (e.g., Cyders & Coskunpinar, 2011; Hamilton et al., 2015b).

Utilizing EMA. Recent methodological advances allow the current research to test the role that state impulsivity has in real-time drinking behaviors by using EMA. The larger framework known as EMA can include various real-time, real-world methods such as daily diary assessments (e.g., one assessment each day) and ambulatory methods (e.g., physiological data). A common EMA method is known as a daily diary design, which assesses behavior typically at one fixed time point on each day over a specified assessment period (e.g., Shiffman et al., 2008). However, there is high flexibility in EMA designs regarding how often assessments occur and the constructs being measured, but all EMA studies include three main features (Shiffman, Stone, & Hufford, 2008). First, data is collected from individuals in their natural environment, and thus, EMA designs demonstrate high ecological validity. Second, EMA studies are advantageous because their data collection occurs typically in short intervals and over time, and as such, dynamic fluctuations in behavior are able to be captured. And third, EMA methods assess behaviors that are current or recent states (e.g., current mood). Consequently, participants report their behavior close to the time that they occur in real life and thus, reduce potential retrospective recall biases (Shiffman et al., 2008). Taken together, an EMA design would

address many of the limitations previously noted that have affected the state impulsivity literature.

Momentary impulsivity. Given prior measurement limitations surrounding traditional state models of impulsivity (i.e., impulsive choice and action), Tomko et al. (2014) developed a measurement instrument (i.e., Momentary Impulsivity Scale; Tomko et al., 2014) that enables impulsivity's state assessment at the momentary level (i.e., how impulsive an individual is at that moment) and can be used in naturalistic settings. Findings using the MIS support significant within-person variability in impulsivity from day-to-day (e.g., Ansell et al., 2015; Schmid, Stadler, Dirk, Fiege, & Gawrilow, 2016; Stamates, Linden-Carmichael, Preonas, & Lau-Barraco, 2018; Tomko et al., 2014). For example, Tomko et al. (2014) examined multiple assessments of momentary impulsivity over a 28-day study period and examined between versus within-individual reliability scores for momentary impulsivity scores. Their findings indicated moderate within-person reliability ($R = 0.56$) indicating that momentary scores of impulsivity did fluctuate (i.e., change over time) within individuals over 28 days. Findings on impulsivity within-person variability in Tomko et al. (2014) were consistent with reliability estimates of impulsivity indicated in Schmid et al. (2016). Stamates et al. (2018) examined daily fluctuation in impulsivity over a 14-day study period. In this study, authors sought to determine how much variability could be explained by within-person changes over the 14-day period, and thus, the intraclass correlation coefficient (ICC) was calculated. Findings revealed that the ICC was .575, suggesting that about 57.5% of the variability in daily impulsivity could be explained by between-person differences. Thus, about 42% (almost half) of the variability in daily impulsivity was due to within-person fluctuations over 14 days. Findings from Stamates et al. (2018) are consistent with Ansell et al. (2015) which found that 56% of the variability in daily impulsivity

was due to within-person fluctuations over a 14-day study period. Overall, despite a small literature on within-person changes in impulsivity from moment-to-moment, findings are consistent that there is a moderate level of variation in impulsivity that occurs from day-to-day within a person.

Conclusions. Impulsivity has a long history as a psychological construct relevant for various aspects of psychopathology, including substance use disorders. There has been much disagreement among researchers regarding its operationalization and measurement (e.g., see Stamates & Lau-Barraco, 2017 for review). Recent developments in the personality literature support the idea that impulsivity may fluctuate within-individuals due to situational factors (e.g., Fleeson, 2007); however, scant research has examined momentary impulsivity in the context of alcohol use. If fluctuations in momentary impulsivity are predictive of subsequent changes in drinking behavior, then the idea of impulsivity as a varying state construct would be supported. Further, an EMA design would elucidate how within-person changes in impulsivity manifest in real-time and account for variation in alcohol use. If impulsivity is supported as a malleable construct, then findings would have a profound impact on state personality research and have implications for alcohol interventions.

Impulsivity's Association with Alcohol Use

Trait impulsivity and alcohol use. Much of what is known about impulsivity's association with alcohol use has been from studies that examined differences between-individuals at the trait level rather than state. As such, previous research has largely targeted typical impulsive behavior and typical alcohol use over a period of time rather than the way that impulsivity was experienced at the time of actual alcohol consumption.

Of studies testing the association between trait impulsivity and alcohol use, there is substantial cross-sectional evidence among emerging adults supporting a positive association between impulsivity and alcohol use (e.g., Adams, Kaiser, Lynam, Charnigo, & Milich, 2012; Curcio & George, 2007; Fischer & Smith, 2008; Kiselica, Echevarria, & Borders, 2015; LaBrie, Kenny, Napper, & Miller, 2014; Pearson, Kite, & Henson, 2012; Smith, Fischer, Cyders, Annus, Spillane, & McCarthy, 2007), such that greater levels of trait impulsivity are associated with greater typical alcohol use quantity (i.e., how many drinks consumed; e.g., Adams et al., 2012; Curcio & George, 2007; Cyders, Smith, Spillane, Fischer, Annus, & Peterson, 2009; Fischer & Smith, 2008; Hahn, Simons, & Hahn, 2016; Kiselica et al., 2015; LaBrie et al., 2014; Pearson et al., 2012; Smith et al., 2007), frequency (i.e., how many days drinking occurred; e.g., Coskunpinar et al., 2013; Henges & Marczinksi, 2011; Stamates & Lau-Barraco, 2017), heavy drinking (typically 4+/5+ drinks for women/men in a single sitting; e.g., Bo, Billieux, & Landro, 2016; Coskunpinar et al., 2013; Kiselica et al., 2015), alcohol-related problems (e.g., blacking out, hangovers; Curcio & George, 2011; King, Karyadi, Luk, & Patock-Peckham, 2011; Kiselica & Borders, 2013; LaBrie et al., 2014; Magid & Colder, 2007; Murphy & MacKillop, 2012; Pearson et al., 2012; Pearson & Henson, 2013; Shin, Hong, & Jeon, 2012), and symptoms of alcohol dependence (e.g., withdrawal effects such as shaking; Coskunpinar et al., 2013). Trait impulsivity also has been shown to prospectively predict alcohol use (e.g., Kaiser, Bonsu, Charnigo, Milich, & Lynam, 2016) and binge/heavy use (e.g., Ashenhurt, Hardin, Corbin, & Fromme, 2015; Quinn, Stappenbeck, & Fromme, 2011) among emerging adults. Thus, previous research clearly supports a bivariate association between trait impulsivity and several alcohol-related outcomes, but research lacks on mechanisms explaining this association.

A main limitation of the trait impulsivity and alcohol literature is that it does not capture within-person variability in impulsivity, despite studies supporting that state changes in impulsivity exist within a person. Although trait levels of impulsivity may be important in identifying *who* may be at most risk for alcohol-related harms, individuals with high scores on impulsivity do not act impulsively all of the time. Further, trait and state levels of impulsivity often do not correlate (see Stamates & Lau-Barraco for review), and as such, suggest that previous models of trait and state are assessing two different aspects of impulsive behavior. Thus, it may be particularly beneficial to use study designs (e.g., EMA) that allow for the examination of *both* individual differences (i.e., between-individuals) and intra-individual differences (i.e., within-individuals). Then, researchers may be better able to capture between-person differences in impulsivity, but also the day-to-day conditions that associate with impulsive behavior in one's daily life.

Another important limitation of the trait impulsivity literature is that findings are subject to retrospective recall biases (e.g., Stamates & Lau-Barraco, 2017). Participants are often asked to remember typical impulsive behaviors over the past 12 months, or their typical alcohol use and experiences with alcohol-related consequences over the past 3 to 12 months. Although this information about typical behaviors has been important for establishing impulsivity's influence in the alcohol literature, recent assertions on impulsivity's fluctuation present gaps in the literature regarding this relationship. For example, it is not known whether momentary fluctuations in impulsivity associate with changes in drinking behavior during an alcohol use occasion in the natural environment. Further, it is not known whether fluctuations in impulsivity are subsequently associated with alcohol-related problems experienced that same day. Findings for both of these would offer more firm conclusions as to the way impulsivity confers alcohol-

related risk for emerging adults. As such, the present research took a more fine-grained approach in analyzing impulsivity's influence in alcohol use and alcohol-related problems at the momentary level.

State impulsivity and alcohol use. State impulsivity's association with alcohol use is less clear as compared to findings regarding trait impulsivity. A handful of studies have cross-sectionally examined state impulsivity (e.g., behavioral performance on go/no-go tasks, delay discounting tasks) and tested its relationship with *typical* levels of alcohol use, rather than alcohol use consumed at that moment. Of this research, there is general support for a positive association between state impulsivity and typical alcohol use (e.g., Courtney et al., 2012; Henges & Marczinski, 2011; Murphy & MacKillop, 2012) and heavy drinking (Czapla, Simon, Friedrich, Herpertz, Zimmnerman, & Loeber, 2014; Henges & Marczinski, 2011). Thus, greater impulsivity displayed on behavioral measures of state impulsivity generally associate with greater levels of typical alcohol use patterns among emerging adults. However, two studies using participants from the UK did not find an association between state impulsivity and typical alcohol use (Caswell, Celio, Morgan, & Duka, 2015; Fernie, Cole, Goudie, & Field, 2010).

There are study limitations in this line of work. For example, the aforementioned studies assessed typical levels of alcohol use over a specified period of time (e.g., 6 months) and thus, is subject to recall biases. Further, how much alcohol participants consumed at the time of the state impulsivity assessment was not examined which could offer important implications for how states of impulsivity influences drinking behavior. In addition, each of these studies examined state impulsivity using a behavioral task in a laboratory-based setting. Thus, it is not clear whether the level of impulsive behavior demonstrated during the study is generalizable to impulsive behavior experienced in the real world. Given the limited and sometimes inconsistent

work examining this area of impulsivity, further investigations are needed to clarify state impulsivity's role in drinking behavior.

Daily diary/EMA designs of state impulsivity and alcohol use. Recent EMA studies have examined state impulsivity and support that impulsivity fluctuates at the daily and momentary level and is associated with risky and other types of behaviors (e.g., alcohol use, marijuana use; Ansell et al., 2015; Stamates et al., 2018; Tomko et al., 2015). For example, Ansell et al. (2015) used a 14-day daily diary study (i.e., reports collected daily for 14 consecutive days) to examine within-person changes in impulsivity, marijuana use, and interpersonal hostility among 43 men and women recruited from the community. Their findings suggested that daily levels of marijuana were associated with increases in level of impulsivity reported on the same day. Further, while daily levels of marijuana were associated with same-day feelings of hostility (e.g., aggression), daily levels of impulsivity were not associated with level of interpersonal hostility experienced that same day. In another study, Tomko et al. (2015) examined several negative emotions (i.e., undifferentiated negative affect) and impulsivity among individuals with borderline personality disorder (BPD) over a 28-day EMA study period. Their findings revealed that momentary levels of impulsivity were positively associated with momentary negative affect. That is, on assessments when impulsivity was higher than average, participants also reported experiencing more negative affect. The pattern of findings with regard to impulsivity and negative affect can be particularly concerning for individuals with borderline personality disorder, as these behaviors play a central role in maladaptive coping behaviors (e.g., Tomko et al., 2015).

To the best of knowledge, only one study has used a daily diary design to examine state impulsivity's association with alcohol use specifically (Stamates, Linden-Carmichael, Preonas,

& Lau-Barraco, 2018). Stamates et al. (2018) piloted a 14-day daily diary study to examine fluctuations between daily impulsivity, affect, intentions to drink, and alcohol-related outcomes (i.e., alcohol use and alcohol problems) among community-based sample of 18 to 25 year-old individuals. Participants completed an online survey each day over 14 consecutive days. During each survey, participants reported their drinking behavior *last night* and their impulsivity and affect so far *that day*.

Stamates et al. (2018) examined the association between daily levels of impulsivity on drinking and non-drinking days except when alcohol-related problems were the outcome, and in this case, only drinking days were examined. Findings revealed that on days when individuals were more impulsive than average, they reported lower intentions to drink and greater alcohol-related problems that evening, if they also endorsed higher positive mood than average during that day. These findings suggested that daily impulsivity fluctuated, interacted with mood, and subsequently associated with same-day drinking behaviors. Specifically, greater impulsivity in combination with greater positive mood that day was also associated with experiencing more alcohol-related problems that day. As such, impulsivity may be a fluctuating variable influenced by situational factors that may affect its association with alcohol outcomes. A primary limitation of this study was that impulsivity and alcohol-related behaviors were only assessed at one time point each day, and thus, the directionality of these associations as well as potential dynamic processes between impulsivity and alcohol use were not able to be addressed. Thus, the present research sought to address these limitations.

Support for a bidirectional relationship. Although there is compelling evidence that impulsivity is associated with greater drinking, research also supports the idea that drinking may affect impulsivity (e.g., de Wit, 2009). Thus, impulsivity is argued to have a bidirectional

relationship with alcohol use because impulsivity may be a cause and a consequence of alcohol use. As a cause of alcohol use, impulsivity serves as a risk factor for increased alcohol use (de Wit, 2009), and evidence for this relationship was previously summarized above. On the other hand, alcohol use itself may increase one's impulsivity, as alcohol may impair inhibition and result in engaging in risky behaviors such as risky sexual behaviors or driving while intoxicated (de Wit, 2009). Further, prolonged exposure to heavy alcohol use may impair functioning in brain areas response for impulse control, and subsequently, increase one's impulsivity (see Lopez-Caneda, Holguin, Cadaveira, Corral, & Doallo, 2014 for review). In sum, the transactional effects between impulsivity and alcohol use may create a vicious cycle for some drinkers.

Research examining alcohol's influence on impulsivity has typically been tested in controlled, laboratory designs whereby the acute effects of alcohol are observed (Dougherty, Marsh-Richard, Hatzis, Nouvion, & Mathias, 2008; Field, Wiers, Christiansen, Fillmore, & Verster, 2010; Lopez-Caneda et al., 2014; Marczinski, Fillmore, Bargett, & Howard, 2011). More specifically, in this line of research, participants are typically administered an alcohol dose to consume, and as their blood alcohol concentration peaks, they complete a computerized task to measure impulsivity. Several studies have demonstrated that alcohol doses leading to blood alcohol concentrations of .06 to .09% impair impulse control in young and healthy adults (Dougherty et al., 2008; Fillmore & Vogel-Sprott, 1999; Marczinski & Fillmore, 2003; Marczinski et al., 2011). Although this research contributes to alcohol's disinhibiting effects, its generalizability of impulsive behavior in real-world settings is limited.

Longitudinal research also has tested bidirectional relationships between impulsivity and alcohol among emerging adults and indicates that alcohol may indeed impact impulsivity over

time (e.g., Kaiser et al., 2016; Quinn, Stappenbeck, & Fromme, 2011). For example, Kaiser et al. (2016) examined several impulsivity traits and alcohol use behaviors among 525 first-year college students at two different time points: one assessment during the first year of college (Time 1), and the second assessment occurring approximately one year later (Time 2). Their findings revealed that aspects of impulsivity at Time 1 predicted higher levels of alcohol use at Time 2 after controlling for typical alcohol use at T1. Further, they found that alcohol use at T1 predicted higher levels of impulsivity at T2, while controlling for impulsivity at T1. In another study, Quinn et al. (2011) examined impulsivity and heavy drinking in a cohort of 1,434 high school students each semester through their senior year of college. Their findings supported a bidirectional association between impulsivity and heavy drinking. Specifically, impulsivity was related to greater levels of heavy drinking prior to entering college and predicted greater levels of heavy drinking across the first two years of college. Further, changes in impulsivity were observed across time points, and heavy drinking was positively related to changes in impulsivity. As such, research supports the idea that impulsivity and alcohol use may be mutually influential. However, to date, it is unknown whether alcohol use in the natural environment elicits similar within-person changes in impulsivity. The cyclical relationship between impulsivity and alcohol use has important implications for the etiology and maintenance of problem drinking given that each may impact one another. Thus, examination of this link in the natural environment is warranted. Further, the use of EMA would clarify whether more immediate effects of alcohol are observed.

Conclusions. Overall, the literature strongly supports an association between impulsivity and engaging in alcohol use and problems. However, research has yet to examine whether momentary impulsivity is associated with these outcomes in the natural environment. The

knowledge gained by understanding a real-time, moment-to-moment pattern between impulsivity and drinking would support the validity of state theories suggesting that impulsivity fluctuates within-person. Further, if fluctuations predict immediate drinking, then impulsivity may be a viable intervention target. Thus, understanding how impulsivity and alcohol use manifest in daily life, before and after drinking, may improve our ability to reduce alcohol-related risk.

Theoretical Mechanisms

Despite a robust literature supporting an association between impulsivity and alcohol use, mediators (i.e., mechanisms) explaining this relationship are not well understood. A mediator is a variable that intervenes between a predictor and an outcome variable that fully or partially explains the relationship (e.g., Cohen, Cohen, West, & Aiken, 2013). Using theory (Caspi, Roberts, & Shiner, 2005; Cooper, Frone, Russell, & Mudar, 1995; Corbin, Iwamoto, & Fromme, 2011) and previous research (e.g., Adams et al., 2012; McCarthy, Miller, Smith, & Smith, 2001; Quinn et al., 2011), the present research examined drinking motives, alcohol expectancies, and normative perceptions as real-time mediating variables between impulsivity and alcohol use.

Drinking motivations. Motives for drinking (i.e., an individual's reason for drinking) are based on the idea that drinking occurs in an effort to experience specific valued outcomes (Cooper, 1994; Cox & Klinger, 1988). According to the Motivational Model of Alcohol Use (Cooper et al., 1995; Cox & Klinger, 1988), motives can vary on two independent dimensions: (1) valence (positive vs. negative) and (2) in source (internal vs. external). Considering these two dimensions, there are four motives (coping, enhancement, conformity, and social) that an individual might have for drinking. *Coping motives* reflect an internal, negative-reinforcement motive that is associated with drinking to cope with negative affect. *Enhancement motives* reflect an internal, positive-reinforcement motive that is associated with drinking to increase

positive affect. *Conformity motives* reflect an external, negative-reinforcement motive that is associated drinking to avoid social consequences. Lastly, *social motives* reflect an external, positive-reinforcement motive that is associated with drinking to obtain social rewards. For the present study, internal motives (coping and enhancement) were examined because Cooper et al. (1995) suggests that these motives are "situationally activated" for drinkers rather than due to individual differences, and thus, may be more subject to variability.

Consistent with the Motivational Model of Alcohol Use (Cooper et al., 1995), motives act as antecedents of drinking through which personality characteristics may influence. Thus, it is plausible that impulsivity may influence an individual's motives for drinking, which in turn, influence their own drinking behavior. Indeed, there is empirical support for this mediational pathway in relation to impulsivity, as cross-sectional (e.g., Adams et al., 2012; Curcio & George, 2011; Jones, Chryssanthakis, & Groom, 2014; Magid, MacLean, & Colder, 2007) and longitudinal (e.g., Littlefield, Sher, & Wood, 2010) studies have found that motives (primarily support for coping, enhancement, and social) significantly mediate the association between impulsivity and alcohol use. In other words, there is evidence that greater impulsivity may lead to specific motivations to drink, that in turn, associate with greater alcohol use. In addition, there is consistent evidence that supports coping motives as a mediator between the relationship of impulsivity and alcohol-related problems, such that greater impulsivity is associated with alcohol-related problems through the influence of coping motives (e.g., Adams et al., 2012; Curcio & George, 2011; Jones et al., 2014; Littlefield et al., 2010; Magid et al., 2007). However, these associations have not been temporally examined in an EMA context. It may be that impulsivity experienced in-the-moment may associate with particular motives (i.e., coping and enhancement), which in turn, predict either immediate or same-day drinking behaviors.

Similar to the literature on impulsivity, drinking motives have typically been argued as stable constructs. However, Cooper et al. (1995) argued that internal motives such as coping and enhancement are "situationally activated", and thus, should also be considered as a product of situational factors rather than distinct individual differences. Indeed, research suggests that motives may vary within individuals and over time. For example, a 14-day daily diary study by Arbeau, Kuiken, & Wild (2011) found that daily enhancement and daily coping motives vary as a function of daily mood. In another study, Dvorak, Pearson, and Day (2014) used an EMA study to assess a temporal pattern of mood, motives, and alcohol use. Their findings supported significant heterogeneity in drinking motives across drinking days, suggesting motives as dynamic constructs that are frequently situation-specific and correspond with differential drinking patterns across days.

Alcohol expectancies. Alcohol expectancies are an individual's beliefs about the positive and negative consequences that will result from drinking (e.g., Fromme, Stroot, & Kaplan, 2003). According to alcohol expectancy theory, information learned from alcohol-related experiences either directly (i.e., personal drinking experience) or indirectly (i.e., peer or parental alcohol use) can influence one's alcohol use later on (see Jones, Corbin, & Fromme, 2001 for review). Alcohol expectancies can be positive or negative. For example, positive expectancies may include beliefs regarding tension reduction or increased sociability, and these beliefs have been linked to greater alcohol use among college students (e.g., Bartholow, Sher, & Strathman, 2000; Del Boca, Darkes, Greenbaum, & Goldman, 2004; Fromme, Stroot, & Kaplan, 1993; Stamates, Lau-Barraco, & Linden, 2016). Negative expectancies may include beliefs regarding impairment or aggression, and findings on the relationship between negative

expectancies and alcohol use has been inconsistent (see Jones et al., 2001). In general, negative expectancies are thought to *restrain* drinking behavior (Jones et al., 2001).

Alcohol expectancies may be influenced by one's impulsivity. According to The Acquired Preparedness Model (Corbin et al., 2011), personality traits (e.g., impulsivity) may influence learning mechanisms with regard to alcohol use. More specifically, individuals with high levels of impulsivity may tend to focus more on the positive alcohol stimuli in their environment (e.g., McCarthy et al., 2001). Thus, greater impulsivity may predispose individuals to acquiring more positive and less negative alcohol expectancies, which in turn influences their own levels of drinking. Taken together, alcohol expectancies are argued to be a mechanism through which impulsivity influences alcohol use.

There is strong cross-sectional (Anderson, Smith, & Fischer, 2003; Barnow, Schultz, Lucht, Ulrich, Preuss, & Freyberger, 2004; McCarthy et al., 2001) support for indirect effects from greater impulsivity to greater drinking through the influence of positive and negative expectancies. These paths also have been observed longitudinally (e.g., 1 to 4 years of college; Corbin et al., 2011; Settles, Cyders, & Smith, 2010). For example, Corbin et al. (2011) tested The Acquired Preparedness Model in 2,245 incoming freshman who completed surveys during the summer before college matriculation through their fourth year of college. Their findings revealed indirect effects of impulsivity on both alcohol use and alcohol-related problems operating through the mechanisms of positive expectancies, not negative, and these effects occurred across all years of college. However, similar to drinking motives, the association between impulsivity and alcohol expectancies has not been examined in an EMA context.

Alcohol expectancy theory and most prior research examining alcohol expectancies have treated these cognitions as stable traits rather than a variable that is subject to change. According

to theory (see Jones et al., 2001 for review), alcohol expectancies are argued as structures in long-term memory that are learned via directly or through observations of behavior that influence current or future alcohol use. In addition to theory, previous measurement scales support the idea that expectancies are typically thought to be stable traits. For example, Brown, Christiansen, and Goldman (1987) and Fromme et al. (1993) developed instruments that assess one's typical beliefs about drinking outcomes over a specified time frame (e.g., one year). Thus, these scales do not take into account daily experiences that may contribute to the process of expectancy development.

Despite that most of the literature has examine expectancies as a stable construct, recent EMA research has shown that expectancies may vary significantly within-persons across time (e.g., Armeli et al., 2005; Lee, Atkins, Cronce, Walter, & Leigh, 2015). For example, Armeli et al. (2005) examined alcohol expectancies in a 21-day daily diary study and demonstrated that expectancies and the desire for these alcohol outcomes vary significantly within-person from day-to-day. In another study, Lee et al. (2015) developed a 15-item daily measurement instrument to assess expectations on the likelihood of experiencing different positive and negative outcomes from drinking among a sample of 352 college students. Participants were assessed daily over a two-week period. Lee et al. (2015) revealed intraclass correlation coefficients (ICC) between .30 and .40 for positive and negative effects. The ICC reflects the proportion of variance explained between-individuals, and thus, given that approximately 30% to 40% of the variance in expected positive and negative effects was due to between-person differences, approximately 60% to 70% could be explained due to within-person differences, respectively. This measure has since been used in other EMA studies that demonstrated associations between greater positive and negative expectancies and heavier levels of drinking on

drinking days (Patrick, Cronce, Fairlie, Atkins, & Lee, 2016). Thus, expectancies also may have state-like qualities. The extent that momentary changes in impulsivity elicit subsequent changes in expectancy states has not been tested.

Normative perceptions of alcohol use. Descriptive norms, or one's perceived level of drinking by others, have been linked to one's own level of alcohol use (e.g., Borsari & Carey, 2003). Little research has examined the role of personality traits on descriptive norms. Of the research on this topic, it is plausible that norms may mediate the association between impulsivity and drinking, such that greater impulsivity has associated with greater drinking, and is explained through greater perceived drinking by others. This idea is in line with the Corresponsive Principle (Caspi et al., 2005), which suggests that individuals select into environments on the basis of their personality traits that in turn reinforce these traits. Thus, it may be that impulsive drinkers select into peer groups whom they perceive to be risky and heavy drinkers which in turn guide their own risk-taking and drinking behavior. To the best knowledge, only one study has demonstrated this mediational pathway (Hustad, Pearson, Neighbors, & Borsari, 2014). Specifically, Hustad et al. (2014) cross-sectionnally found that the effect of impulsivity on alcohol use was fully mediated by descriptive norms.

In the context of EMA, descriptive norms have been examined previously. For example, previous research has shown that on days when norms were higher, individuals also drank more (O'Grady, Cullum, Tennen, & Armeli, 2011). To explain, O'Grady et al. (2011) used a measurement-burst design to assess the association between descriptive drinking norms and personal alcohol use among college students. Their participants completed a baseline survey and a 30-day daily diary each year for four years. Findings from O'Grady et al. (2011) revealed that on drinking days when descriptive norms were high, students drank more, and this relationship

was stronger for men than women. Further, these associations did not change over time. As such, norms appear to guide drinking behavior in one's daily life, but impulsivity's influence at the daily or momentary level has not been examined.

Conclusions. Overall, there are several limitations of the literature on mechanisms explaining the relationship between impulsivity and alcohol use. Specifically, the use of global assessments to measure constructs such as motives, expectancies, and norms, are subject to retrospective biases, limit conclusions regarding causality, and strongly focus on individual differences rather than how these constructs may vary within a person. Thus, their temporal ordering in real-time and in real life is unknown. Such knowledge would inform the etiology of alcohol use and harms by highlighting processes that drive drinking behavior and how they unfold in an individual's own environment. Scant research has examined the within-person processes of these sociocognitive mechanisms and how they may potentially vary from day-to-day. An examination of these factors would inform the limited literature on their stability and/or change of these constructs known to influence drinking from day-to-day. In sum, findings from this research would contribute to dynamic daily process models of risky alcohol use and potentially offer information for intervention work, particularly ecological momentary interventions.

Moderators

A final goal of the present study was to explore relevant moderators that may impact the association between impulsivity and alcohol use. A moderating variable is a third variable that affects the relationship between an independent and dependent variable (e.g., Cohen et al., 2013). Moderators provide beneficial information by determining under which conditions an association is most salient. As such, examining moderators of the relationship between impulsivity and

alcohol use would enhance state conceptualizations of impulsivity by elucidating *when* fluctuations are most relevant as well as *which* individuals may be most vulnerable for experiencing variability in impulsivity and alcohol use. Given the long history of impulsivity's implications in alcohol use, there have been many factors shown to moderate this association. However, two factors specifically (i.e., context and sex), were chosen given their support in the literature as moderating variables as well as their relevance using an EMA design. Ultimately, information on moderators may inform future interventions aimed at reducing impulsive drinking behavior by highlighting the context in which impulsivity and alcohol use operate and for whom this relationship may be most salient for.

Context. Using the Corresponsive Principle (Caspi et al., 1995) previously described, it also may be that impulsivity and alcohol use is moderated by a peer drinking environment. To explain, individuals with higher levels of impulsivity may seek out environments or peers with similar personality traits who are prone to heavy drinking. Thus, a peer drinking environment may promote higher levels of drinking, particularly among those with higher impulsivity. Previous research has shown that impulsive individuals are more susceptible to influence by their peers (Kahler, Read, Wood, & Palfai, 2003; Robinson, Jones, Christiansen, & Field, 2015). Further, findings from two studies (Robinson et al., 2015; Wills, Pokhrel, Morehouse, & Fenster, 2011) suggested that self-control (i.e., a related construct of impulsivity) moderated the association between perceived peer drinking and personal heavy alcohol use. That is, the relationship between level of peer drinking and personal use was stronger for individuals with lower self-control. Thus, it may be that greater momentary states of impulsivity are associated with alcohol use, and this is particularly evident for those in peer drinking contexts versus those who drink alone.

Sex. Although, historically, men have typically consumed more alcohol than women, a convergence between men and women's drinking has been observed over the past decade (SAMHSA, 2016). Impulsivity may be a promising factor relevant for contributing to this recent trend. To explain, there is evidence that men tend to be more impulsive than women in general (e.g., see Cross, Copping, & Campbell, 2011 for review), but recent research has found a stronger association between state impulsivity and problem drinking in women as compared to men (e.g., Weafer, De Arcandelis, & de Wit, 2015; Weafer & de Wit, 2014). For example, two studies (Nederkoom, Baltus, Guerrieri, & Wiers, 2009; Weafer et al., 2014) have found that heavy drinking women display poorer inhibitory control than heavy drinking men in laboratory settings. Further, a 3-month longitudinal study by Stojek & Fischer (2013) supported prospective links between impulsivity and symptoms of alcohol dependence among first semester college women. One possible explanation for the relationship between impulsivity, drinking, and sex is that that impulsivity may elicit greater cravings for alcohol among women, as compared to men (Yarmush, Manchery, Luehring-Jones, & Erblich, 2016). Thus, examining state impulsivity and alcohol use in one's own setting will further highlight the role that sex has in determining these links. Based on laboratory findings, it is plausible that women may be more vulnerable to variations in impulsive behavior as it relates to drinking.

Conclusions. Overall, some research has pinpointed context and sex as factors relevant for the association between impulsivity and alcohol use. Given that a main component of EMA designs is to understand contextual factors occurring "in-the-moment", information surrounding the drinking occasion's context was assessed (i.e., who an individual is drinking with and how many individuals are also drinking). Further, the present study could potentially yield important findings on the association between impulsivity and alcohol use for men and women. Thus, sex

was explored as a moderator in the present research. Given that rates of drinking among college women are on the rise, research examining factors that contribute to women's drinking rates is needed for building efficacious interventions.

EMA Research Design

EMA designs. EMA is a large framework of research methods that are designed to collect ecologically valid data. Thus, using EMA, behaviors and feelings are assessed in one's natural environment and close to the time that they occur. EMA designs include various real-time, real-world methods such as daily diary assessments (e.g., one assessment each day) and ambulatory methods (e.g., physiological data). There is high flexibility in EMA designs regarding how often assessments occur and the constructs being measured, which often depend on the type of behavior of interest. When specific events are of interest, such as drinking, the participant is asked to monitor their drinking behavior and record their data using event-based assessments. As such, the event-based assessments are initiated by the participant when they begin drinking, so that behaviors related to the drinking occasion may be assessed. Other behaviors sampled may occur regularly in daily life (e.g., impulsivity, mood), and thus, researchers may assess these behaviors using time-based assessments. Time-based assessments are sent to the participant's cellular phone or other data recording device (e.g., palm pilot) and can be either sent on a regular or random schedule during each day of the study. The goal of time-based assessments is to capture an accurate representation of the behavior of interest. Event and time-based assessments can be combined in an EMA study and used to compare different associations among the behaviors measured (e.g., Shiffman, 2008).

Benefits of EMA designs. In addition to the highly flexible design, EMA methods have several benefits. For example, data are collected from individuals in their natural environment,

and thus, EMA designs demonstrate high ecological validity to how behaviors may occur in real life settings. This information is particularly important for capturing accurate levels of certain behaviors as well as providing data that may be used for interventions. Another benefit of EMA designs is related to how the data are assessed. Specifically, EMA studies are advantageous because their data collection occurs typically in short intervals and over time, and as such, dynamic fluctuations in behavior are able to be captured. Ultimately, EMA methods capture within-person processes that are often not assessed in cross-sectional or experimental designs that "summarize" information on typical behaviors over a specific period of time. Thus, surveying within-person processes allow for behaviors to be captured over time, as well as the processes that associate with how behaviors unfold (e.g., Shiffman, 2008). Another benefit to using EMA methods include that behaviors are assessed as their current or most recent state (e.g., current mood). Consequently, participants report their behavior close to the time that they occur in real life and thus, reduce potential retrospective recall biases that are problematic in the cross-sectional literature (Shiffman et al., 2008). Regarding alcohol use specifically, EMA methods are particularly well-suited to examine drinking occasions, as they are typically episodic and can be easily assessed at the event-level.

Study Purpose

The primary purpose of the present research was to examine momentary impulsivity and the extent of its temporal relation before and after drinking in real-time using a 14-day EMA design in a sample of college student heavy drinkers. The secondary goal of the research was to examine factors that explain (i.e., drinking motives, alcohol expectancies, and normative perceptions) or impact (i.e., context, sex) the relationship between impulsivity and alcohol use at

the momentary level. Participants reported on their impulsivity, alcohol use, alcohol-related cognitions, and context throughout each day over a 14-day period.

Aim 1. To determine momentary *impulsivity as a predictor* of subsequent alcohol use and problems. Currently, only one daily diary study has examined the association between impulsivity and alcohol use (Stamates et al., 2018) which only assessed each construct at one time point each day. Given that Stamates et al. (2018) only used one assessment each day, the levels of impulsivity and alcohol use were aggregated across each day. Thus, the temporal pattern of processes occurring in-the-moment were not able to be captured. The present research used multiple assessments each day to establish a temporal pattern among impulsivity and alcohol use as well as experiences with alcohol-related problems. The decision to examine alcohol use and problems was based off previous research supporting impulsivity's unique variance in explaining both outcomes (see Stamates & Lau-Barraco, 2017 for review).

Hypothesis 1a (Momentary-level). It was hypothesized that momentary levels of impulsivity would be positively associated with subsequent momentary levels of alcohol use. Specifically, momentary impulsivity would be related to subsequent alcohol use in the moment.

Hypothesis 1b (Daily-level). Greater impulsivity experienced prior to a drinking occasion would be related to greater alcohol-related problems experienced that same night.

Exploratory Aim 1 (Daily-level). To examine the indirect effect of impulsivity on alcohol-related problems through the influence of alcohol use.

Aim 2. To examine the influence of alcohol use on *subsequent impulsivity* reported. Theoretically, it has been posited that impulsivity has a bidirectional relationship with alcohol use, and thus, alcohol use also may predict changes in impulsivity (e.g., de Wit, 2009). This notion is supported by research examining the acute effects of alcohol on impulsivity (see Lopez-

Caneda et al., 2014 for review) and longitudinal evidence exploring prospective patterns of impulsivity and alcohol use for more than a year period (e.g., Kaiser et al., 2016; Quinn et al., 2011).

Hypothesis 2 (Momentary-level). It was hypothesized that greater alcohol use consumed in the moment would predict greater subsequent levels of impulsivity reported in the moment.

Aim 3. To test socio-cognitive mechanisms (i.e., drinking motives, alcohol expectancies, and normative perceptions) as mediators explaining the association between momentary impulsivity and alcohol use. Several theories (i.e., Motivational Model of Alcohol Use [Cooper et al., 1995], Acquired Preparedness Model [Corbin et al., 2011], and Corresponsive Principle [Caspi et al., 1995]) posit that drinking motivations, alcohol expectancies, and normative perceptions act as antecedents of drinking through which personality may influence. Several studies support these models, as motives, expectancies, and norms each have been shown to mediate the association between impulsivity and alcohol use. However, little is known about the temporal ordering of these factors in the natural environment which would strengthen evidence on their mediational role explaining impulsivity's association with alcohol use.

Hypothesis 3 (Momentary-level mediators). Greater momentary impulsivity experienced prior to drinking would elicit subsequent momentary changes in motives, expectancies, and norms, which in turn, would predict subsequent greater levels of alcohol use.

Aim 4. To test context as a moderator of the association between momentary impulsivity and alcohol use. Impulsive individuals are more susceptible to peer influence (e.g., Kahler et al., 2003). Thus, it may be that greater momentary states of impulsivity are associated with alcohol use, and this is particularly evident for those in peer drinking contexts versus alone.

Hypothesis 4 (Momentary-level moderator). It was expected that momentary context would moderate the association between momentary impulsivity and alcohol use. Specifically, the relationship between momentary impulsivity and alcohol use was expected to be stronger in a peer drinking context.

Exploratory Aim 2 (Cross-level interaction). To explore sex as a moderator of the association between momentary impulsivity and alcohol use.

CHAPTER II

METHOD

Participants

Participants for the current study were college students recruited through Old Dominion University via the psychology research pool (i.e., SONA systems). SONA advertisements provided a short description of study, time commitment, compensation, instructions for the screening survey, and eligibility criteria. The advertisements indicated that this was a two-part study in which they must first complete a baseline survey and then complete follow-up surveys for 14 consecutive days. To be eligible, participants must have (1) been between 18 to 25 years old, (2) used a smartphone (Android/iOS) in order to access to EMA software application, and (3) reported moderate to heavy drinking (i.e., have engaged in heavy episodic drinking at least twice in the past month). The decision to limit the sample to moderate-to-heavy drinkers was to increase the probability of capturing alcohol use and problems during the 14-day assessment period and was consistent with previous research (e.g., Simons, Dvorak, Batien, & Wray, 2010; Stevens, Littlefield, Talley, & Brown, 2017). Participants were awarded course credit via SONA systems for their participation in the present study. In addition, if participants completed 80% of the random assessments, they were entered into a raffle to potentially earn $25 dollars. Forty $25 prizes were awarded to participants in the current study. The current study was approved by the university's Institutional Review Board and all APA ethical guidelines were followed (APA, 2010).

Four hundred and twenty-two participants were screened for inclusion in the current study. Of those screened, 251 did not meet study inclusion criteria, and 171 were eligible to participate. Those who were eligible were emailed a sign-up code to access SONA timeslots.

Among the 171 who met inclusion criteria, 96 participants signed up for a timeslots on SONA, attended the baseline session, and completed the EMA portion of the study. Fifty-eight of the 75 participants (77.3%) who met inclusion criteria but did not participate in the study provided incomplete contact information, and thus, could not be contacted. Chi-square analyses compared eligible individuals who participated compared to those that did not on demographic variables provided in the screening form (i.e., age, marital status, ethnicity, employment status, individual-level of income, Greek affiliation, and ADHD diagnosis), and all results were nonsignificant, $p > .182$.

The final sample for analysis consisted of 96 (63 women) participants. The mean age was 19.80 ($SD = 1.76$) years with 68.8% under the age of 21. Class standing was 38.5% freshman, 29.2% sophomore, 19.8% junior, and 12.5% senior. Ethnicity make-up was 50.5% Caucasian/White, 40.0% African American/Black, 6.3% self-reported "other" or biracial, 1.1% Asian, 1.1% American Indian/Alaskan Native, and 1.1% Native Hawaiian/Pacific Islander; approximately 7.4 indicated that they were Hispanic. The majority of participants lived in a campus dormitory, residence hall, or apartment (52.1%) and were not a member of a fraternity or sorority (79.2%). The majority were employed part-time (47.9%); others were not employed (43.8%), or were employed full-time (8.3%). Most participants reported a yearly individual income of less than $10,000 (80.2%) followed by $10,001 to $20,000 per year (10.4%), $20,001 to $30,000 per year (6.3%), $30,001 to $40,000 per year (1.0%), and $40,001 to $50,000 per year (1.0%). The majority of participants were single or never married (88.5%); others were living with a partner (8.3%) or married (2.1%). Most participants identified as heterosexual (87.5%); others identified as lesbian (1.0%), bisexual (10.4%), or 'other' (1.0%).

The sample for analysis provided a total of 3,670 momentary reports. On average, participants completed 38.23 momentary reports out of 42 (i.e., 3 reports times 14 days; 79.5%). Most participants (92.71%) responded to reports sent on at least 13 out of the 14-day study period. Participants provided a total of 330 (8.99% of all momentary reports collected) reports in which they consumed alcohol. On average, participants completed 3.44 user-initiated reports about their drinking. Men and women did not differ on how many reports they submitted, $t(94) = -0.39$, $p = .698$.

It is important to note that 75% (72/96) reported using another drug during the study period. Specifically, there were 746 momentary reports that indicated another drug was being used at the moment. Frequency of momentary reports for each drug included: marijuana (325 reports), tobacco (traditional cigarettes and chewing dip, excluding vapes/e-cigarettes; 120 reports), tobacco via vapes/e-cigarettes (273 reports), cocaine (four reports), nonprescribed medications (stimulants and/or sedatives; 41 reports), methampthetamine (zero reports), inhalants (i.e., nitrous oxide, glue, gas, paint thinner; one report), hallucinogens (i.e., LSD, acid, mushrooms, PCP, Special K, ecstasy; one report), opioids (i.e., street or prescribed; zero reports), and other substances not listed (59 reports). Out of the 746 momentary reports of drug use, 148 (19.8%) reports coincided with alcohol consumption at that moment.

Procedure

Overview. Participants were screened remotely and if eligible, participants were notified to attend their baseline session. After attending their baseline session, they received prompts for the EMA portion of the study for 14 consecutive days. Specifically, the current study had two main parts: (1) an in-person baseline assessment that included the completion of a baseline

survey and training on the EMA phone application (i.e., app; LifeData), and (2) completion of assessments for 14 days remotely.

Screening. Study advertisements provided a link to a quick five-minute screening survey. Individuals completed a brief online survey to determine their eligibility and provided their contact information. Study screening criteria were that participants must have: (1) been 18 to 25 years old, (2) used a smartphone (Android/iOS), and (3) reported moderate to heavy drinking (i.e., have engaged in heavy episodic drinking [4+/5+ drinks for women/men] at least twice in the past month). Eligible individuals were notified by the researcher to attend an in-person baseline assessment at the on-campus laboratory. They were informed that the study was a two-part study (baseline plus 14 days) that aimed to better understand alcohol use behaviors among emerging adults.

Baseline Assessment/EMA Training. During the in-person baseline session, participants provided informed consent for their involvement in both study parts (i.e., the baseline session and the 14 days assessment period). Participants completed a baseline survey to provide baseline information about their typical drinking and other study variables (see measures below). The baseline session took approximately 30 to 45 minutes to complete.

Upon completion of the baseline, participants were trained on the EMA protocol and how to use the LifeData app on their smartphones. The researcher downloaded the LifeData app onto the participant's smartphone and provided a tutorial on how to use the app to enter their surveys. Thus, all participants practiced entering their reports and asked any questions about the study. Participants were instructed not to complete assessments at any time when they felt unable to reply or if safety was a concern (e.g., when driving).

Momentary Assessments. Momentary assessments via the LifeData app were collected for 14 consecutive days via participants' smartphones, and assessments started one day after baseline. A 14-day assessment period was chosen based on previous research and pilot data for the present research. Prior EMA work examining alcohol use has commonly used a 14-day period (Collins, Kashdan, & Gollnisch, 2003; Hufford, Shields, Shiffman, Paty, & Balabanis, 2002; Martino, Kovalchik, Collins, Becker, Shadel, & D'Amico, 2016); EMA research examining momentary impulsivity has used a 14-day period and yielded significant relationships (e.g., Ansell et al., 2015); and pilot data indicated significant within-variability (about 42%) in impulsivity over 14 days (Stamates et al., 2018). In sum, 14 days (including two weekends) was supported as a sufficient period to capture variability and the associations hypothesized in the present research. Each day, participants completed a combination of time-based, random time-based, and user-initiated event-based reports (see Appendix A for summary). All assessments were tailored to be about two minutes to reduce participant burden.

Time-based reports. Time-based reports refer to scheduled reports for each day (e.g., Shiffman, 2007). Participants responded to one morning report each day upon waking that established how they felt so far that day and summarized the events of last night (e.g., experiences with alcohol-related problems). For the present study, the purpose of time reports was to establish whether problems occurred the night before (see Appendix O). If drinking did not occur the night before, a decoy list of questions (i.e., reasons for not drinking; Appendix P) was administered so that there was no difference in the length of surveys for drinking and non-drinking days. Participants were sent their morning report at 10:00 A.M. and were given until 12:00 P.M to complete it.

Random time-based reports. Random time-based (also known as signal) reports refer to reports sent at random, variable times within specified time intervals throughout each day (e.g., Shiffman, 2008), which were programmed via the LifeData application. The purpose of random time-based reports was to capture typical representations of state behaviors exhibit during each day. In the present study, random time-based reports sampled random representations of pre-drinking states. Based on prior research (e.g., Mason et al., 2017; Shiffman, 2009; Treloar et al., 2015, participants were delivered an afternoon report between 1:00 P.M. and 4:00 P.M. and an evening report between 5:00 P.M. and 8:00 P.M. Each random prompt expired once another prompt was sent, so there was no backlogging.

User-initiated event-based reports. User-initiated event-based reports assessed behaviors occurring during a drinking occasion (e.g., Shiffman, 2007). If participants consumed alcohol, they initiated these reports on their phone at the beginning and the end of their drinking occasion. Thus, once their first alcoholic beverage was consumed, they entered a report (i.e., beginning of the drinking episode report). On their last alcoholic beverage of the evening, they completed another user-initiated report (i.e., end of the drinking episode report). Any random report that was sent after a drinking report was excluded from analyses to avoid confounding effects of alcohol. Therefore, random reports were random samples of *pre-drinking* states whereas user-initiated reports captured states of behavior while drinking. The researcher monitored the data and response rates and updated participants on their compliance rates on Day 3 and 10 of the study. A daily reminder was sent to participants about completing user-initiated reports if they consumed alcohol, to minimize attrition. The purpose of this monitoring strategy was to increase compliance in the study protocol. Previous research indicates that this strategy of researcher-to-participant contact throughout the entire study phase, using a similar EMA survey strategy as the

current proposal, has yielded compliance rates of 86-87% (e.g., Hufford et al., 2002; Mason et al., 2017). See Table 1 for summary of measures for each type of report. See Table 2 for an example assessment during the EMA portion of the study.

Table 1

Summary of Measures for Each Type of Report

Measures	Time-based	Random Time-based	User-initiated Event-based
Context (4 items)	X	X	X
Impulsivity (4 items)	X	X	X
Motives (3 items)	X	X	X
Expectancies (13 items)	X	X	
Problems/decoy (up to 13 items)	X		
Norms (up to 2 items)		X	X
Alcohol Use Current (up to 2 items)		X	X
Alcohol Use Morning Report (up to 4 items)	X		

Table 2

Example of Surveys on Drinking Days

Time	Type of Report	Measure
10:30 AM	(1) Time-based (morning report)	Context Impulsivity Drinking Motives Alcohol Expectancies Alcohol-related problems Reasons for not drinking Alcohol Use (last night)
1:00 P.M.	(2) Random time-based (afternoon)	Context Impulsivity Drinking Motives Alcohol Expectancies Normative Perceptions (if drinking reported) Alcohol Use (current)
6:00 P.M.	(3) Random time-based (evening)	Context Impulsivity Drinking Motives Alcohol Expectancies Normative Perceptions (if drinking reported) Alcohol Use (current)
10:00 P.M.	(4) User-initiated: Beginning of Drinking	Context Impulsivity Drinking Motives Normative Perceptions Alcohol Use (current)
1:00 A.M.	(5) User-initiated: End of Drinking	Context Impulsivity Drinking Motives Normative Perceptions Alcohol Use (current)

Measures

Baseline Assessment.

Impulsivity. The Urgency Premeditation Perseverance Sensation Seeking Positive Urgency (UPPS-P; see Appendix B) Impulsive Behavior Scale (Cyders & Smith, 2007; Whiteside & Lynam, 2001) was used to measure one's typical levels of impulsivity. The UPPS-P is a 59-item measure that assesses five facets impulsivity: (1) negative urgency (i.e., tendency to act rashly under extreme negative emotions; "I always keep my feelings under control"; α = .87), (2) lack of perseverance (i.e., inability to remain focused on a task; "I generally like to see things through to the end" ; α = .78), (3) lack of premeditation (i.e., tendency to act without thinking; "My thinking is usually careful and purposeful" ; α = .76), (4) sensation seeking (i.e., tendency to seek out novel and thrilling experiences; "I generally seek new and exciting experiences and sensations" ; α = .80), and (5) positive urgency (i.e., tendency to act rashly under extreme positive emotions; "When I am in a great mood, I tend to get into situation that could cause me problems" ; α = .93). Each item was rated from 1 (*strongly agree*) to 4 (*strongly disagree*). A total score was summed with higher scores indicating higher impulsivity. The UPPS-P is widely used to assess impulsivity and has good internal consistency and divergent and external validity (e.g., Whiteside, Lynam, Miller, & Reynolds, 2005). The UPPS-P was used as a control variable for between-person impulsivity in analyses.

Alcohol use. The Timeline Follow-Back (TLFB; Sobell & Sobell, 1992; see Appendix C) was used to assess typical alcohol use. The TLFB assesses self-reported daily patterns of drinking during the past 30 days using a calendar method with anchors indicating holidays and relevant university days (e.g., spring break). Participants estimated the number of standard drinks (equivalent of 1 standard drink in liquor, beer, and wine) consumed on each day during

the past month. The TLFB is a widely used method to assess alcohol use among college students. It has high test-retest reliability across college drinkers and problem drinkers (Sobell & Sobell, 1992). The measure of interest from the TLFB included the total number of drinks consumed (i.e., quantity) as well as the number of days in which alcohol was consumed (i.e., frequency). Typical drinking reported during the past two weeks on the TLFB was compared to drinking reported during the 14-day EMA to examine any participant reactivity (i.e., behavior change when being monitored). Research among college student drinkers has found minimal reactivity effects to EMA (e.g., Hufford et al., 2002).

Alcohol-related problems. The Young Adult Alcohol Consequences Questionnaire (YAACQ; Read, Kahler, Strong, & Colder, 2006; see Appendix D) measured negative alcohol consequences. The scale consists of 48 items in which participants indicated if they have experienced overall alcohol-related problems in the past year with "*yes*" or "*no*" response options. Examples of negative consequences included items such as, "I have become very rude, obnoxious, or insulting after drinking" and "I have neglected my obligations to family, work, or school because of my drinking." The total score of the scale was calculated by summing the number of positive endorsements with higher scores indicating a greater likelihood of experiencing alcohol-related problems in the past year. The YAACQ has demonstrated high internal consistency in many studies examining young adult alcohol use outcomes (e.g., Barthelmes, Borsari, Hustad, & Barnett, 2010). Internal consistency for the present research was .91.

Drinking motives. The Drinking Motives Questionnaire (DMQ; Cooper, 1994; see Appendix E) measured one's motivations for drinking. The scale is a 20-item measure used to assess typical drinking motives. The scale consists of four subscales: coping (e.g., "To forget

your worries" ; α = .83), conformity (e.g., "To fit in with a group you like" ; α = .82), social (e.g., "To be sociable" ; α = .88), and enhancement (e.g., "Because it helps you to enjoy a party" ; α = .80). Responses range from 1 (*almost never/never)* to 5 (*all of the time*). Subscales were scored by summing the responses that correspond to each individual subscale. Higher scores on a subscale indicate greater endorsement of that particular drinking motive. This scale is widely used and has demonstrated adequate good reliability, internal consistency, and predictive validity (e.g., Copper, 1994). In the present study, coping and enhancement motives were used.

Normative perceptions. The Descriptive Norms Rating Form (DNRF; Baer, Stacy, & Larimer, 1991; see Appendix F) was used to assess descriptive drinking norms. The DNRF asks participants to estimate the number of standard drinks members in their social group consumed on each day of a typical week during the past three months. The DNRF has demonstrated good test-retest reliability and convergent validity (e.g., Baer et al., 1991; Borsari & Carey, 2000).

Alcohol-expectancies. The Comprehensive Effects of Alcohol (CEOA; Fromme, Stroot, & Kaplan,1993; see Appendix G) was used to measure perceptions of the positive and negative effects of alcohol consumption prior to consumption of alcohol. The 38-item scale measures the degree to which the participant believes that alcohol will affect them when under the influence of alcohol, ranging from 1 (*disagree*) to 4 (*agree*). The CEOA consists of seven subscales. Positive expectancies include: sociability (e.g., "I would be talkative" ; α = .82), tension reduction (e.g., "My body would feel relaxed" ; α = .81), liquid courage (e.g., "I would feel brave and daring" ; α = .84), and sexuality (e.g., "I would be a better lover" ; α = .71). Negative expectancies include: cognitive and behavioral impairment (e.g., "I would feel dizzy"; α = .84), risk and aggression (e.g., "I would be loud, boisterous, or noisy"; α = .74), and self-perception (e.g., "I would feel self-critical" ; α = .66). Subscales were summed, and higher scores

represented stronger held expectancies about alcohol. This is a scale commonly used among college students and has demonstrated adequate levels of internal consistency, construct validity, and criterion validity (e.g., Dimeff, Baer, Kivlahan, & Marlatt, 1999; Fromme et al., 1993; Ham, Stewart, Norton, & Hope, 2005).

Demographics. A general background questionnaire assessed demographic information (e.g., age, class standing, sex, etc.). See Appendix H.

Momentary Assessments (over 14 consecutive days).

Context. Context was assessed during all reports. Participants responded to four items. They were asked, "Where is your current location?" with several options (e.g., school, work, bar, etc.). Participants also indicated who they had been with during the past 15 minutes (e.g., partner/spouse, friend, family, etc.). This method of assessing context has been used in prior EMA work (e.g., Treloar et al., 2015). If drinking, participants were asked approximately how many other people they were with, and if these people were mostly male, mostly female, about the same make-up of males and females, or if they were alone. See Appendix I.

Impulsivity. Impulsivity was assessed during all EMA reports (i.e., time, random, user-initiated event). The MIS was used to assess momentary impulsivity (see Appendix J). Participants completed the MIS (Tomko et al., 2014) to assess their impulsivity since the last prompt by responding to 4 items (e.g., "I have made a spur of the moment decision") on a 5-point Likert scale ranging from 1 (*very slightly/not at all*) to 5 (*extremely*). Responses were summed for current feeling of impulsivity. The MIS has good content and convergent validity with other impulsivity scales (Tomko et al., 2014) and has been used in prior EMA/daily diary work (e.g., Bresin et al., 2013; Stamates et al., 2018; Tomko et al., 2014).

Drinking motives. Motives were assessed during all EMA reports (i.e., time, random, user-initiated event; see Appendix K). Drinking motives were assessed using three items from existing DMQ measures (e.g., Cooper, 1994) as consistent with Dvorak et al. (2014). Participants were asked, "If you were to drink tonight, what would be your reason?" Three modified-DMQ items were used to assess coping (2 items; "I want to drink to forget my worries, or because it helps me when I feel depressed" and "I want to drink tonight to reduce my anxiety, and because it helps me when I'm feeling nervous") and enhancement (1 item; "I want to drink tonight because it is fun, and I like the way I feel when I drink"). During user-initiated reports, these items were altered to reflect their current motives while they were currently drinking alcohol. Each item was rated from 0 (*strongly disagree*) to 4 (*strongly agree*). The two items were summed for coping motives, and higher scores indicated stronger motives for drinking. This approach is consistent with previous EMA/daily diary research and has shown good internal consistency at .81 (Arbeau et al., 2011; Dvorak et al., 2014).

Alcohol-expectancies. Expectancies were assessed during all pre-drinking reports (see Appendix L). Daily expectancies were assessed using the Positive and Negative Alcohol Expectancies and Evaluations scale (Lee et al., 2015). This scale consists of 13 items used to measure positive and negative expectancies. Participants were asked, "If you were to drink tonight, how likely would you feel or do the following things?" Six positive (e.g., be more sociable) and seven negative (e.g., feel nauseated or vomit) expectancies were assessed. Responses ranged from 1 (*very unlikely*) to 9 (*very likely*). Items were summed for positive and negative effects, with higher scores indicating greater expectations of outcomes (i.e., positive or negative). This approach is consistent with previous EMA/daily diary research (e.g., Lee et al., 2015; Patrick et al., 2016).

Norms. Descriptive norms were assessed during random and user-initiated reports if participants indicate that their company is consuming alcohol. Participants were asked if they are with other people who are drinking *(Yes/No*) and if "yes", they reported the average number of drinks overall that they believed had been consumed by their company since they started drinking that day. Response options ranged from 0 to 50+, which is consistent with prior EMA work (O'Grady et al., 2011). Each day, participants received the following definition of a serving of alcohol: one 12-oz. can or bottle of beer, one 5-oz. glass of wine, one 12-oz. wine cooler, or 1.5 oz. of distilled spirits. See Appendix M.

Alcohol use. Participants reported whether they were drinking in random and user-initiated reports. Participants were asked, **"**Since the last recording, have you consumed alcohol?" (*Yes/No*). If "*yes*", then participants were asked "If yes, how many drinks (i.e., number of beers, glasses of wine, shots, and mixed drinks) have you had since your last survey recording?" with a drop-down list of options ranging from 0 to 50+ or more. This is consistent with prior EMA work (e.g., O'Grady et al., 2011; Treloar et al., 2015). During each time-based report (i.e., morning), participants were asked to summarize their drinking from the night before. Participants reported the total number of drinks consumed yesterday, how many hours were spent drinking, and approximately what time they started and stopped drinking yesterday. These items were used to ensure drinking data was collected from the night prior. See Appendix N.

Alcohol-related problems. For each time report (i.e., morning report), participants were asked if they experienced any problems last night (e.g., blacking out) or that morning (e.g., hangover). They received a 13-item alcohol problems measure known as the Daily Alcohol-Related Consequences and Evaluations Measure for Young Adults (Lee et al., 2017; see Appendix O). This measure assesses six positive consequences (e.g., "I was able to express my

feelings more easily", "I felt more energetic") and seven negative consequences (e.g., "I did something that embarrassed me", "I couldn't remember what I did while drinking"). Generalizability coefficients on these scales range from good to excellent (Lee et al., 2017). Further, this scale has demonstrated good convergent validity with other widely-used problematic alcohol use instruments (i.e., Rutgers Alcohol Problem Index and Alcohol Use Disorder Identification Test; Lee et al., 2017). Responses were coded as 0 (*did not occur)* and 1 (*did* occur). Scores for positive and negative consequences were summed, with higher scores indicating more consequences for each dimension. This method of assessment is consistent with previous daily diary research (e.g., Fairlie, Ramirez, Patrick, & Lee, 2016). If participants did not drink last night, they completed a 6-item decoy questionnaire that assessed reasons for not drinking (see Appendix P). The Reasons for Not Drinking Scale (O'Hara, Armeli, & Tennen, 2014) includes 6 items that may be reasons why one did not consume alcohol on the day prior (e.g., "I had to work at my job", "I had to much school work to do"). Participants responded whether they agreed with each item on a scale with response options coded as 0 (*No*) and 1 (*Yes*). None of these items were included for analyses.

CHAPTER III

RESULTS

Power Analysis

The author conducted a pilot study to examine the association between impulsivity and alcohol use at the daily level (Stamates et al., 2018). Participants were assessed at one time point each day for 14 days about the previous night's drinking and their level of impulsivity experienced so far that day. To determine how much variability could be explained within-person over the 14-day period, the intraclass correlation coefficient (ICC) was calculated. In the pilot study, the ICC was .575, suggesting that about 57.5% of the variability in daily impulsivity could be explained by between-person differences. Thus, about 42% (almost half) of the variability in daily impulsivity was due to within-person differences. Using this information and West et al. (2011)'s formula for power, it was expected that 55 participants would be needed for the present analyses. However, Aim 3 tested multilevel structural equation modeling (MSEM), and Hox and Maas (2001) recommend at least 100 clusters to obtain trustworthy estimates of variances and path standard errors for MSEM. Thus, 100 participants were estimated to be needed for the present study analyses.

Data Cleaning

All analyses were conducted using HLM version 6 software, Mplus version 8.2, and SPSS 25. The current study produced data at multiple levels, including momentary- or daily-level data (level 1) and person-level data (level 2). Momentary-level data included measures of context, impulsivity, drinking motives, alcohol expectancies, normative perceptions, and alcohol use. Daily-level data included alcohol-related problems, and momentary-level data were aggregated to create day-level scores for some of the study analyses. Momentary- and daily-

level files were formatted using the LONG format in SPSS. Person-level data included sex of the participant as well as baseline scores for typical impulsivity, alcohol use, alcohol-related problems, drinking motives, alcohol-related expectancies, and normative perceptions. Thus, three datasets were created: (1) a dataset for all level-1 variables at the momentary level, (2) a dataset with day-level variables including alcohol-related problems experienced last night and aggregated momentary scores, and (3) a dataset for all person-level data.

Prior to conducting analyses, data were cleaned. First, all participants provided at least two reports, thus, all participants (N = 96) were included in the study analyses. Second, missing data were addressed. Zero data were missing at baseline, and thus, no imputation was used. For momentary measures, listwise deletion was used, as it is the missing data method default in HLM software. Given this approach to missing data, HLM is generally resilient to missing data because individuals who complete fewer daily surveys have less influence on final study outcomes. Most participants (92.71%) responded to reports sent on at least 13 days out of the 14-day study period, on average, participants completed 38.23 momentary reports out of 42 (i.e., 3 reports times 14 days; 79.5%) across the entire study period. In addition, participants responded, on average, within approximately 41 minutes of receiving their prompt.

Statistical assumptions were addressed prior to conducting analyses. First, normality was assessed (1) using histograms, (2) examining skewness and kurtosis, and (3) examining outliers via boxplots on baseline, momentary, and daily data. At baseline, all continuous scales were normally distributed with the exception of the social expectancy subscale of the CEOA and the total quantity and frequency scores of alcohol use on the TLFB. One outlier was present on the CEOA subscale, one outlier was present on the quantity score from the TLFB, and two outliers were present on the frequency score from the TLFB. At the momentary level, all continuous

scales were normally distributed with the exception of the total number of drinks consumed based on the momentary reports. Five outliers were present on the total number of drinks score based on momentary reports. All continuous daily data were normally distributed, and no outliers were present. All extreme outliers outside of the 3 *SD* range were Winsorized (Barnet & Lewis, 1994) to match the next highest value. Third, to reduce potential multicollinearity, all main effects and interaction terms were centered. Level-1 predictors were group-mean centered (i.e., to reflect whether momentary or day-level score was higher or lower than that person's typical score) and level-2 predictors were grand-mean centered (i.e., to reflect whether person-level score was higher or lower than other individuals). Fourth, a Bernoulli distribution was specified for all dichotomous outcomes (e.g., whether someone experienced a problem after drinking last night), a Poisson distribution was specified for continuous outcomes (i.e., number of drinks consumed), and a normal distribution was specified for all other study variables (i.e., impulsivity, expectancies, etc.). Fifth, variance components of each model were examined to determine whether they should be treated as random or fixed effects. Impulsivity did vary significantly between-person, and thus, variance components were estimated as random in subsequent analyses. When random variance components were nonsignificant, effects were fixed. For all analytic models, results from the unit-specific model with robust standard errors were reported.

Potential covariates were tested prior to analyzing main statistical analyses for the present study. Age was unrelated to momentary impulsivity, B = -0.13, SE = 0.09, p = .166, and likelihood of drinking at the momentary level, OR = 0.99, p = .850. Sex was unrelated to momentary impulsivity, B = -0.27, SE = 0.34, p = .433, and likelihood of drinking at the momentary level, OR = 1.12, p = .574. Thus, age and sex were not included as covariates in

main study analyses to be parsimonious. Further, sex was proposed as a moderator for Aim 4; as such, rather than controlling for potential sex differences, associations were tested to examine whether relationships occurred differentially for men versus women. Baseline impulsivity was associated with momentary impulsivity, $B = 0.03$, $SE = 0.01$, $p < .001$, but not likelihood of drinking at the momentary level, OR = 0.00, $p = .524$. All analyses controlled for between-person effects of main study variables (i.e., baseline alcohol use, baseline impulsivity, baseline expectancies, etc.). Specific data analytic approaches for each study aim are described below.

Participant Reactivity

Typical drinking reported during the past two weeks on the TLFB was compared to drinking reported during the 14-day EMA to examine any participant reactivity (i.e., behavior change when being monitored). At baseline, participants reported consuming a total of 17.09 ($SD = 14.69$) alcoholic drinks over 3.68 ($SD = 2.52$) days during the past 14 days. During the 14-day EMA study period, participants reported consuming a total of 11.04 ($SD = 12.55$) alcoholic drinks over 2.35 ($SD = 2.52$) days. A paired *t*-test was used to examine whether differences were significantly different between baseline and follow-up drinking reports. For total amount of alcohol consumed, there was a significant difference, $t(95) = 3.73$, $p < .001$, $d = 0.44$. For total amount of drinking days, there was a significant difference, $t(95) = 4.84$, $p < .001$, $d = 0.528$. Thus, participants, on average, reported *less* drinking during the EMA study period compared to their typical drinking patterns during the two weeks prior to the study period. This effect was small-to-moderate, suggesting that there was some participant reactivity.

Variability in Study Outcomes

To determine how much variability could be explained by within-person changes in study variables over the 14-day period, the intraclass correlation coefficient (ICC) was calculated for

each study variable. See Table 3 for calculations. Generally, it has been suggested that these values should be neither too close to 0 nor too close to 1 for multilevel analyses (Preacher, Zyphur, & Zhang, 2010). Overall, there was a moderate amount of variability in most study variables. For example, momentary impulsivity's ICC was .4022; thus, 40.22% of the variability in momentary impulsivity could be explained by between-person differences, and 59.78% was due to within-person variability. The lowest amount of within-person variability was observed for negative expectancies (ICC = .7052), suggesting that differences in negative expectancies are more likely due to differences between individuals rather than variation from moment-to-moment.

Table 3

Intraclass Correlation Coefficients for Momentary Variables

	Sigma-squared	Tau	ICC
Impulsivity	3.52	2.37	0.4022*
Positive expectancies	54.54	118.55	0.6849*
Negative expectancies	33.85	80.95	0.7052*
Coping motives	2.01	2.93	0.5933*
Enhancement motives	0.86	1.178	0.5771*
Norms	20.09	11.238	0.3587*

*$p < .001$.

Statistical Analyses for Study Aims

Aim 1. Aim 1 was to determine momentary impulsivity as a predictor of subsequent alcohol use and problems.

Hypothesis 1a. It was hypothesized that momentary levels of impulsivity would be positively associated with subsequent momentary levels of alcohol use. Specifically, momentary impulsivity would be related to subsequent alcohol use in the moment.

Findings. To examine temporality (i.e., whether day levels of impulsivity were associated with greater alcohol use consumed that night, and lagged bidirectional effects for Aim 2), aggregated scores were created to analyze associations at the day level. Specifically, four variables were created that indicated the level of impulsivity at various timepoints before, during, and after drinking (Time 1, Time 2, Time 3, and Time 4). Time 1 represented the level of momentary impulsivity prior to initiation of drinking. Thus, Time 1 impulsivity was calculated based on the aggregated mean of each day's morning, afternoon, and evening report, sent each day and prior to a drinking episode. As previously stated, any random time-based report that was sent after a drinking report was excluded from analyses to avoid confounding effects of alcohol. Therefore, random reports represented *pre-drinking states*. Time 2 momentary impulsivity represented the initial change in impulsivity at the first drink assessment (i.e., the start of the drinking occasion). Thus, when participants consumed their first drink, they created a user-initiated event-based report and indicated their level of impulsivity at that moment. As such, impulsivity at Time 2 was the first recording of momentary impulsivity once drinking started. Time 3 represented the level of momentary impulsivity reported *after* drinking (i.e., the end of the drinking occasion). Time 4 represented impulsivity reported at the morning report. Thus,

when participants completed their time-based report each morning, they reported their current level of impulsivity at the start of the day. See Figure 1.

HLM was used to test whether day levels of impulsivity (i.e., at Time 1) were associated with greater levels of alcohol use later that same day. Results are in Table 4. An example equation of day-level impulsivity predicting the number of drinks that night is provided below:

$$\text{TotalDrinks}_{ti} = \pi_{00} + \pi_{10}(\text{DayImpulsivity}_{ti} - \overline{\text{DayImpulsivity}_i}) + \pi_{01}(\text{Impulsivity}_i - \overline{\text{Impulsivity.}}) + \pi_{02}(\text{Drinks}_i - \overline{\text{Drinks.}}) + e_{ti} + r$$

Here, the outcome is the total number of drinks for person *i* at time *t*. The coefficient π_{00} is the intercept for person *i* when all other predictors are zero. Within-subject predictors (π_{10}) represent group-mean centered day-level impulsivity. Between-subject predictors (π_{01}, π_{02}) represent the person's average impulsivity and average number of drinks reported at baseline, and both are grand-mean centered. A random effect (e_{ti}) is included to allow each participant to have a unique regression equation predicting the outcome variable, and a residual term (r) captures the within-person error.

Day levels of impulsivity were unrelated to the number of alcoholic drinks consumed that day, ERR = 0.98, $p = .756$. Follow-up analyses explored whether levels of impulsivity in the morning, afternoon, and evening were associated with the total number of drinks consumed that night. All main effects were nonsignificant (see Table 4).

Table 4

Multilevel Models of Impulsivity Predicting Total Number of Drinks Consumed that Day

	Aggregated Day Impulsivity ERR (CI)	Morning Impulsivity ERR (CI)	Afternoon Impulsivity ERR (CI)	Evening Impulsivity ERR (CI)
Intercept	**0.56 (0.44-0.73)***	**0.56 (0.43-0.72)***	**0.57 (0.45-0.71)***	**0.46 (0.36-0.59)***
Level 1: Day level				
Impulsivity	0.98 (0.87-1.11)	1.07 (0.96-1.18)	1.05 (0.97-1.12)	0.95 (0.84-1.08)
Level 2: Person level				
Baseline Impulsivity	0.99 (0.99-1.01)	1.00 (0.99-1.01)	1.00 (0.99-1.02)	1.00 (0.99-1.02)
Baseline Alcohol Use	**1.01 (1.01-1.02)***	**1.01 (1.00-1.02)***	**1.01 (1.00-1.02)***	**1.01 (1.01-1.02)***

Note. ERR = event rate ratio from Poisson multilevel modeling distribution. CI = confidence interval. Significant effects are bolded.

*$p < .01$.

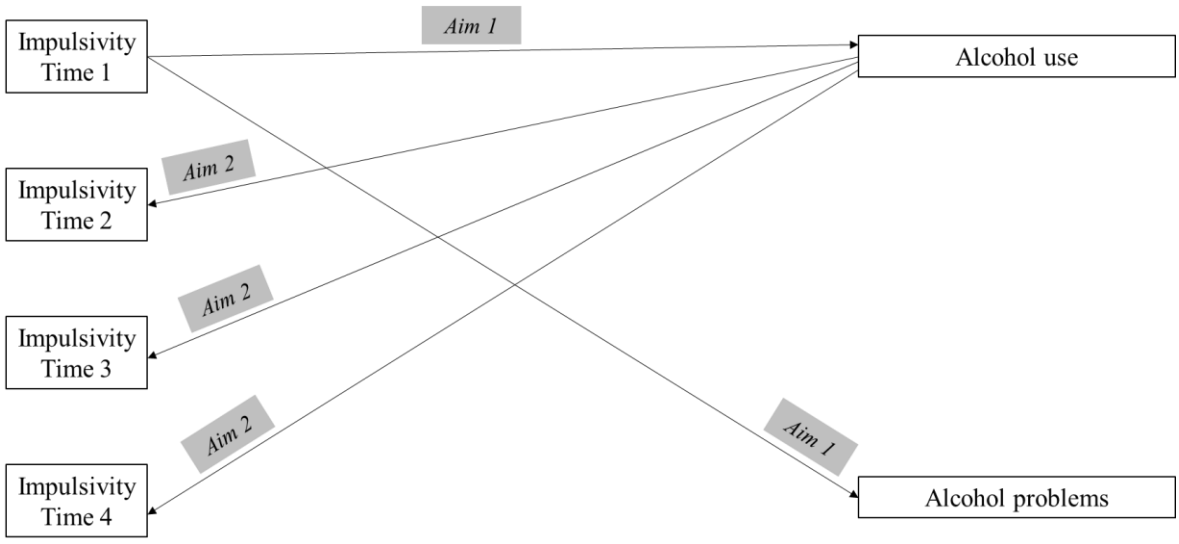


Figure 1. Conceptual model for Aims 1 and 2.

Hypothesis 1b (Daily-level). It was hypothesized that greater day-levels of impulsivity experienced prior to a drinking occasion would be related to greater alcohol-related problems experienced that same night.

Findings. For Hypothesis 1b, the variables of interest included aggregated levels of momentary impulsivity and alcohol-related problems experienced on drinking days. Using the scores calculated from Hypothesis 1a and HLM, impulsivity at Time 1 was examined as a predictor of alcohol-related problems experienced that night. Because alcohol-related problems were assessed during the time-based report (i.e., morning report), consecutive days were lagged so that impulsivity's score would be matched with the previous day's assessment. Typical levels of impulsivity (level 2) and alcohol use from that evening (level 1) were controlled for. All continuous level 1 predictors were group-mean centered whereas level 2 predictors were grand-mean centered. Although alcohol-related problems were the primary construct of interest, positive consequences were also explored. An example equation is below:

$$\log(\pi/1\text{-}\pi) = \pi_{00} + \pi_{10}(\text{Impulsivity}_{ti} - \overline{\text{Impulsivity}_i}) + \pi_{20}(\text{Drinks}_{ti} - \overline{\text{Drinks}_i}) +$$

$$\pi_{01}(\text{Impulsivity}_i - \overline{\text{Impulsivity}_\cdot}) + \pi_{02}(\text{Drinks}_i - \overline{\text{Drinks}_\cdot}) + e_{ti} + r$$

Day levels of impulsivity were unrelated to the likelihood of experiencing any alcohol-related problems (0 = *did not experience problems*, 1 = *did experience problems*) that day as well as the total number of alcohol-related problems experienced on drinking days. This finding was consistent across various day-level scores of impulsivity (i.e., aggregated across morning, afternoon, and evening, morning only, afternoon only, and evening only). While within-person impulsivity was not associated with problems experienced on that day, trait levels of impulsivity were significantly associated to alcohol-related problems. Specifically, individuals who reported higher trait levels of impulsivity had a higher likelihood of experiencing alcohol-related

problems. In addition, individuals who reported higher trait levels of impulsivity reported experiences with more alcohol-related problems (i.e., continuous score; total number of problems experienced). This finding was consistent across all impulsivity models on alcohol-related problems (see Table 5). Follow-up analyses explored experiences with positive alcohol-related consequences. All main effects of impulsivity also were nonsignificant (see Table 6).

Table 5

Multilevel Models of Impulsivity Predicting Alcohol-related Problems and Positive Consequences that Day

	Number of Problems B (*SE*)	Problem Occurred (Y/N) OR (CI)	Number of Positive Consequences B (*SE*)	Positive Consequence Occurred (Y/N) OR (CI)
Intercept	**0.58 (0.10)*** **	**0.34 (0.21-0.54)*** **	**2.99 (0.22)*** **	**9.58 (4.69-19.59)*** **
Level 1: Day level				
Total Drinks Consumed	-0.00 (0.01)	0.99 (0.88-1.01)	**-0.09 (0.04)***	1.09 (0.93-1.28)
Aggregated Impulsivity	0.09 (0.08)	1.14 (0.68-1.90)	-0.07 (0.23)	1.00 (0.59-1.69)
Level 2: Person level				
Baseline Impulsivity	**0.02 (0.01)****	**1.05 (1.02-1.08)****	0.02 (0.01)	1.03 (0.99-1.07)
Baseline Alcohol Use	-0.00 (0.00)	1.00 (0.98-1.01)	-0.00 (0.01)	0.99 (0.98-1.01)
Intercept	**0.58 (0.10)*** **	**0.34 (0.21-0.54)*** **	**1.01 (0.08)*** **	**9.99 (4.80-20.77)*** **
Level 1: Day level				
Total Drinks Consumed	-0.01 (0.01)	0.98 (0.89-1.01)	**-0.04 (0.02)***	1.07 (0.91-1.27)
Morning Impulsivity	0.05 (0.08)	1.11 (0.74-1.65)	-0.07 (0.04)	0.76 (0.48-1.22)
Level 2: Person level				
Baseline Impulsivity	**0.02 (0.01)****	**1.05 (1.02-1.08)****	0.01 (0.00)	1.03 (0.99-1.07)
Baseline Alcohol Use	-0.00 (0.00)	1.00 (0.98-1.01)	-0.00 (0.00)	0.99 (0.98-1.01)
Intercept	**0.47 (0.09)*** **	**0.30 (0.19-0.48)*** **	**0.97 (0.08)*** **	**8.64 (4.44-16.86)*** **
Level 1: Day level				
Total Drinks Consumed	-0.02 (0.01)	0.95 (0.84-1.07)	**-0.04 (0.02)****	0.99 (0.90-1.09)
Afternoon Impulsivity	0.06 (0.06)	1.08 (0.89-1.30)	-0.02 (0.03)	0.78 (0.55-1.10)
Level 2: Person level				
Baseline Impulsivity	**0.02 (0.01)****	**1.04 (1.02-1.07)****	0.01 (0.01)	1.02 (0.99-1.06)
Baseline Alcohol Use	-0.00 (0.00)	0.99 (0.98-1.01)	-0.00 (0.00)	1.00 (0.98-1.02)
Intercept	**0.63 (0.11)*** **	**0.38 (0.23-0.62)*** **	**0.98 (0.09)*** **	**6.62 (3.53-12.43)*** **
Level 1: Day level				
Total Drinks Consumed	-0.00 (0.01)	1.01 (0.86-1.18)	-0.01 (0.02)	1.00 (0.89-1.12)
Evening Impulsivity	0.06 (0.06)	1.12 (0.87-1.43)	0.01 (0.04)	1.25 (0.80-1.95)
Level 2: Person level				
Baseline Impulsivity	**0.02 (0.01)****	**1.04 (1.02-1.07)****	0.01 (0.01)	1.00 (0.97-1.04)
Baseline Alcohol Use	-0.00 (0.00)	.99 (0.97-1.03)	0.00 (0.00)	1.00 (0.98-1.03)

Note. OR = odds ratio from Bernoulli multilevel modeling distribution. CI = confidence interval. Y/N = Yes/No. B = unstandardized estimates for path. SE = standard error.

Significant effects are bolded.

*$p < .05$. **$p < .01$. ***$p < .001$.

Exploratory Aim 1 (Daily-level). The indirect effect from day-level impulsivity to alcohol-related problems through the influence of alcohol use was explored. To test this aim, multilevel structural equation modeling (i.e., MSEM; Zhang, Zyphur, & Preacher, 2009) with fixed slopes was used to test the indirect effects using Mplus version 8.3. MSEM allows for simultaneous examination of separate level 1 (within-person) and level 2 (between-person) effects while preventing the conflation of these effects. Because all variables for the mediation models were captured at level 1, this model was considered a 1-1-1 model, meaning that the independent variable (impulsivity), mediator (alcohol use), and dependent variable (alcohol-related problems) were all level 1 within-person variables. Indirect effects were estimated using BAYES estimation and the BITERATIONS (5,000) command in Mplus to estimate independent Markov chain Monte Carlo (MCMC) confidence intervals. The base model (i.e., indirect effect) and the direct effect were estimated. Specifically, parameters were estimated for paths from *X* to *M* (path *a*), the path from *M* to *Y* (path *b*), and the path from *X* to *Y* (path *c'*). See Table 6 for results.

At the between-level, all estimated paths were nonsignificant. Thus, typical levels of impulsivity were not associated with alcohol use or alcohol-related problems over the 2-week study period. Within-person analyses revealed that impulsivity was not associated with alcohol use or alcohol-related problems experienced on the same day. Level of alcohol use was positively associated with the number of alcohol-related problems experienced, $p < .001$. The indirect effect from impulsivity → alcohol use → problems was nonsignificant at both the within- and between-person level.

Table 6

Daily Mediation of Impulsivity to Problems through Alcohol Use

	Within				Between			
	B	SE	*p*		B	SE	*p*	
Path a								
Impulsivity → Use	-0.06	0.19	.379		0.05	0.27	.434	
Path b								
Use → Problems	**0.12**	**0.03**	**<.001**		-0.12	0.06	.415	
Main effect (c')								
Impulsivity → Problems	0.06	0.06	.186		0.10	0.08	.090	
			95% MCMC				95% MCMC	
Indirect effect (ab)	B	SE	LL	UL	B	SE	LL	UL
Imp → Use → Problems	-0.01	0.02	-0.06	0.04	0.00	0.02	-0.03	0.03

Note. B = unstandardized estimates for path. SE = standard error. MCMC = Markov chain Monte Carlo. LL = Lower limit; UL = upper limit.

Aim 2. Aim 2 was to examine the influence of alcohol use on subsequent impulsivity reported.

Hypothesis 2 (Momentary-level). It was hypothesized that greater alcohol use in the moment would predict greater subsequent levels of impulsivity reported in the moment.

Findings. The variables of interest included momentary levels of impulsivity and alcohol use. HLM was used to test whether alcohol use was related to impulsivity at Time 2 (i.e., impulsivity at start of drinking occasion), Time 3 (i.e., impulsivity at the end of the drinking occasion), and Time 4 (i.e., impulsivity reported the next morning). Thus, three models were analyzed (see Figure 1 previously shown).

In the models examining impulsivity at Time 2 and Time 3 (i.e., during the drinking episode), only drinking days were examined. Impulsivity from the time point prior to alcohol consumption (i.e., the evening report) was compared to impulsivity reported at the beginning of drinking occasion, and in addition, evening impulsivity was compared to impulsivity reported at the end of drinking occasion. Each report was dummy coded to reflect the time of the report (e.g., 0 = *evening impulsivity*; 1 = *beginning of drinking occasion*). Results revealed that initiating a drinking occasion did not influence impulsivity. Specifically, there was no difference in individual's impulsivity during the timepoint prior to drinking compared to their impulsivity at the initiation of alcohol use, $B = 0.33$, $SE = 0.27$, $p = .215$. However, impulsivity at the end of the drinking occasion was significantly different from impulsivity reported prior to drinking. Specifically, individuals reported greater impulsivity at the end of their drinking occasion compared to their impulsivity prior to drinking that day, $B = 0.97$, $SE = 0.26$, $p < .001$. See Table 7.

To examine impulsivity at Time 4, consecutive days were matched that included at least one drinking day, so that prior night's drinking could be modeled with next-morning impulsivity. In this model, impulsivity from the prior day (i.e., lagged effect of impulsivity) was controlled for. Using this approach, directional claims could be made about the predictors because models controlled for associations between the predictor and the outcome across assessments (Wickham and Knee, 2013). Level of alcohol use was significantly associated with impulsivity reported the next morning. Specifically, controlling for prior-day impulsivity (i.e., lagged effect) and trait levels of impulsivity and alcohol use, alcohol use from the prior day was positively associated with impulsivity reported the next morning, $B = 0.04$, $SE = 0.02$, $p = .048$. That is, those who reported higher alcohol use the night before also reported higher levels of impulsivity the next morning, and this effect was found controlling for their level of impulsivity the prior day and between-level impulsivity and alcohol use. See Table 8.

Table 7

Multilevel Models of Alcohol Use Predicting Impulsivity During the Drinking Occasion

	Impulsivity B (*SE*)
Intercept	**5.42 (0.22)***
Level 1: Momentary level	
Time (0 = evening; 1 = beginning of drinking occasion)	0.33 (0.27)
Level 2: Person level	
Baseline Impulsivity	**0.06 (0.01)***
Baseline Alcohol Use	-0.01 (0.01)
Intercept	**5.38 (0.23)***
Level 1: Momentary level	
Time (0 = evening; 1 = end of drinking occasion)	**0.97 (0.26)***
Level 2: Person level	
Baseline Impulsivity	**0.72 (0.01)***
Baseline Alcohol Use	-0.02 (0.01)

Note. B = unstandardized estimates for path. SE = standard error.

Significant effects are bolded.

*$p < .001$.

Table 8

Multilevel Models Predicting Impulsivity Next-Morning Alcohol Use

	Next-Morning Impulsivity B (*SE*)
Intercept	**5.03 (0.12)****
Level 1: Day level	
Total Drinks Consumed	**0.04 (0.02)***
Lagged Impulsivity	**0.86 (0.06)****
Level 2: Person level	
Baseline Impulsivity	**0.02 (0.01)***
Baseline Alcohol Use	-0.00 (0.00)

Note. B = unstandardized estimates for path. SE = standard error.

Significant effects are bolded.

**p* < .05. ***p* < .001.

Aim 3. Aim 3 was to test socio-cognitive mechanisms (i.e., drinking motives, alcohol expectancies, and normative perceptions) as mediators explaining the association between momentary impulsivity and alcohol use.

Hypothesis 3 (Momentary-level). It was hypothesized that greater momentary impulsivity experienced prior to drinking would elicit subsequent momentary changes in motives, expectancies, and norms, which in turn, would predict subsequent greater levels of alcohol use.

Findings. For Aim 3, the variables of interest included momentary levels of impulsivity, coping motives, enhancement motives, expectancies, norms, and total drinks consumed. To test Hypothesis 3, multilevel structural equation modeling (i.e., MSEM; Zhang, Zyphur, & Preacher, 2009) with fixed slopes was used to test the indirect effects using Mplus version 8.3. MSEM allows for simultaneous examination of separate level 1 (within-person) and level 2 (between-person) effects while preventing the conflation of these effects. Because all variables for the mediation models were captured at level 1, this model was considered a 1-1-1 model, meaning that the independent variable (impulsivity), mediator (mechanism), and dependent variable (alcohol use) were all level 1 within-person variables. In each model, the independent variable was aggregated day-level impulsivity (i.e., prior to drinking). For expectancies and motives, these mediating variables were also aggregated to create a day-level score occurring *prior* to drinking. For norms, normative perceptions were only assessed when individuals were with others who were also drinking, and thus, a day-level score across all reports when drinking was indicated was aggregated. Alcohol use was the dependent variable and calculated as the total number of drinks consumed that day. As seen in Figure 2, observed variables at the daily level were modeled as a latent within-person and between-person value. The model examined how

the predictor variable of impulsivity, *X*, influence the outcome variable of number of drinks, *Y*, both directly and indirectly through the mediator of social-cognitions (e.g., expectancies; *M*). Separate models were examined for each type of social cognition (i.e., coping motives, enhancement motives, positive expectancies, negative expectancies, and normative perceptions of others' drinking). Indirect effects were estimated using the BAYES estimation and the BITERATIONS (5,000) command in Mplus to estimate independent MCMC confidence intervals. The base model (i.e., indirect effect) and the direct effect were estimated. Specifically, parameters were estimated for paths from *X* to *M* (path *a*), the path from *M* to *Y* (path *b*), and the path from *X* to *Y* (path *c'*).

Table 9 displays the results for the indirect effects. For positive expectancies, day-level impulsivity was positively associated with day-level positive expectancies. That is, individuals who reported greater than usual impulsivity also reported greater positive expectancies that same day, prior to drinking. Greater day-level positive expectancies were associated with more alcoholic drinks consumed that day. The indirect effect was significant at the within-person level, indicating greater than usual impulsivity was associated with greater alcohol use through the influence of increased positive expectancies. At the between-person level, impulsivity was associated with greater positive expectancies. Thus, individuals who indicated greater typical levels of impulsivity tended to also report greater positive expectancies throughout the 14-day study period. All other effects were nonsignificant at the between-person level.

For negative expectancies, day-level impulsivity was positively associated with day-level negative expectancies. That is, individuals who reported greater than usual impulsivity also reported greater negative expectancies that same day, prior to drinking. Greater day-level negative expectancies were associated with more alcoholic drinks consumed that day. The

indirect effect was significant at the within-person level, indicating greater than usual impulsivity was associated with greater alcohol use through the influence of increased negative expectancies. At the between-person level, impulsivity was associated with greater negative expectancies. Thus, individuals who indicated greater typical levels of impulsivity tended to also report greater negative expectancies throughout the 14-day study period. All other effects were nonsignificant at the between-person level.

For coping motives, day-level impulsivity was positively associated with day-level coping motives. That is, individuals who reported greater than usual impulsivity also reported greater drinking-to-cope motives that same day, prior to drinking. Greater day-level drinking-to-cope motives were associated with more alcoholic drinks consumed that day. Although the *a* and *b* paths were significant, the indirect effect was not. Thus, impulsivity did not influence alcohol use that day through coping motives. At the between-person level, impulsivity was associated with greater coping motives. Thus, individuals who indicated greater typical levels of impulsivity tended to also report coping motives throughout the 14-day study period. All other effects were nonsignificant at the between-person level.

For enhancement motives, day-level impulsivity was positively associated with day-level enhancement motives. That is, individuals who reported greater than usual impulsivity also reported greater enhancement motives (i.e., wanting to drink to enhance current mood) that same day, prior to drinking. Greater day-level enhancement motives were associated with more alcoholic drinks consumed that day. The indirect effect was significant at the within-person level, indicating greater than usual impulsivity was associated with greater alcohol use through the influence of increased enhancement motives. No effects were significant at the between-person level.

For norms, day-level impulsivity was not associated with day-level normative perceptions. That is, individuals' level of impulsivity was unrelated to their perceptions of how much others were drinking. Individual's norms were associated with greater alcoholic drinks consumed that day. Thus, greater perceptions of others' alcohol use were associated with one's own level of consumption that same day. The indirect effect from impulsivity to alcohol use through the influence of norms for that day was nonsignificant. No effects were significant at the between-person level.

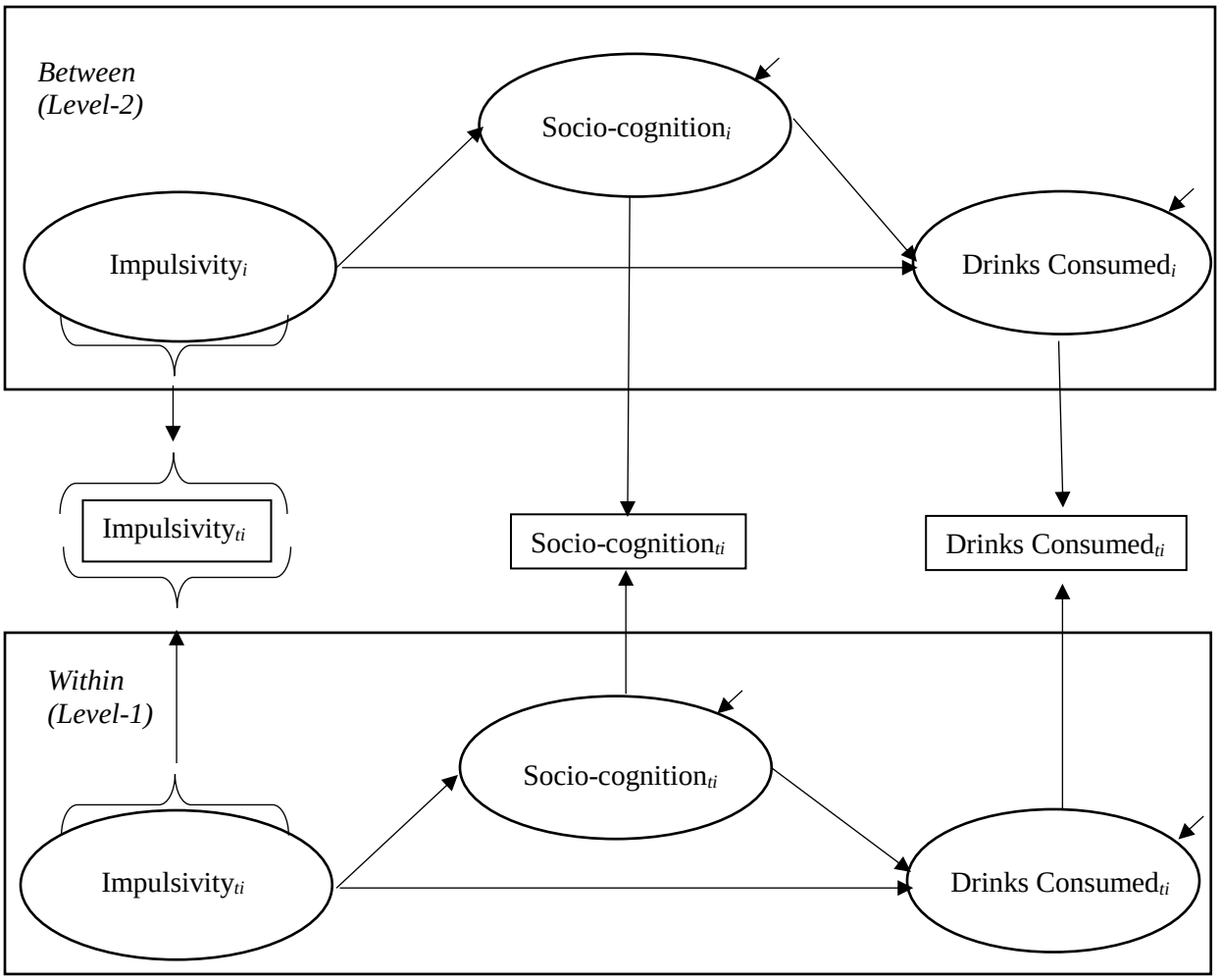


Figure 2. The influence of impulsivity on number of drinks consumed through socio-cognitions. Socio-cognitions included motives, expectancies, and norms. Each model was conducted separately. The subscript *i* denotes *individual* whereas the subscript *t* denotes *time* (or day).

Table 9

Indirect Effects from Impulsivity to Alcohol Use through Socio-Cognitions

	Within			Between		
	B	SE	*p*	B	SE	*p*
Positive Expectancies						
Path a						
Impulsivity → *M*	**0.78**	**0.15**	**<.001**	**1.89**	**0.94**	**.021**
Path b						
M → Drinks Consumed	**0.04**	**0.01**	**.002**	-0.00	0.01	.433
Main effect (c')						
Impulsivity → Drinks	-0.04	0.06	.233	0.09	0.08	.125
Negative Expectancies						
Path a						
Impulsivity → *M*	**0.62**	**0.11**	**<.001**	**3.20**	**0.71**	**<.001**
Path b						
M → Drinks Consumed	**0.04**	**0.02**	**.022**	0.00	0.01	.427
Main effect (c')						
Impulsivity → Drinks	-0.04	0.06	.272	0.08	0.09	.184
Coping Motives						
Path a						
Impulsivity → *M*	**0.11**	**0.03**	**<.001**	**0.54**	**0.14**	**<.001**
Path b						
M → Drinks Consumed	**0.12**	**0.07**	**.041**	0.08	0.07	.104
Main effect (c')						
Impulsivity → Drinks	-0.03	0.06	.307	0.04	0.09	.304
Enhancement Motives						
Path a						
Impulsivity → *M*	**0.04**	**0.02**	**.009**	0.09	.10	.189
Path b						
M → Drinks Consumed	**0.38**	**0.11**	**<.001**	0.14	0.09	.051
Main effect (c')						
Impulsivity → Drinks	-0.03	0.06	.291	0.08	0.08	.153
Normative Perceptions						
Path a						
Impulsivity → *M*	0.42	0.31	.175	-0.31	0.26	.231
Path b						
M → Drinks Consumed	**0.18**	**0.04**	**<.001**	0.01	0.04	.717
Main effect (c')						
Impulsivity → Drinks	-0.09	0.07	.212	0.10	0.08	.235

			95% MCMC				95% MCMC	
Indirect effect (ab)	B	SE	LL	UL	B	SE	LL	UL
Imp → PE → Drinks	**0.03**	**0.01**	**0.01**	**0.06**	-0.00	0.02	-0.05	0.04
Imp → NE → Drinks	**0.02**	**0.01**	**0.00**	**0.05**	0.01	0.04	-0.07	0.09
Imp → Coping → Drinks	0.01	0.01	-0.00	0.03	0.04	0.04	-0.03	0.13
Imp → Enh → Drinks	**0.02**	**0.01**	**0.00**	**0.04**	0.01	0.02	-0.02	0.06
Imp → Norms → Drinks	0.07	0.06	-0.05	0.20	-0.00	0.01	-0.03	0.02

Note. Significant effects are bolded. *M* = mediator tested; PE = positive expectancies; NE = negative expectancies; Enh = enhancement motives; Norms = normative drinking perceptions; B = unstandardized estimates for path; SE = standard error; MCMC = Markov chain Monte Carlo; LL = Lower limit; UL = upper limit.

Aim 4. Aim 4 was to test context and sex as moderators of the association between momentary impulsivity and alcohol use.

Hypothesis 4 (Momentary-level moderator). It was expected that momentary context would moderate the association between momentary impulsivity and alcohol use. Specifically, the relationship between momentary impulsivity and alcohol use was expected to be stronger in a peer drinking context.

Findings. For Hypothesis 4a, the variables of interest included momentary levels of impulsivity, context, and alcohol use. Using HLM, moderation analyses were conducted to examine whether context (*alone* = 0 versus *with other peers* = 1) moderated the relationship between momentary levels of impulsivity and likelihood of drinking alcohol at that moment (0 = *no*; 1 = *yes*). In the moderation model, context and impulsivity were both entered as level 1 main effects. In addition to the main effects, a centered interaction variable examining the combined effect of context X impulsivity was created and entered into the model. Because context and impulsivity were both assessed at Level 1, their interaction term was created in SPSS prior to analyses in HLM. Typical impulsivity and drinking were entered as covariates in the model. Thus, intercepts reflected the estimated value of the outcome for the average participant, at an average time, and at their personal average level of impulsivity. Between-person variance components were freely estimated. An example equation of the model is below:

$$\text{TotalDrinks}_{ti} = \pi_{00} + \pi_{10}(\text{Impulsivity}_{ti}) + \pi_{20}(\text{Context}_{ti}) + \pi_{30}(\text{Impulsivity}_{ti} \text{ X } \text{Context}_{ti}) +$$
$$\pi_{01}(\text{Impulsivity}_{\text{Avg}}) + \pi_{02}(\text{Drinks}_{\text{Avg}}) + e_{ti} + r$$

Results are presented in Table 10. Context effects of whether someone was alone or with others did not influence likelihood of alcohol use at that moment. Further, context did not significantly interact with level of impulsivity to predict whether someone was drinking alcohol

at that moment, $p = 320$. That is, the association between momentary impulsivity and likelihood of alcohol use did not vary based on whether someone was alone or with others. A follow-up analysis examined if peer drinking influenced the present study variables. Specifically, a model was tested whereby impulsivity, context (0 = *no peers drinking alcohol*; 1 = *peers drinking alcohol*), and their interaction was estimated to determine their influence on the likelihood of alcohol use at that moment. Model results are presented in Table 11. The interaction term was nonsignificant, $p = .767$, indicating that the association between momentary impulsivity and likelihood of alcohol use did not vary based on peer drinking context.

Table 10

Multilevel Models of Context on Momentary Impulsivity and Alcohol use

	Alcohol Use OR (CI)
Alone (1) Vs. With Others (0)	
Intercept	**12.13 (7.23-20.35)***
Level 1: Momentary level	
Momentary impulsivity	1.13 (0.82-1.56)
Context	0.95 (0.33-2.74)
Momentary impulsivity X Context	0.72 (0.48-1.10)
Level 2: Person level	
Baseline Impulsivity	1.03 (0.99-1.07)
Baseline Alcohol Use	0.99 (0.97-1.01)
Peers Drinking (1) Vs. Not (0)	
Intercept	**8.10 (2.22-29.58)***
Level 1: Momentary level	
Momentary impulsivity	1.04 (0.78-1.38)
Context	1.39 (0.39-4.89)
Momentary impulsivity X Context	1.06 (0.72-1.55)
Level 2: Person level	
Baseline Impulsivity	1.02 (0.98-1.06)
Baseline Alcohol Use	1.00 (0.98-1.02)

Note. OR = odds ratio from Bernoulli multilevel modeling distribution.

CI = confidence interval. Significant effects are bolded.

*$p < .001$.

Exploratory Aim 2 (Person-level moderator). Sex was tested as a moderator of the relationship between momentary impulsivity and momentary alcohol use.

For Hypothesis 4b, the variables of interest included momentary levels of impulsivity and alcohol use and sex. Using HLM version 6, moderation analyses were conducted to examine whether sex (i.e., level 2; *males* = 0 versus *females* = 1) moderated the relationship between momentary levels of impulsivity and likelihood of alcohol use at that moment. In a moderation model, sex and impulsivity were both entered as main effects. In addition to the main effects, a centered cross-level interaction variable examining the combined effect of sex X impulsivity was created and entered into the model. Typical impulsivity and drinking at level 2 were entered as covariates in the model. Thus, intercepts reflected the estimated value of the outcome for the average participant, at an average time, and at their personal average level of impulsivity. Between-person variance components were freely estimated. An example equation of the model is below:

$$\text{TotalDrinks}_{ti} = \pi_{00} + \pi_{10}(\text{Impulsivity}_{ti}) + \pi_{01}(\text{Sex}_{ti}) + \pi_{20}(\text{Impulsivity}_{ti} \text{ X } \text{Sex}_{ti}) +$$

$$\pi_{02}(\text{Impulsivity}_{\text{Avg}}) + \pi_{03}(\text{Drinks}_{\text{Avg}}) + e_{ti} + r$$

Results are presented in Table 11. Sex was not associated with higher likelihood of momentary drinking, $p = .160$, and did not affect the relationship between impulsivity and alcohol use at the momentary level, $p = .738$. Thus, the relationship between impulsivity and alcohol use in the moment did not vary for males versus females.

Table 11

Multilevel Models of Sex on Momentary Impulsivity and Alcohol Use

	Alcohol Use OR (CI)
Intercept	**0.06 (0.04-0.09)*** **
Level 1: Momentary level	
Momentary impulsivity	**1.22 (1.08-1.38)** **
Sex	1.35 (0.89-2.06)
Momentary impulsivity X Sex	0.98 (0.85-1.01)
Level 2: Person level	
Baseline Impulsivity	1.00 (0.99-1.01)
Baseline Alcohol Use	**1.01 (1.01-1.02)** **

Note. OR = odds ratio from Bernoulli multilevel modeling distribution.

CI = confidence interval. Significant effects are bolded.

*$p < .05$. **$p < .01$. ***$p < .001$.

CHAPTER IV

DISCUSSION

Impulsivity is a robust predictor of alcohol use and alcohol-related problems among young adults (King et al., 2014; Stautz & Cooper, 2013). To date, the extent of our knowledge on impulsivity's association with alcohol use has been limited to cross-sectional studies and between-subject designs that may lack ecological validity. Further, although impulsivity may vary from moment-to-moment (Ansell et al., 2015; Tomko et al., 2014), scant research has examined how momentary states of impulsivity manifest before and after alcohol use and what factors may explain or impact these associations. The current study sought to address gaps in our knowledge on state impulsivity by examining variation in impulsivity and alcohol use using a 14-day EMA methodology. Specifically, the current study aimed to examine (1) the association between momentary states of impulsivity and alcohol use, (2) how alcohol use influences momentary states of impulsivity, (3) mechanisms (i.e., drinking motivations, alcohol-related expectancies, and normative perceptions) that may explain the link between momentary states of impulsivity and alcohol use, and (4) moderators (i.e., peer drinking context, sex) that may impact the association between impulsivity and alcohol use.

Impulsivity's Association with Alcohol Use and Problems

Traditional theories of impulsivity argue that impulsiveness is a trait (e.g., Loree et al., 2015; Stamates & Lau-Barraco, 2017). A trait perspective implies that impulsivity is an enduring characteristic that determines behavior across a variety of situations. Further, trait theories indicate that impulsivity is relatively stable throughout the life course (e.g., McCrae & Costa, 1994; Stamates & Lau-Barraco, 2017), as traits are conceptualized as unchanging within a person. This long-held view has yielded a wealth of research focused on differences in

impulsivity *between* individuals rather than how impulsivity may change *within* a person. Given the lack of knowledge on momentary states of impulsivity, particularly in the context of alcohol use, the first aim of the current study was to examine momentary fluctuations in impulsivity and how this variation may be associated with alcohol use the same day. In addition, given impulsivity's strong association with alcohol-related problems (e.g., King et al., 2014), problems were examined as well.

Alcohol Use. One aspect of the first aim was to determine whether momentary changes in impulsivity were associated with alcohol use. Specifically, pre-drinking states of impulsivity were examined as predictors of the level of alcohol consumed later that day. It was hypothesized that greater impulsivity experienced during the day (i.e., prior to drinking) would be associated with greater levels of alcohol consumed later that day. In the present study, findings suggested that pre-drinking momentary reports of impulsivity were not associated with alcohol use that day. To the best of my knowledge, this is the first study to examine the relationship between impulsivity and alcohol use at the momentary level. The lack of temporality between impulsivity predicting alcohol use within the same day is inconsistent with the larger, cross-sectional literature on state impulsivity (i.e., on behavioral tasks) and alcohol use. Of this research, there is general support for a positive association between state impulsivity and alcohol use (e.g., Courtney et al., 2012; Henges & Marczinski, 2011; Murphy & MacKillop, 2012). Thus, previous research supports that individuals who exhibit greater state impulsivity tend to also report greater levels of alcohol consumption. However, in the present study, earlier states of impulsivity in the day may not have directly predisposed one to consume alcohol later that day. It is possible that null findings might be attributed to power. Sixteen participants reported no user-initiated reports of alcohol use over the two-week period (see Limitations); however, these

participants *did* report consuming alcohol use the night prior on their morning report. Thus, some participants may have consumed alcohol but were noncompliant in the present study procedures. A follow-up analysis combined alcohol use data reported on *either* momentary reports or their morning report from the previous night. Results revealed that the effect of day-level impulsivity on the number of drinks consumed that evening was closer to a nonsignificant trend, $p = .110$.

Alcohol-related problems. Another goal of the primary study aim was to examine whether impulsivity experienced prior to alcohol use was associated with alcohol-related problems experienced that night, on drinking days. The current study's approach to analyze alcohol use versus alcohol-related problems was taken because impulsivity has been shown to predict both types of alcohol use outcomes (e.g., Stamates & Lau-Barraco, 2017 for review). Further, some evidence suggests that impulsivity may be directly associated with alcohol-related problems, independent of how much alcohol was consumed that during the drinking episode (Stamates & Lau-Barraco, 2017). It was hypothesized that greater day-levels of impulsivity would be associated with both greater likelihood of experiencing alcohol-related problems that evening and number of alcohol-related problems experienced. Findings suggested that day-levels of impulsivity (aggregated and isolated momentary states prior to drinking) were not associated with negative problems experienced that evening. These findings were consistent for positive alcohol-related consequences as well. Interestingly, although momentary *state* levels of impulsivity were not associated with alcohol-related problems, *trait* levels of impulsivity were positively associated with experiencing alcohol-related problems. Specifically, individuals who reported experienced higher baseline impulsivity than others reported experiencing more problems over the 14-day study period. Thus, although individuals' momentary impulsivity

prior to drinking did not confer risk for problems, typically being more impulsive was associated with experiencing more problems in general.

Although the link between impulsivity and alcohol-related problems was nonsignificant, the indirect path from impulsivity to alcohol-related problems through the influence of alcohol use was examined. It is plausible that greater impulsivity experienced that day would be associated with greater alcohol use, which in turn, would be related to more experiences with alcohol-related problems. However, the indirect effect was nonsignificant. Given that the *a* (i.e., impulsivity to alcohol use) and *b* (i.e., alcohol use to alcohol-related problems) were both nonsignificant, this finding was not surprising.

Conclusions. Overall, findings did not support the present study's first hypothesis on temporality effects of impulsivity on alcohol use behaviors. Specifically, impulsivity prior to drinking was not associated with level of alcohol use or alcohol-related problems experienced that evening.

Bidirectional Effects

Although impulsivity is associated with greater drinking, research also supports the idea that drinking may affect impulsivity (e.g., de Wit, 2009). For example, alcohol use itself may increase one's impulsivity, as alcohol may impair inhibition and result in engaging in risky behaviors such as risky sexual behaviors or driving while intoxicated (de Wit, 2009). Further, prolonged exposure to heavy alcohol use may impair functioning in brain areas response for impulse control, and subsequently, increase one's impulsivity (see Lopez-Caneda et al., 2014 for review). Consequently, the transactional effects between impulsivity and alcohol use may create a vicious cycle for some drinkers. As such, the second aim of this study examined how alcohol use affected momentary states of impulsivity.

There was some support that alcohol use may influence momentary impulsivity *during* the alcohol use occasion. Specifically, impulsivity was significantly higher at the end of the drinking occasion compared to impulsivity reported prior to the drinking occasion. Further, level of alcohol use predicted momentary impulsivity *the next morning*. Thus, greater number of drinks consumed the prior evening was associated with greater impulsivity reported the next morning, and this effect was observed controlling for level of impulsivity reported on the prior day, trait levels of impulsivity, and typical levels of alcohol consumption.

Findings from *during* the alcohol use occasion are consistent with prior research examining alcohol's influence on impulsivity states. However, prior research typically has tested this association in controlled, laboratory designs whereby the acute effects of alcohol are observed on computerized impulsivity tasks (Dougherty et al., 2008; Field et al., 2010; Lopez-Caneda et al., 2014; Marczinski et al., 2011). In this line of work, blood alcohol concentrations (BAC) of .06 to .09% have been shown to impair impulse control in young and healthy adults (Dougherty et al., 2008; Fillmore & Vogel-Sprott, 1999; Marczinski & Fillmore, 2003; Marczinski et al., 2011). The current study extended these prior findings by demonstrating that momentary states of impulsivity may increase as a result of alcohol use in the real world. Although changes in impulsivity were not observed at the initiation of drinking, changes were observed at the end of the alcohol use occasion. That is, greater impulsivity was observed at the end of drinking compared to pre-drinking impulsivity reported. Given the present study findings, it is plausible that the disinhibiting effects of alcohol were not present until later in the drinking occasion once greater BAC levels were achieved.

Findings on *next morning* impulsivity are consistent with a burgeoning literature on longitudinal effects of alcohol use on impulsivity. For example, Kaiser et al. (2016) found that

alcohol use during the first year of college predicted higher levels of impulsivity approximately one year later, while controlling for first-year impulsivity. In another study, Quinn et al. (2011) found impulsivity was related to greater levels of heavy drinking prior to entering college and predicted greater levels of heavy drinking across the first two years of college. Further, changes in impulsivity were observed across time points, and heavy drinking was positively related to changes in impulsivity. Results from the present study extend these prior findings by demonstrating that lagged effects of alcohol use on impulsivity reported the next day can be observed at the daily level. Thus, alcohol use in the natural environment may potentially elicit more immediate within-person changes in momentary impulsivity.

Conclusions. In sum, the present study's examination of the association between alcohol use and impulsivity in an EMA context elucidated how these constructs manifest in daily life. Findings from the present study partially supported bidirectional effects between impulsivity and alcohol use. Specifically, alcohol use positively predicted greater impulsivity at the end of the drinking occasion and impulsivity reported the next morning. Thus, there is support that impulsivity may fluctuate within person, and variability may be observed post-drinking. Given that impulsivity was also associated with likelihood of drinking at the momentary level, impulsivity may play a role in the etiology and maintenance of alcohol use.

Mechanisms Explaining Impulsivity and Alcohol Use

Mediators explaining the relationship between impulsivity and alcohol use are not well understood. Using theory (Caspi et al., 2005; Cooper et al., 1995; Corbin et al., 2011) and previous research (e.g., Adams et al., 2012; McCarthy et al., 2001; Quinn et al., 2011), the third aim of the present study examined drinking motives, alcohol expectancies, and normative perceptions as real-time mediating variables between impulsivity and alcohol use.

Drinking Motivations. Consistent with the Motivational Model of Alcohol Use (Cooper et al., 1995), motives act as antecedents of drinking through which personality characteristics may influence. Thus, it was hypothesized that impulsivity may influence an individual's motives for drinking, which in turn, influence their own drinking behavior at the daily level. For the present study, internal motives (coping and enhancement) were examined because Cooper et al. (1995) suggest that these motives are "situationally activated" for drinkers rather than due to individual differences, and thus, may be more subject to variability.

Within-person findings suggested for drinking-to-cope motives, greater than usual impulsivity was associated with greater coping motives during the day. Further, greater drinking-to-cope motives reported during the day was associated with greater level of alcohol consumed that night. However, the indirect path from impulsivity to alcohol use, through the influence of coping motives was nonsignificant. At the between-person level, impulsivity and coping motives were positively related. That is, individuals who reported greater impulsivity over the 14-day study period also tended to report greater coping motives. The indirect was also not supported at the between-person level. To the best of my knowledge, this is the first study to examine the mediating effects of impulsivity and alcohol use through coping motives at the daily level. Although indirect paths were not supported at the within- or between-person level, these findings are consistent with prior cross-sectional research suggesting that coping motives may not mediate the relationship of impulsivity and alcohol use (e.g., Curcio & George, 2011). Further, other studies have found that although coping motives may not mediate the association between impulsivity and alcohol use, it may mediate the relationship between impulsivity and alcohol-related problems (e.g., Adams et al., 2012; Littlefield et al., 2010). This finding may be because of a couple of reasons. First, coping motives are, in general, associated with more

negative outcomes (e.g., Kuntche et al., 2008). Second, impulsive individuals are prone to react to negative emotional states (e.g., Cooper et al., 2000), and thus, may engage in maladaptive behaviors (e.g., drink alcohol) to manage their negative affect. Given that alcohol use may exacerbate impulsivity and negative affective states, experiences with alcohol-related problems (e.g., initiating fights) may occur despite the level of alcohol use consumed. In sum, although level of impulsivity may have elicited stronger drinking-to-cope motives, this association did not necessarily result in greater alcohol consumption on that same day.

Within-person findings suggested for enhancement motives, greater than usual impulsivity was associated with greater enhancement (i.e., wanting to drink to enhance current mood) motives. Further, greater enhancement motives reported during the day was associated with greater level of alcohol consumed that night. The indirect effect was significant at the within-person level, indicating that greater than usual impulsivity was associated with greater alcohol use through the influence of increased enhancement motives. These findings are consistent with prior cross-sectional research (e.g., Magid et al., 2007). Further, this pathway is supported by theory. Specifically, impulsive individuals are characterized by a desire to engage in risk-taking behaviors in order to achieve an optimal level of arousal (see Stamates & Lau-Barraco, 2017 for review). Thus, when individuals are experiencing greater impulsivity than usual, they may be drawn toward rewarding behaviors that enhance their current state (Stamates & Lau-Barraco, 2017). Alcohol use provides stimulation as individuals physiologically feel more stimulated when consuming alcohol (e.g., Berey, Leeman, Pittman, Franco, & Krishnan-Sarin, 2019), and young adults commonly consume alcohol in stimulating environments (e.g., parties, with others, etc.). It is important to note that no effects were observed at the between-

person level; thus, these associations would not have been observed had within-person effects not been parsed out.

Overall, findings regarding drinking motivations are consistent with previous findings that suggest motives may serve as a proximal mechanism through which impulsivity impacts drinking behavior. Compared to coping motives, enhancement motives were a more salient mechanism. It is possible that enhancement motives are more relevant for young adult college drinkers compared to coping motives, considering that this was a heavy drinking but less severe drinking population.

Expectancies. According to The Acquired Preparedness Model (i.e., APM; Corbin et al., 2011), personality traits (e.g., impulsivity) may influence learning mechanisms with regard to alcohol use. More specifically, impulsive individuals tend to focus more on the positive alcohol stimuli in their environment (e.g., McCarthy et al., 2001). Thus, greater impulsivity may predispose individuals to acquiring more positive and less negative alcohol expectancies, which in turn may influence their own levels of drinking. Taken together, it was hypothesized that impulsivity would influence alcohol use through alcohol expectancies. The present study examined positive (i.e., positive beliefs about the effects of alcohol) and negative (i.e., negative beliefs about the effects of alcohol) expectancies.

For positive expectancies (e.g., feeling relaxed, feeling more sociable), individuals who reported greater than usual impulsivity also reported greater positive expectancies that same day, prior to drinking. Greater than usual positive expectancies were associated with more alcoholic drinks consumed later that day. Further, the indirect pathway was significant at the within-person level, indicating greater than usual impulsivity was associated with greater alcohol use through the influence of increased positive expectancies. At the between-person level,

impulsivity was associated with greater positive expectancies. Thus, individuals who indicated greater typical levels of impulsivity tended to also report greater positive expectancies throughout the 14-day study period. No other effects were observed at the between-person level. Similar findings were observed for negative expectancies (e.g., feeling embarrassed, feeling hungover). Specifically, greater than usual impulsivity was associated with greater negative expectancies which in turn predicted more alcohol consumed later that night. In addition, individuals who indicated greater typical levels of impulsivity tended to also report greater negative expectancies throughout the 14-day study period.

The within-person findings from the present study regarding positive and negative expectancies are consistent with strong cross-sectional (Anderson et al., 2003; McCarthy et al., 2001; Barnow et al., 2004) and longitudinal (e.g., 1 to 4 years of college; Corbin et al., 2011; Settles et al., 2010) support for indirect effects from greater impulsivity to greater drinking through the influence of positive and negative expectancies. Although alcohol expectancy theory and most prior research examining alcohol expectancies have treated these cognitions as stable traits rather than a variable that is subject to change, findings from the present study support significant variability in expectancies from moment-to-moment, with ICCs ranging from .68 to .70, suggesting that about 30% of the variability in expectancies is due to within-person differences. Although present study findings indicate more variability at the between-person level, within-person variation was still accounted for and demonstrated associations with impulsivity and alcohol use the same day. Thus, consistent with prior research (e.g., Lee et al., 2015; Patrick et al., 2016), expectancies also may have state-like qualities.

An interesting finding from the present study was that greater than usual impulsivity elicited greater endorsement of both positive and negative expectancies. Although the indirect

pathway through positive expectancies was expected based on theory and prior research, the indirect pathway through negative expectancies was more surprising because negative expectancies are thought to *restrain* drinking. Instead, the present study found that impulsivity influenced negative expectancies, which in turn, predicted *greater* alcohol use that day. Thus, although impulsive individuals may have *both* positive and negative expectancies about drinking, they may be more motivated to drink alcohol because of their beliefs of positive drinking outcomes versus negative drinking outcomes (e.g., McCarthy et al., 2001). According to the APM, impulsive individuals focus on the rewarding properties of alcohol use, and as such, are more likely to attend to and encode rewarding events over negative (i.e., punishing) events (e.g., Corbin et al., 2011). Consequently, impulsive individuals are more vulnerable in developing a learning bias in which they are more driven by expectation for reward (i.e., Patterson & Newman, 1993). Thus, compared to negative expectancies, the perceived benefit of drinking may be driving alcohol use at the daily level.

Overall, consistent with prior research, alcohol expectancies were a salient mechanism explaining the link between impulsivity and alcohol use. Findings from the present study extended prior research by demonstrating this relationship at the momentary level. Specifically, study findings support that momentary changes in impulsivity may elicit subsequent changes in expectancy states in real-time.

Norms. Consistent with the Corresponsive Principle (Caspi et al., 2005), it was hypothesized that norms may mediate the association between impulsivity and drinking, such that greater impulsivity would be associated with greater drinking, through the influence of greater perceptions of alcohol use by others. Findings from the present study did not support this hypothesis. Specifically, greater than usual impulsivity was unrelated to perceptions of how

much others were drinking during an alcohol use occasion. However, norms were positively associated with the number of alcoholic drinks consumed that day. The indirect pathway from impulsivity to alcohol use through the norms was nonsignificant, and no effects were observed at the between-person level.

There is scant research on the pathway from impulsivity to alcohol use through norms in the literature. To the best knowledge, only one cross-sectional study has demonstrated this mediational pathway (Hustad et al., 2014); thus, findings from the present study are inconsistent with this prior study. Although there was less empirical support for this association, the hypothesized effect was driven based on prior theory. Specifically, according to the Corresponsive Principle, individuals may select into environments on the basis of their personality traits that, in turn, reinforce these traits. As such, it may be that impulsive drinkers select into peer groups whom they perceive to be risky and heavy drinkers which in turn guide their own risk-taking and drinking behavior. Consequently, it was hypothesized that individuals would opt into heavier drinking groups when reporting higher impulsivity, which would in turn, influence their own alcohol use. This line of thought was not supported in the current study. Thus, when individuals were feeling more impulsive than usual, this did not influence their perceptions of others' alcohol use. However, it is important to note that norms *were* associated with level of alcohol consumed that night. That is, the greater perceptions of others' alcohol use reported during the drinking episode, the greater personal alcohol use was also consumed. This finding is consistent with O'Grady et al. (2011). Thus, although norms appear to guide drinking behavior in one's daily life, impulsivity was not supported to influence this association.

Conclusions. Overall, there were several limitations in the literature regarding mechanisms explaining the relationship between impulsivity and alcohol use. Prior research

primarily used global assessments to measure constructs such as motives, expectancies, and norms, which are subject to retrospective biases, limit conclusions regarding causality, and strongly focus on individual differences rather than how these constructs may vary within a person. The present study supported variability in each of these mechanisms at the momentary level. Further, enhancement motives, positive expectancies, and negative expectancies were supported as real-time mechanisms explaining the association between impulsivity and alcohol use across the day. Knowledge of the temporal ordering of these processes occurring in real time is informative of how drinking behaviors unfold in one's own environment.

Moderators Impacting Impulsivity and Alcohol Use

The final aim of the present study was to explore relevant moderators that may impact the association between impulsivity and alcohol use. Examining moderators of the relationship between impulsivity and alcohol use would enhance state conceptualizations of impulsivity by elucidating *when* fluctuations are most relevant as well as *which* individuals may be most vulnerable for experiencing variability in impulsivity and alcohol use. Two moderators (i.e., context and sex) were examined. It was hypothesized that the association between momentary impulsivity and alcohol use would be stronger for those in a peer drinking context versus alone. No formal hypothesis was given for sex since this was an exploratory aim.

Peer Context. Previous research has shown that impulsive individuals are more susceptible to influence by their peers (Kahler et al., 2003; Robinson et al., 2015). Using the Corresponsive Principle (Caspi et al., 1995) previously described, greater momentary states of impulsivity may be associated with alcohol use, and this may be particularly evident for those in peer drinking contexts versus those who drink alone. Findings from the present study indicated that peer context did not moderate the association between impulsivity and likelihood of drinking

at that moment. Specifically, being alone versus with others (in general) did not influence impulsivity's link with alcohol use, and being with others who are also drinking versus not did not influence impulsivity's link with alcohol use. In fact, being with others (who were either drinking or not) did not influence the likelihood of alcohol use, regardless of impulsivity, at the momentary level. One potential explanation for these findings may be related to measurement. For example, given that normative perceptions of others' alcohol use influenced one's personal level of alcohol use at the daily level, it may be that a peer context is more strongly associated with the *amount* of alcohol consumed across the day rather than likelihood of drinking at the moment. Another point regarding measurement may be the type of peer context examined. In the present study, peer context was dichotomous (i.e., either with others or not, either with peers drinking or not). Perhaps it is the number of peers consuming alcohol, the type of people that are in the context (e.g., friends versus family), and the location in which one is drinking. Another explanation could be the low endorsement of drinking alone (n=51 momentary reports; 15.9%). Thus, lower frequency of these contexts reduced power to detect such differences.

Sex. Sex was explored as a moderator of the association between impulsivity and alcohol use at the momentary level. Although impulsivity predicted likelihood of engaging in alcohol use at the momentary level, sex did not moderate this association. That is, the link between impulsivity and alcohol use did not vary as a function of sex, so it was a relevant relationship for men *and* women and was not stronger for one sex versus the other. Another interesting finding was that level of momentary impulsivity did not differ between men and women. Findings from the present study are inconsistent with prior research demonstrating that men tend to be more impulsive than women in general (e.g., see Cross et al., 2011 for review). Further, the present study found no difference between men and women and likelihood of alcohol use at the

momentary level. Historically, men have typically consumed more alcohol than women. However, a recent convergence between men and women's drinking has been observed over the past decade (SAMHSA, 2016), which is supported by the present study findings.

Conclusions. Overall, some research has pinpointed context and sex as factors relevant for the association between impulsivity and alcohol use. Findings from the present study did not support context and sex as moderators. Interestingly, impulsivity's association with alcohol use did not vary across men and women, which should be explored in future research.

General Discussion

Overall, some of the current study hypotheses were supported. Specifically, the present study found that (1) impulsivity increased as a result of alcohol use on drinking days, (2) level of alcohol use from the prior day predicted greater levels of impulsivity report the next morning, (3) enhancement motives, positive expectancies, and negative expectancies served as real-time mediators explaining the association between impulsivity and alcohol use, and (4) the association between impulsivity and alcohol use at the momentary level operated similarly for men and for women. However, the present study did not support temporal associations between impulsivity and alcohol use and problems. That is, impulsivity experienced prior to drinking was not associated with greater alcohol use or experiencing alcohol-related problems later that day. Further, the association between impulsivity and alcohol use did not vary across being alone versus with others (drinking or in general).

The current research contributed to the literature in several ways. For example, the present study contributed to impulsivity's conceptualization as a trait or state variable. In this body of research, many theories on impulsivity have been proposed, and to date, there is no consensus in the field on how to define impulsivity specifically. Findings from the present study

support the conceptualization of impulsivity as a state construct, and in particular, that impulsivity may vary from moment-to-moment. In fact, trait levels of impulsivity did not influence level of alcohol use in nearly every model tested in the present study. Thus, the majority of findings between impulsivity and alcohol use behaviors (with the exception of alcohol-related problems) were only observed at the within-person level. As such, significant findings were observed *when* individuals were more impulsive than usual rather than examining *who* reported the highest levels of impulsivity in general. Thus, findings supported impulsivity as a malleable construct rather than a stable trait. Regarding within-person variability, the present study found that approximately 60% (including measurement error) of the variation in daily impulsivity was due to within-person differences over the course of two weeks. This variability is consistent with previous research examining within-person fluctuations in impulsivity at the daily level (e.g., Ansell et al. 2015; Stamates et al., 2018). Taken together, the present study suggests that individuals' impulsivity may operate as transient states rather than fixed scores (e.g., Fleeson, 2007) and vary due to situational factors (e.g., Fleeson, 2012).

Another contribution included that this was the first study to examine the bidirectional relationship between impulsivity and alcohol use in real-time and in the natural environment using an EMA design. Specifically, findings supported that alcohol use was associated with greater levels of impulsivity reported at the end of the drinking occasion and the next morning, while controlling for lagged effects. Assertions regarding bidirectional effects argue that impulsivity serves as a cause and consequence of drinking (e.g., de Wit, 2009); however, the present study from stronger support for the latter effect (i.e., alcohol use on momentary impulsivity). The relationship between alcohol use and impulsivity is consistent with longitudinal research supporting that alcohol use can increase impulsivity over time (e.g., one

year; Kaiser et al., 2018). An interesting finding was that greater levels of alcohol use the night prior predicted greater levels of impulsivity *the next morning*. Thus, while it could be argued that greater alcohol consumption the night before would make one less likely to be impulsive the next morning (e.g., because of hangover, etc.), the present study found that individuals reported *greater* impulsivity the next morning. Impulsivity as a consequence of drinking has typically been conceptualized as occurring during the drinking episode, as disinhibiting effects of alcohol have been observed in laboratory-based settings (e.g., de Wit, 2009), or as a result of prolonged alcohol use exposure affecting areas of the prefrontal cortex responsible for impulse control (e.g., Lopez-Caneda et al., 2014). Findings from the present study suggest that alcohol use's impact on changes in impulsivity can be observed more immediately in relatively short intervals in real-time. Thus, momentary states of impulsivity resulting from drinking may play a key role in the etiology and maintenance of alcohol use among heavy-drinking young adults.

Considering that impulsivity significantly varied from moment-to-moment, and there were significant associations with alcohol use (either indirectly through other mechanisms or as a result of alcohol use), impulsivity could potentially be a modifiable target for intervention. Although impulsivity has a robust relationship with alcohol use, information about impulsivity is not typically included in alcohol intervention efforts for young adults. Psychoeducation on the relationship between impulsivity and alcohol use may be useful in reducing alcohol use. For instance, Conrod, Castellanos, and Mackie (2008; 2011) developed an intervention that involves presenting information related to impulsivity's association with alcohol use (e.g., reward sensitivity, boredom susceptibility). Their findings on this approach suggested that, among their sample of adolescents, this information was effective in reducing quantity and frequency of alcohol use over a 6-month period. However, this finding has yet to be explored in young adults.

Additionally, incorporating training in mindfulness techniques may be beneficial, as they have been shown to reduce impulsivity (e.g., Murphy & MacKillop, 2012) and heavy drinking behaviors among college students (e.g., Mermelstein & Garske, 2015).

Several theory-driven, socio-cognitive mechanisms (i.e., drinking motives, alcohol expectancies, and norms) were tested as mediators explaining the relationship between impulsivity and alcohol use. Among drinking motives, enhancement motives, but not drinking-to-cope motives, served as a salient mechanism explaining the relationship between impulsivity and alcohol use. Given that impulsive individuals are highly motivated by reward (see Stamates & Lau-Barraco, 2017 for review), it is not surprising that individuals engaged in greater alcohol use to achieve their optimal level of arousal. It may also be that enhancement motives were more relevant for the present study's sample of young adult college drinkers compared to coping motives because it was a less severe drinking population. Among alcohol expectancies, both positive and negative expectancies explained the relationship between impulsivity and alcohol use. Impulsive individuals develop a learning bias towards the positive effects of alcohol use rather than negative effects (e.g., McCarthy et al., 2001). Thus, although impulsive individuals may hold positive and negative beliefs about drinking, they are more motivated by the rewarding effects of alcohol use rather than potential negative outcomes that could occur (McCarthy et al., 2001). Among norms, momentary norms were associated with level of alcohol consumed that day, but impulsivity did not play a role in this association. The lack of influence others had in the impulsivity and alcohol use link was further evident because peer context did not serve as a moderator. Thus, the momentary association between impulsivity and alcohol use occurred regardless of whether individuals were with others or not, who were or were not drinking alcohol. The unfolding of these processes in real time demonstrated the mechanisms through

which impulsivity may influence drinking in the real world. As such, findings advanced the conceptualization of impulsivity's role in etiological processes of problem drinking and informed daily process models of drinking. Because impulsivity was linked to changes in motivation and expectancy states, this information may be used to develop prevention and intervention programs to reduce alcohol harms and risk-taking behaviors, and subsequently improve outcomes for emerging adult drinkers.

Overall, findings from the present study provided meaningful information about impulsivity and its association with alcohol use behaviors. Because impulsivity has traditionally been viewed as a trait, research has rarely examined impulsivity in an EMA context. In the present study, findings revealed that state changes in impulsivity can be captured from moment-to-moment, and thus, supported the conceptualization of impulsivity as a state-varying construct. It is important to note that findings from the present study do not negate trait impulsivity's importance in the alcohol use literature. A robust literature has supported individual differences between levels of impulsivity and risk for alcohol use and alcohol-related problems. However, in the present study, within-person variability in impulsivity, compared to between-person effects, had more influence overall on the study outcomes. Further, there was some support for a moment-to-moment pattern between impulsivity and alcohol use via specific mechanisms (e.g., drinking motivations, alcohol expectancies), suggesting that impulsivity states are influential in the daily etiological alcohol use process. Given that many of the pathways analyzed in the present study were not observed at the between-person level, disaggregating between- versus within-person effects were critical in understanding the present study's examined associations.

Future Directions

The present study offered a necessary first step in understanding the bidirectional relationship of impulsivity in real-time. In general, it appears that alcohol use may influence impulsivity reported later in the drinking occasion and impulsivity reported the next day. In addition, specific mechanisms, such as alcohol-related expectancies and enhancement drinking motivations, may explain how impulsivity influences alcohol use behaviors. Based on these initial findings, several future directions are suggested.

One area that warrants additional research includes examining the effects of alcohol use on impulsivity during the alcohol use occasion. The present study did find significant effects of alcohol use on impulsivity during the drinking episode, specifically at the end of the drinking occasion. Similar effects of alcohol on state impulsivity have been consistently found in controlled, laboratory designs (Dougherty et al., 2008; Field et al., 2010; Lopez-Caneda et al., 2014; Marczinski et al., 2011). However, the present study's methodology only yielded two momentary assessments for each drinking occasion; thus, impulsivity was only assessed at the initiation and end of alcohol use. Future research may want to incorporate more assessments during the alcohol use occasion to have a more fine-grained approach of examining alcohol's influence on levels of impulsivity reported. Further, comparisons made to estimated blood alcohol concentrations via wearable sensors would provide more valid data.

Another research direction regarding impulsivity pertains to how it is defined. In the current study, the Momentary Impulsivity Scale (MIS; Tomko et al., 2014) assessed a general impulsivity score. However, impulsivity is a multi-faceted construct, and several facets (e.g., sensation seeking, urgency) have shown differential relationships in significance and strength to alcohol use outcomes (i.e., level of consumption and alcohol-related problems experienced; see Stamates & Lau-Barraco, 2017 for review) in the cross-sectional literature. Thus, it is possible

that within-person changes may vary based on the type of impulsivity assessed, and some facets of impulsivity may produce stronger relationships with alcohol use at the momentary level. For example, a recent study (Lydon-Stanley & Bassett, 2019) used a 21-day daily diary to examine within-person associations between sensation seeking and alcohol use and found on days when individuals reported higher than usual sensation seeking, they also reported higher alcohol use involvement. Thus, within-person fluctuation in some other facets have been captured and have predictive utility for alcohol use outcomes. Future research should explore how these different facets related to impulsive behavior manifest in daily life to fully understand the role that impulsivity has in alcohol use at the momentary- and daily-level.

A primary area for future work is to gain a greater understanding of mechanisms underlying the association between impulsivity and alcohol use. The present study examined theory-based mechanisms (i.e., drinking motivations, alcohol expectancies, and normative perceptions) explaining the association between impulsivity and alcohol use. Although these mechanisms were an important first step in understanding the daily process through impulsivity operates, future research may want to examine other mechanisms that may be influential. For example, it is clear that affective states are a primary source driving impulsive individuals' behavior (Stamates & Lau-Barraco, 2017). Impulsive individuals are theorized to engage in impulsive responses during intense emotional states because they have limited cognitive resources available that they can contribute to adaptive decision making (e.g., Cyders & Smith, 2008). This argument is true for negative and positive emotional states. As such, impulsive individuals may use drinking as a means to cope with their distress (e.g., Adams et al., 2012; Jones et als., 2014). Regarding positive affect, impulsive individuals may use drinking to reinforce their positive mood (Cyders & Smith, 2008) and potentially for celebratory drinking

occasions (Del Boca et al., 2004). In the present study, greater than usual impulsivity was associated with greater coping motives and greater enhancement motives, and enhancement motives were more salient in predicting actual greater alcohol use consumed that day. Future research should explore negative and positive emotional states as an additional mechanism contributing to this pathway to more fully understand these associations.

The present study tested the Acquired Preparedness Model, which primarily hypothesizes a mediation pathway whereby impulsivity exerts its influence on alcohol use through its relationship with alcohol-related expectancies (e.g., Corbin et al., 2011). An alternative hypothesis recently proposed in the literature is that alcohol expectancies may instead moderate the association between impulsivity and alcohol use (e.g., Carlson & Johnson, 2012). Thus, rather than impulsivity driving expectancy development, impulsivity and positive expectancies are *independently* related to alcohol use. As such, it may be that individuals high in *both* impulsivity and positive alcohol expectancies are more likely to drink. Moderating effects of expectancies on the impulsivity to alcohol use relationship have been supported in the cross-sectional literature (e.g., Carlson & Johnson, 2012; LaBrie et al., 2014). Another possibility may be that alcohol expectancies influence impulsive responding, which in turn, influences alcohol use. Thus, future research should explore these alternative explanations to fully understand the associations between impulsivity, expectancies, and alcohol use outcomes.

Lastly, future research is needed in understanding how impulsivity relates to alcohol use longitudinally. Although there is evidence that impulsivity has a bidirectional relationship with alcohol use, longitudinal investigations investigating the transactional effects between impulsivity and alcohol use are limited (Kaiser et al., 2016). Thus, research is still needed to assess how impulsivity may change over time to understand its relationship with drinking.

Furthermore, future research may benefit from using a measurement-burst design whereby these associations are examined to determine whether they vary across different time points, or if they are stable relationships across the emerging adulthood period.

Limitations

There are several limitations that should be noted. First, the present study was conducted among a sample of heavy-drinking, young-adult college students who were recruited from a psychology research subject pool; thus, findings may not be generalizable to other populations (e.g., lighter drinkers, non-psychology research pools). Second, momentary reports of alcohol use were self-reported and not verified via physiological data (i.e., daily urine or Breathalyzer assessments). However, EMA methods have been shown to be valid for collecting alcohol data (Patrick & Lee, 2010). Third, although participants were asked to complete user-initiated reports when they were drinking alcohol, 16 out of 96 participants (16.7%) did not complete any user-initiated reports. However, it is important to note that these participants reported alcohol use from the prior evening on their morning report the next day. Thus, although morning reports collected missed data from the night before about alcohol use, it is possible that individuals missed completing user-initiated surveys during their alcohol use occasion. Fourth, the present study used the Momentary Impulsivity Scale, which focuses on a general definition of impulsivity. Thus, differential findings may be observed when using other definitions of impulsivity (e.g., sensation seeking). Lastly, small-to-medium sized effects were found regarding participant reactivity during the study. Specifically, individuals, on average, reported consuming less during the 14-day EMA study compared to their alcohol use during the 14 days prior to baseline. Thus, findings should be interpreted cautiously. It is possible that participants

consumed less alcohol because they were being monitored, missed completing user-initiated reports of their alcohol use, or reported less alcohol use due to social desirability concerns.

CHAPTER V

CONCLUSIONS

This study was the first to examine the bidirectional effects of impulsivity and alcohol use using an ecological momentary assessment design. Specifically, this study examined the associations between impulsivity and alcohol use in real-time, as well as potential factors that explained or impacted the relationship between impulsivity and alcohol use. For bidirectional effects, alcohol consumption predicted greater levels of impulsivity reported at the end of a drinking occasion compared to impulsivity reported prior to drinking. Further, level of alcohol consumption the night before predicted greater impulsivity the next morning. Within-person mediation pathways were supported, such that on days when individuals reported greater than usual impulsivity, they also reported greater enhancement motives, positive expectancies, and negative expectancies, which in turn, was associated with greater alcohol use. Overall, these findings demonstrated the role that impulsivity plays in alcohol use at the momentary level as well as mechanisms that impulsivity operates through. Future research is needed to examine other potential within-person mechanisms that may underlie the examined relationships.

REFERENCES

Adams, Z. W., Kaiser, A. J., Lynam, D. R., Charnigo, R. J., & Milich, R. (2012). Drinking motives as mediators of the impulsivity-substance use relation: Pathways for negative urgency, lack of premeditation, and sensation seeking. *Addictive Behaviors, 37*, 848-855. doi: 10.1016/j.addbeh.2012.03.016.

Anderson, K. G., Smith, G. T., & Fischer, S. F. (2003). Women and acquired preparedness: Personality and learning implications for alcohol use. *Journal of Studies on Alcohol, 64*, 384-392. doi: 10.15288/jsa.2003.64.384.

Ansell, E. B., Laws, H. B., Roche, M. J., & Sinha, R. (2015). Effects of marijuana use on impulsivity and hostility in daily life. *Drug and Alcohol Dependence, 148*, 136-142. doi: 10.1016/j.drugalcdep.2014.12.029

Arbeau, K. J., Kuiken, D., & Wild, T. C. (2011). Drinking to enhance and to cope: A daily process study of motive specificity. *Addictive Behaviors, 36*, 1174-1183. doi: 10.1016/j.addbeh.2011.07.020.

Armeli, S., Todd, M., & Mohr, C. (2005). A daily process approach to individual differences in stress-related alcohol use. *Journal of Personality, 73*, 1657-1686. doi: 10.111/j.022-3506.2005.00362.x.

Ashenhurst, J. R., Harden, K. P., Corbin, W. R., & Fromme, K. (2015). Trajectories of binge drinking and personality change across emerging adulthood. *Psychology of Addictive Behaviors, 29*, 978-991. doi: 10.1037/adb0000116.

Baer, J. S., Stacy, A., & Larimer, M. (1991). Biases in the perception of drinking norms among college students. *Journal of Studies on Alcohol, 52*, 580-586. doi: 0.15288/jsa.1991.52.580.

Barnett, V., & Lewis, T. (1994). Outliers in Statistical Data (Probability & Mathematical Statistics).

Barnow, S., Schultz, G., Lucht, M., Ulrich, I., Preuss, U. W., & Freyberger, H. J. (2004). Do alcohol expectancies and peer delinquency/substance use mediate the relationship between impulsivity and drinking behaviour in adolescence? *Alcohol and Alcoholism, 39,* 213-219. doi: 10.1093/alcalc/agh048.

Barthelmes, C. K., Borsari, B., Hustad, J. T. P., & Barnett, N. P. (2010). Hostility in mandated students: Exploratory analysis and implications for treatment. *Journal of Substance Abuse Treatment, 38,* 284-291. doi: 10.1016/j.jsat.2010.01.004.

Bartholow, B. D., Sher, K. J., & Strathman, A. (2000). Moderation of the expectancy-alcohol use relation by private self-consciousness: Data from a longitudinal study. *Personality and Social Psychology Bulletin, 26,* 1409-1420.

Berey, B. L., Leeman, R. F., Pittman, B., Franco, N., & Krishnan-Sarin, S. (2019). Does self-reported or behavioral impulsivity predict subjective response to low-dose alcohol? *Alcohol and Alcoholism*.

Bo, R., Billieux, J., & Landro, N. I. (2016). Which facets of impulsivity predict binge drinking? *Addictive Behavior Reports, 3,* 43-47. doi: 10.1016/j.abrep.2016.03.001.

Bolger, N., & Laurenceau, J. P. (2013). Intensive longitudinal methods: An introduction to diary and experience sampling research. New York: Guilford Press Google Scholar.

Borsari, B., & Carey, K. B. (2003). Descriptive and injunctive norms in college drinking: A meta-analytic integration. *Journal of Studies on Alcohol, 64,* 331-341. doi: 10.15288/jsa.2003.64.331.

Borsari, B., & Carey, K. B. (2000). Effects of a brief motivational intervention with college student drinkers. *Journal of Consulting and Clinical Psychology, 68*, 728-733. doi: 10.1037/0022-006X.68.4.728.

Bresin, K., Carter, D. L., & Gordon, K. H. (2013). The relationship between trait impulsivity, negative affective states, and urge for nonsuicidal self-injury: A daily diary study. *Psychiatry Research, 205*, 227-231. doi: 10.1016/j.psychres.2012.09.033.

Brown, S. A., Christiansen, B. A., & Goldman, M. S. (1987). The alcohol expectancy questionnaire: an instrument for the assessment of adolescent and adult alcohol expectancies. *Journal of Studies on Alcohol, 48*, 483-491.

Burke, L. E., Shiffman, S., Music, E., Styn, M. A., Kriska, A., Smailagic, A., … Rathbun, S. L. (2017). Ecological momentary assessment in behavioral research: Addressing technological and human participant challenges. *Journal of Medical Internet Research, 19*, e77. doi: 10.2196/jmir.7138.

Carlson, S. R., & Johnson, S. C. (2012). Impulsivity is not always associated with student drinking: A moderation study of impulsivity and drinking by positive alcohol expectancies. *Addictive Behaviors*, *37*, 556-560. doi: 10.1016/j.addbeh.2011.12.007.

Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology, 56*, 453-484. doi: 10.1146/annurev.psych.55.090902.141913.

Caswell, A. J. Celio, M. A., Morgan, M. J., & Duka, T. (2015). Impulsivity as a multifaceted construct related to excessive drinking among UK students. *Alcohol and Alcoholism, 51*, 77-83. doi: 10.1093/alcalc/agv070.

Clay, S. W., Allen, J., & Parran, T. (2008). A review of addiction. *Postgraduate Medicine, 120,* E01-E07. doi: 10.3810/pgm.2008.07.1802.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge.

Collins, R. L., Kashdan, T. B., & Gollnisch, G. (2003). The feasibility of using cellular phones to collect ecological momentary assessment data: Application to alcohol consumption. *Experimental and Clinical Psychopharmacology, 11,* 73-78. doi: 10.1037/1064-1297.11.1.73.

Conrod, P. J., Castellanos, N., & Mackie, C. (2008). Personality-targeted interventions delay the growth of adolescent drinking and binge drinking. *Journal of Child Psychology and Psychiatry, 49,* 181–190. doi: 10.1111/j.1469-7610.2007.01826.x.

Conrod, P. J., Castellanos-Ryan, N., & Mackie, C. (2011). Long-term effects of a personality-targeted intervention to reduce alcohol use in adolescents. *Journal of Consulting and Clinical Psychology, 79,* 296– 306. doi: 10.1037/a0022997.

Cooper, M. L. (1994). Motivations for alcohol use among adolescents: Development and validation of a four-factor model. *Psychological Assessment, 6,* 117-128. doi:10.1037/1040-3590.6.2.117.

Cooper, M. L., Frone, M. R., Russell, M., & Mudar, P. (1995). Drinking to regulate positive and negative emotions: A motivational model of alcohol use. *Journal of Personality and Social Psychology, 69,* 990-1005. doi: 10.1037/0022-3514.69.5.990.

Corbin, W. R., Iwamoto, D. K., & Fromme, K. (2011). A comprehensive longitudinal test of the acquired preparedness model for alcohol use and related problems. *Journal of Studies on Alcohol and Drugs, 72,* 602-610. doi: 10.15288/jsad.2011.72.602.

Coskunpinar, A., Dir, A. L., & Cyders, M. A. (2013). Multidimensionality in impulsivity and alcohol use: A meta-analysis using the UPPS model of impulsivity. *Alcoholism: Clinical and Experimental Research, 37,* 1441-1450. doi: 10.1111/acer.12131.

Courtney, K. E., Arellano, R., Barkley-Levenson, E., Gálvan, A., Poldrack, R. A., MacKillop, J., ... & Ray, L. A. (2012). The relationship between measures of impulsivity and alcohol misuse: an integrative structural equation modeling approach. *Alcoholism: Clinical and Experimental Research*, *36,* 923-931. doi: 10.1111/j.1530-0277.2011.01635.x.

Cox, W. M., & Klinger, E. (1988). A motivational model of alcohol use. *Journal of Abnormal Psychology, 97,* 168-180. doi: 10.1037/0021-843X.97.2.168.

Cross, C. P., Copping, L. T., & Campbell, A. (2011). Sex differences in impulsivity: A meta-analysis. *Psychological Bulletin*, *137*, 97. doi: 10.1037/a0021591.

Curcio, A. L., & George, A. M. (2011). Selected impulsivity facets with alcohol use/problems: The mediating role of drinking motives. *Addictive Behaviors*, *36,* 959-964. doi: 10.1016/j.addbeh.2011.05.007.

Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review, 31*, 965-982. doi: 10.1016/j.cpr.2011.06.001.

Cyders, M. A., Smith, G. T., Spillane, N. S., Fischer, S., Annus, A. M., & Peterson, C. (2007). Integration of impulsivity and positive mood to predict risky behavior: Development and validation of a measure of positive urgency. *Psychological Assessment, 19,* 107-118. doi: 10.1037/1040-3590.19.1.107.

Cyders, M. A., & Smith, G. T. (2007). Mood-based rash action and its components: Positive and negative urgency. *Personality and Individual Differences, 43,* 839-850. doi: 10.1016/j.paid.2007.02.008

Czapla, M., Simon, J. J., Friederich, H, C., Herpertz, S.C., Zimmerman, P., & Loeber, S. (2014). Is binge drinking in young adults associated with an alcohol-specific impairment of response inhibition. *European Addiction Research, 21,* 105-113. doi: 10.1159/000367939.

de Wit, H. (2009). Impulsivity as a determinant and consequence of drug use: A review of underlying processes. *Addiction Biology, 14,* 22-31. doi: 10.1111/j.1369-1600.2008.00129.x.

Del Boca, F. K., Darkes, J., Greenbaum, P. E., & Goldman, M. S. (2004). Up close and personal: Temporal variability in the drinking of individual college students during their first year. *Journal of Consulting and Clinical Psychology*, *72,* 155-164. doi: 10.1037/0022-006X.72.2.155.

Dick, D. M., Smith, G., Olausson, P., Mitchell, S. H., Leeman, R. F., O'Malley, S. S., & Sher, K. (2010). Review: Understanding the construct of impulsivity and its relationship to alcohol use disorders. *Addiction Biology, 15,* 217-226. doi: 10.1111/j.1369-1600.2009.00190.x.

Dimeff, L. A. (Ed.). (1999). *Brief alcohol screening and intervention for college students (BASICS): A harm reduction approach*. Guilford Press.

Dougherty, D. M., Marsh-Richard, D. M., Hatzis, E. S., Nouvion, S. O., & Mathias, C. W. (2008). A test of alcohol dose effects on multiple behavioral measures of impulsivity. *Drug and Alcohol Dependence, 96,* 111-120. doi: 10.1016/j.drugalcdep.2008.02.002.

Dvorak, R. D., Pearson, M. R., & Day, A. M. (2014). Ecological momentary assessment of acute alcohol use disorder symptoms: Associations with mood, motives, and use on planned drinking days. *Experimental and Clinical Psychopharmacology, 22,* 285-297. doi: 10.1037/a0037157.

Fairlie, A. M., Ramirez, J. J., Patrick, M. E., & Lee, C. M. (2016). When do college students have less favorable views of drinking? Evaluations of alcohol experiences and positive and negative consequences. *Psychology of Addictive Behaviors, 30,* 555-565. doi: 10.1037/adb0000190.

Fernie, G., Cole, J. C., Goudie, A. J., & Field, M. (2010). Risk-taking but not response inhibition or delay discounting predict alcohol consumption in social drinkers. *Drug and Alcohol Dependence, 112,* 54-61. doi:10.1016/j.drugalcdep.2010.05.011.

Field, M., Wiers, R. W., Christiansen, P., Fillmore, M. T., & Verster, J. C. (2010). Acute alcohol effects on inhibitory control and implicit cognition: Implications for loss of control over drinking. *Alcoholism: Clinical and Experimental Research, 34,* 1346-1352. doi: 10.1111/j.1530-0277.2010.01218.x.

Fillmore, M. T. (2003). Drug abuse as a problem of impaired control: Current approaches and findings. *Behavioral and Cognitive Neuroscience Reviews, 2,* 179-197. doi: 10.1177/1534582303257007

Fillmore, M. T., & Vogel-Sprott, M. (1999). An alcohol model of impaired inhibitory control and its treatment in humans. *Experimental and Clinical Psychopharmacology, 7,* 49-55. doi: 10.1037/1064-1297.7.1.49.

Fineberg, N. A., Chamberlain, S. R., Goudriaan, A. E., Stein, D. J., Vanderschuren, L. J., Gillan, C. M., ... & Denys, D. (2014). New developments in human neurocognition: Clinical,

genetic, and brain imaging correlates of impulsivity and compulsivity. *CNS Spectrums, 19,* 69-89. doi: 10.1017/S1092852913000801.

Fischer, S., & Smith, G. T. (2008). Binge eating, problem drinking, and pathological gambling: Linking behavior to shared traits and social learning. *Personality and Individual Differences, 44,* 789-800. doi: 10.1016/j.paid.2007.10.008.

Fleeson, W. (2007). Situation-based contingencies underlying trait-content manifestation in behavior. *Journal of Personality, 75,* 825-862. doi: 10.1111/j.1467-6494.2007.00458.x.

Fleeson, W. (2012). Perspectives on the person: Rapid growth and opportunities for integration. In K. Deaux & M. Snyder (Eds.), *Oxford Library of Psychology. The Oxford handbook of personality and social psychology* (pp. 33-63). New York, NY, US: Oxford University Press.

Fromme, K., Stroot, E. A., & Kaplan, D. (1993). Comprehensive effects of alcohol: Development and psychometric assessment of a new expectancy questionnaire. *Psychological Assessment, 5,* 19-26. doi: 10.1007/s10862-005-0631-9.

Gray, J. A. (1977). Drug effects on fear and frustration. Possible limbic site of action of minor tranquilizers. In L.L. Iverson, S.D. Iverson, & S.H. Snyder (Eds.), Handbook of Psychopharmacology. New York, Plenum.

Hahn, A. M., Simons, R. M, & Hahn, C. K. (2016). Five factors of impulsivity: Unique pathways to borderline and antisocial personality features and subsequent alcohol problems. *Personality and Individual Differences, 99,* 313-319. doi: 10.1016/j.paid.2016.05.035.

Ham, L. S., Stewart, S. H., Norton, P. J., & Hope, D. A. (2005). Psychometric assessment of the Comprehensive Effects of Alcohol Questionnaire: Comparing a brief version to the

original full scale. *Journal of Psychopathology and Behavioral Assessment, 27,* 141-158. doi: 10.1007/s10862-005-0631-9.

Hamilton, K. R., Littlefield, A. K., Anastasio, N. C., Cunningham, K. A., Fink, L. H., Wing, V. C., ... & Lejuez, C. W. (2015a). Rapid-response impulsivity: Definitions, measurement issues, and clinical implications. *Personality Disorders: Theory, Research, and Treatment*, *6*, 168-181. doi: 10.1037/per0000100.

Hamilton, K. R., Mitchell, M. R., Wing, V. C., Balodis, I. M., Bickel, W. K., Fillmore, M., ... & Mathias, C. W. (2015b). Choice impulsivity: Definitions, measurement issues, and clinical implications. *Personality Disorders: Theory, Research, and Treatment*, *6*, 182-198. doi: 10.1037/per0000099.

Henges, A. L., & Marczinski, C. A. (2012). Impulsivity and alcohol consumption in young social drinkers. *Addictive Behaviors, 37,* 217-220. doi: 10.1016/j.addbeh.2011.09.013.

Heron, K. E., Everhart, R. S., McHale, S. M., & Smyth, J. M. (2017). Systematic review: Using mobile-technology-based Ecological Momentary Assessment (EMA) methods with youth: A systematic review and recommendations. *Journal of Pediatric Psychology, 42,* 1087-1107. doi: 10.1093/jpepsy/jsx078.

Howard, M.A. & Marczinski, C.A. (2010). Acute effects of a glucose energy drink on behavioral control. *Experimental and Clinical Psychopharmacology*, *18*, 553-561. doi: 10.1037/a0021740

Hox, J. J., & Maas, C. J. (2001). The accuracy of multilevel structural equation modeling with pseudobalanced groups and small samples. *Structural Equation Modeling, 8,* 157-174. doi: 10.1207/S15328007SEM08021.

Hufford, M. R., Shields, A. L., Shiffman, S., Paty, J., & Balabanis, M. (2002). Reactivity to ecological momentary assessment: An example using undergraduate problem drinkers. *Psychology of Addictive Behaviors, 16*, 205-211. doi: 10.1037/0893-164X.16.3.205.

Hustad, J. T., Pearson, M. R., Neighbors, C., & Borsari, B. (2014). The role of alcohol perceptions as mediators between personality and alcohol-related outcomes among incoming college-student drinkers. *Psychology of Addictive Behaviors*, *28*, 336-347. doi: 10.1037/a0033785.

Jones, K. A., Chryssanthakis, A., & Groom, M. J. (2014). Impulsivity and drinking motives predict problem behaviours relating to alcohol use in university students. *Addictive Behaviors*, *39*, 289-296. doi: 10.1016/j.addbeh.2013.10.024.

Jones, B. T., Corbin, W., & Fromme, K. (2001). A review of expectancy theory and alcohol consumption. *Addiction, 96*(1), 57-72. doi: 10.1046/j.1360-0443.2001.961575.x.

Kahler, C. W., Read, J. P., Wood, M. D., & Palfai, T. P. (2003). Social environmental selection as a mediator of gender, ethnic, and personality effects on college student drinking. *Psychology of Addictive Behaviors*, *17*, 226. doi: 10.1037/0893-164x.17.3.226.

Kaiser, A., Bonsu, J. A., Charnigo, R. J., Milich, R., & Lynam, D. R. (2016). Impulsive personality and alcohol use: Bidirectional relations over one year. *Journal of Studies on Alcohol and Drugs, 77*, 473-482. doi: 10.15288/jsad.2016.77.473.

King, K. M., Karyadi, K. A., Luk, J. W., & Patock-Peckham, J. A. (2011). Dispositions to rash action moderate the associations between concurrent drinking, depressive symptoms, and alcohol problems during emerging adulthood. *Psychology of Addictive Behaviors, 25*, 446-454. doi: 10.1037/a0023777.

King, K. M., Patock-Peckham, J. A., Dager, A. D., Thimm, K., & Gates, J. R. (2014). On the mismeasurement of impulsivity: Trait, behavioral, and neural models in alcohol research among adolescents and young adults. *Current Addiction Reports, 1*, 19-32. doi: 10.1007/s40429-013-0005-4.

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General, 128*, 78-87. doi: 10.1037/0096-3445.128.1.78.

Kiselica, A. M., & Borders, A. (2013). The reinforcing efficacy of alcohol mediates associations between impulsivity and negative drinking outcomes. *Journal of Studies on Alcohol and Drugs, 74*, 490-499. doi: 10.15288/jsad.2013.74.490.

Kiselica, A. M., Echevarria, J. M., & Borders, A. (2015). The relative contributions of impulsivity facets to drinking outcomes. *Addictive Disorders & Their Treatment, 14*, 152-158. doi: 10.1097/ADT.0000000000000067.

LaBrie, J. W., Kenney, S. R., Napper, L. E., & Miller, K. (2014). Impulsivity and alcohol-related risk among college students: Examining urgency, sensation seeking and the moderating influence of beliefs about alcohol's role in the college experience. *Addictive Behaviors, 39*, 159-164. doi: 10.1016/j.addbeh.2013.09.018.

Lee, C. M., Atkins, D. C., Cronce, J. M., Walter, T., & Leigh, B. C. (2015). A daily measure of positive and negative alcohol expectancies and evaluations: Documenting a two-factor structure and within-and between-person variability. *Journal of Studies on Alcohol and Drugs, 76*, 326-335. doi: 10.15288/jsad.2015.76.326.

Lee, C. M., Cronce, J. M., Baldwin, S. A., Fairlie, A. M., Atkins, D. C., Patrick, M. E., ... & Leigh, B. C. (2017). Psychometric analysis and validity of the daily alcohol-related

consequences and evaluations measure for young adults. *Psychological Assessment, 29*(3), 253-362. doi: 10.1037.pas0000320.

Littlefield, A. K., Sher, K. J., & Wood, P. K. (2010). Do changes in drinking motives mediate the relation between personality change and "maturing out" of problem drinking? *Journal of Abnormal Psychology*, *119*, 93-105. doi: 10.1037/a0017512.

López-Caneda, E., Rodríguez Holguín, S., Cadaveira, F., Corral, M., & Doallo, S. (2013). Impact of alcohol use on inhibitory control (and vice versa) during adolescence and young adulthood: A review. *Alcohol and Alcoholism, 49*, 173-181.

Loree, A. M., Lundahl, L. H., & Ledgerwood, D. M. (2015). Impulsivity as a predictor of treatment outcome in substance use disorders: Review and synthesis. *Drug and Alcohol Review, 34*, 119-134. doi: 10.1111/dar.12132.

Lydon-Staley, D. M., & Bassett, D. S. (2019). Within-person variability in sensation-seeking during daily life: Positive associations with alcohol use and self-defined risky behaviors. *PsyArXiv Preprints.* doi: 10.31234/osf.io/djb5c.

Magid, V., & Colder, C. R. (2007). The UPPS impulsive behavior scale: Factor structure and associations with college drinking. *Personality and Individual Differences, 43*, 1927-1937. doi: 10.1016/j.paid.2007.06.013.

Magid, V., MacLean, M. G., & Colder, C. R. (2007). Differentiating between sensation seeking and impulsivity through their mediated relations with alcohol use and problems. *Addictive Behaviors, 32*, 2046-2061. doi: 10.1016/j.addbeh.2007.01.015.

Marczinski, C. A., Fillmore, M. T., Bardgett, M. E., & Howard, M. A. (2011). Effects of energy drinks mixed with alcohol on behavioral control: Risks for college students consuming

trendy cocktails. *Alcoholism: Clinical and Experimental Research, 35,* 1282-1292. doi: 10.1111/j.1530-0277.2011.01464.x.

Marczinski, C.A., & Fillmore, M.T. (2003). Pre-response cues reduce the impairing effects of alcohol on the execution and suppression of responses. *Experimental and Clinical Psychopharmacology, 11*, 110-117. doi: 10.1037/1064-1297.11.1.110.

Martino, S. C., Kovalchik, S. A., Collins, R. L., Becker, K. M., Shadel, W. G., & D'Amico, E. J. (2016). Ecological momentary assessment of the association between exposure to alcohol advertising and early adolescents' beliefs about alcohol. *Journal of Adolescent Health*, *58*, 85-91. doi: 10.1016/j.jadohealth.2015.08.010.

Mason, T. B., Lavender, J. M., Wonderlich, S. A., Crosby, R. D., Engel, S. G., Mitchell, J. E., ... & Peterson, C. B. (2017). Examining a momentary mediation model of appearance-related stress, anxiety, and eating disorder behaviors in adult anorexia nervosa. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 23, 1-8.

McCarthy, D. M., Miller, T. L., Smith, G. T., & Smith, J. A. (2001). Disinhibition and expectancy in risk for alcohol use: Comparing black and white college samples. *Journal of Studies on Alcohol*, *62,* 313-321. doi: 10.15288/jsa.2001.62.313.

McCrae, R. R., & Costa Jr, P. T. (1994). The stability of personality: Observations and evaluations. *Current Directions in Psychological Science*, *3,* 173-175. doi: 10.1111/1467-8721.ep10770693.

Mermelstein, L. C., & Garske, J. P. (2015). A brief mindfulness intervention for college student binge drinkers: A pilot study. *Psychology of Addictive Behaviors, 29,* 259–269. doi: 10.1037/adb0 000040.

Murphy, C., & MacKillop, J. (2012). Living in the here and now: Interrelationships between impulsivity, mindfulness, and alcohol misuse. *Psychopharmacology*, *219*, 527-536. doi: 10.1007/s00213-011-2573-0.

Nederkoom, C., Baltus, M., Guerrieri, R., & Wiers, R. W. (2009). Heavy drinking is associated with deficient response inhibition in women but not in men. *Pharmacology Biochemistry and Behavior, 93,* 331-336. doi: 10.1016/j.pbb.2009.04.015.

O'Grady, M. A., Cullum, J., Tennen, H., & Armeli, S. (2011). Daily relationship between event-specific drinking norms and alcohol use: A four-year longitudinal study. *Journal of Studies on Alcohol and Drugs*, *72*, 633-641. doi: 10.15288/jsad.2011.72.633.

O'Hara, R. E., Armeli, S., & Tennen, H. (2014). Drinking-to-cope motivation and negative mood–drinking contingencies in a daily diary study of college students. *Journal of Studies on Alcohol and Drugs*, *75*, 606-614. doi: 10.15288/jsad.2014.75.606.

Patrick, M. E., Cronce, J. M., Fairlie, A. M., Atkins, D. C., & Lee, C. M. (2016). Day-to-day variations in high-intensity drinking, expectancies, and positive and negative alcohol-related consequences. *Addictive Behaviors, 58*, 110-116. doi: 10.1016/j.addbeh.2016.02.025.

Patrick, M. E., & Lee, C. M. (2010). Comparing numbers of drinks: college students' reports from retrospective summary, followback, and prospective daily diary measures. *Journal of Studies on Alcohol and Drugs*, *71*, 554-561. doi: 10.15288/jsad.2010.71.554.

Patterson, C. M., & Newman, J. P. (1993). Reflectivity and learning from aversive events: Toward a psychological mechanism for the syndromes of disinhibition. *Psychological review, 100,* 716-736. doi: 10.1037/0033-295X.100.4.716.

Pearson, M. R., & Henson, J. M. (2013). Unplanned drinking and alcohol-related problems: A preliminary test of the model of unplanned drinking behavior. *Psychology of Addictive Behaviors, 27,* 584-595. doi: 10.1037/a0030901.

Pearson, M. R., Kite, B. A., & Henson, J. M. (2012). Unique direct and indirect effects of impulsivity-like traits on alcohol-related outcomes via protective behavioral strategies. *Journal of Drug Education, 42*, 425-446. doi: 10.2190/DE.42.4.d.

Piasecki, T. M., Wood, P. K., Shiffman, S., Sher, K. J., & Heath, A. C. (2012). Responses to alcohol and cigarette use during ecologically assessed drinking episodes. *Psychopharmacology, 223*, 331-344.

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods, 15*(3), 209-233. doi:10.1037/a0020141.

Quinn, P. D., Stappenbeck, C. A., & Fromme, K. (2011). Collegiate heavy drinking prospectively predicts change in sensation seeking and impulsivity. *Journal of Abnormal Psychology*, *120*, 543-556. doi: 10.1037/a0023159.

Read, J. P., Kahler, C. W., Strong, D. R., & Colder, C. R. (2006). Development and preliminary validation of the Young Adult Alcohol Consequences Questionnaire. *Journal of Studies on Alcohol, 67,* 169-177. doi: 10.15288/jsa.2006.67.169.

Robinson, E., Jones, A., Christiansen, P., & Field, M. (2015). Drinking like everyone else: Trait self-control moderates the association between peer and personal heavy episodic drinking. *Substance Use & Misuse, 50,* 590-597. doi: 10.3109/10826084.2014.991407.

Schmid, J., Stadler, G., Dirk, J., Fiege, C., & Gawrilow, C. (2016). ADHD symptoms in adolescents' everyday Life: Fluctuations and symptom structure within and between individuals. *Journal of Attention Disorders*. doi: 1087054716629214.

Settles, R. F., Cyders, M., & Smith, G. T. (2010). Longitudinal validation of the acquired preparedness model of drinking risk. *Psychology of Addictive Behaviors, 24*, 198-208. doi: 10.1037/a0017631.

Shiffman, S. (2009). Ecological momentary assessment (EMA) in studies of substance use. *Psychological Assessment, 21*, 486–497. doi: 10.1037/a0017074.

Shiffman, S. (2007). Designing protocols for ecological momentary assessment. *The science of real-time data capture: Self-reports in health research*, 27-53.

Shiffman, S. Stone, A.A., & Hufford, M.R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1-32.

Shin, S. H., Hong, H. G., & Jeon, S. M. (2012). Personality and alcohol use: The role of impulsivity. *Addictive Behaviors, 37*, 102-107. doi:10.1016/j.addbeh.2011.09.006.

Simons, J. S., Dvorak, R. D., Batien, B. D., & Wray, T. B. (2010). Event-level associations between affect, alcohol intoxication, and acute dependence symptoms: Effects of urgency, self-control, and drinking experience. *Addictive Behaviors, 35*, 1045-1053. doi: 10.1016/j.addbeh.2010.07.001.

Smith, G. T., Fischer, S., Cyders, M. A, Annus, A. M., Spillane, N. S., & McCarthy, D. M. (2007). On the validity and utility of discriminating among impulsivity-like traits. *Assessment, 14*, 155-170. doi: 10.1177/1073191106295527.

Sobell, L. C., & Sobell, M. B. (1992). Timeline follow-back measuring alcohol consumption. *Center for Psychological Studies, Nova Southeastern University*, 41-72.

Stamates, A. L., & Lau-Barraco, C. (2017). Impulsivity and risk-taking as predictors of alcohol use patterns and alcohol related-problems. *Addiction, Research, & Theory, 25*, 390-396. doi: 10.1080/16066359.2017.1296953.

Stamates, A. L., & Lau-Barraco, C. (2018). The dimensionality of impulsivity: Perspectives and implications for emerging adult drinking. *Experimental & Clinical Psychopharmacology.*

Stamates, A. L., Lau-Barraco, C., & Linden-Carmichael, A. N. (2016). Alcohol expectancies mediate the relationship between age of first intoxication and drinking outcomes in college binge drinkers. *Substance Use & Misuse*, *51*, 598-607. doi: 10.3109/10826084.2015.1126745.

Stamates, A. L., Linden-Carmichael, A. N., Preonas, P. D., & Lau-Barraco, C. (2018). Testing daily association between impulsivity, affect, and alcohol outcomes: A pilot study. *Addiction Research & Theory*, *27*, 242-248. doi: 10.1080/16066359.2018.1498846.

Stevens, A. K., Littlefield, A. K., Talley, A. E., & Brown, J. L. (2017). Do individuals higher in impulsivity drink more impulsively? A pilot study within a high risk sample of young adults. *Addictive Behaviors, 65*, 147-153. doi: 10.1016/j.addbeh.2016.10.026.

Stojek, M., & Fischer, S. (2013). Impulsivity and motivations to consume alcohol: a prospective study on risk of dependence in young adult women. *Alcoholism: Clinical and Experimental Research*, *37*, 292-299. doi: 10.1111/j.1530-0277.2012.01875.x.

Substance Abuse and Mental Health Services Administration (SAMHSA). (2016). Results from the 2015 National Survey on Drug Use and Health: Mental Health Findings. NSDUH Series H-49. U.S. Department of Health and Human Services, Rockville, MD.

Stautz, K., & Cooper, A. (2013). Impulsivity-related personality traits and adolescent alcohol use: A meta-analytic review. *Clinical Psychology Review, 33,* 574-592. doi: 10.1016/j.cpr.2013.03.003.

Team, R. C. (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing. 2014.

The International Society for Research on Impulsivity. (2016). Retrieved from: http://www.impulsivity.org/.

Tomko, R. L., Solhan, M. B., Carpenter, R. W., Brown, W. C., Jahng, S., Wood, P. K., & Trull, T. J. (2014). Measuring impulsivity in daily life: The momentary impulsivity scale. *Psychological Assessment, 26,* 339-349. doi: 10.1037/a0035083.

Treloar, H., Piasecki, T. M., McCarthy, D. M., Sher, K. J., & Heath, A. C. (2015). Ecological evidence that affect and perceptions of drink effects depend on alcohol expectancies. *Addiction, 110,* 1432-1442. doi: 10.1111/add.12982.

Weafer, J., De Arcangelis, J., & de Wit, H. (2015). Sex differences in behavioral impulsivity in at-risk and non-risk drinkers. *Frontiers in Psychiatry, 6,* 72. doi: 10.3389/fpsyt.2015.00072.

Weafer, J., & de Wit, H. (2014). Sex differences in impulsive action and impulsive choice. *Addictive Behaviors, 39,* 1573-1579. doi: 10.1016/j.addbeh.2013.10.033.

West, S. G., Ryu, E., Kwok, O-M, & Cham, H. (2011). Multilevel modeling: Current and future applications in personality research. *Journal of Personality, 79,* 2-50. doi: 10.1111/j.1467-6494.2010.00681.x.

Whiteside, S. P., & Lynam, D. R. (2001). The five factor model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences, 30,* 669-689. doi: 10.1016/S0191-8869(00)00064-7.

Whiteside, S. P., Lynam, D. R., Miller, J. D., & Reynolds, S. K. (2005). Validation of the UPPS impulsive behaviour scale: A four-factor model of impulsivity. *European Journal of Personality, 19,* 559-574. doi: 10.1002/per.556.

Wills, T. A., Pokhrel, P., Morehouse, E., & Fenster, B. (2011). Behavioral and emotional regulation and adolescent substance use problems: A test of moderation effects in a dual-process model. *Psychology of Addictive Behaviors, 25,* 279–292. doi: 10.1037/a0022870.

Wray, T. B., Merrill, J. E., & Monti, P. M. (2014). Using ecological momentary assessment (EMA) to assess situation-level predictors of alcohol use and alcohol-related consequences. *Alcohol Research: Current Reviews, 36,* 19-27.

Yarmush, D. E., Manchery, L., Luehring-Jones, P., & Erblich, J. (2016). Gender and impulsivity: Effects on cue-induced alcohol craving. *Alcoholism: Clinical and Experimental Research, 40,* 1052-1057. doi: 10.1111/acer.13030.

Zhang, Z., Zyphur, M. J., & Preacher, K. J. (2009). Testing multilevel mediation using hierarchical linear models: Problems and solutions. *Organizational Research Methods, 12,* 695-719. doi: 10.1177/1094428108327450.

APPENDIX A

STUDY MEASURES SUMMARY

Domain	Measure
Baseline Assessment Measures	
Impulsivity	UPPS-P Scale (Whiteside & Lynam, 2001; Cyders et al., 2007)
Alcohol Use	TimeLine Follow-Back (TLFB)
Alcohol-related Problems	Young Adult Alcohol Consequences Questionnaire (YAACQ)
Drinking Motives	Drinking Motives Questionnaire (DMQ)
Normative Perceptions	Drinking Norms Rating Form (DNRF)
Alcohol Expectancies	Comprehensive Effects of Alcohol (CEOA)
Demographics	General Background Questionnaire
Momentary Assessment Measures – *Time reports (morning report)*	
Context	E.g.,"What is your current location?" and "Who are you with"
Impulsivity	Momentary Impulsivity Scale (MIS)
Drinking Motives	Modified DMQ
Alcohol Expectancies	Positive and Negative Alcohol Expectancies and Evaluations
Alcohol-related problems	Daily Positive and Negative Consequences - Lee et al., 2015
Reasons for not drinking	Daily Research for Not Drinking – O'Hara et al., 2016
Alcohol Use (morning)	Self-report drinking behavior (of previous day)
Momentary Assessment Measures - *Random reports*	
Context	E.g.,"What is your current location?" and "Who are you with"
Impulsivity	Momentary Impulsivity Scale (MIS)
Drinking Motives	Modified DMQ
Alcohol Expectancies	Positive and Negative Alcohol Expectancies and Evaluations
Normative Perceptions	Self-report ratings of company's drinking behavior
Alcohol Use (current)	Self-report drinking behavior
Momentary Assessment Measures - *User-initiated reports*	
Context	E.g., "What is your current location?" and "Who are you with"
Impulsivity	Momentary Impulsivity Scale (MIS)
Drinking Motives	Modified DMQ
Alcohol Expectancies	Positive and Negative Alcohol Expectancies and Evaluations
Normative Perceptions	Self-report ratings of company's drinking behavior
Alcohol Use (current)	Self-report drinking behavior

APPENDIX B

UPPS-P IMPULSIVE BEHAVIOR SURVEY

Below are a number of statements that describe ways in which people act and think. For each statement, please indicate how much you agree or disagree with the statement. If you **Agree Strongly** select **1**, if you **Agree Somewhat** select **2**, if you **Disagree somewhat** select **3**, and if you **Disagree Strongly** select **4**. Be sure to indicate your agreement or disagreement for every statement below. Also, there are questions on the following pages.

	Agree Strongly 1	**Agree Some 2**	**Disagree Some 3**	**Disagree Strongly 4**
1. I have a reserved and cautious attitude toward life.				
2. I have trouble controlling my impulses.				
3. I generally seek new and exciting experiences and sensations.				
4. I generally like to see things through to the end.				
5. When I am very happy, I can't seem to stop myself from doing things that can have bad consequences.				
6. My thinking is usually careful and purposeful.				
7. I have trouble resisting my cravings (for food, cigarettes, etc.).				
8. I'll try anything once.				
9. I tend to give up easily.				
10. When I am in great mood, I tend to get into situations that could cause me problems.				
11. I am not one of those people who blurt out things without thinking.				
12. I often get involved in things I later wish I could get out of.				
13. I like sports and games in which you have to choose your next move very quickly.				
14. Unfinished tasks really bother me.				
15. When I am very happy, I tend to do things that may cause problems in my life.				
16. I like to stop and think things over before I do them.				
17. When I feel bad, I will often do things I later regret in order to make myself feel better now.				
18. I would enjoy water skiing.				
19. Once I get going on something I hate to stop.				
20. I tend to lose control when I am in a great mood.				
21. I don't like to start a project until I know exactly how to proceed.				
22. Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse.				
23. I quite enjoy taking risks.				
24. I concentrate easily.				
25. When I am really ecstatic, I tend to get out of control.				
26. I would enjoy parachute jumping.				
27. I finish what I start.				

28. I tend to value and follow a rational, "sensible" approach to things. 29. When I am upset I often act without thinking. 30. Others would say I make bad choices when I am extremely happy about something. 31. I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional. 32. I am able to pace myself so as to get things done on time. 33. I usually make up my mind through careful reasoning. 34. When I feel rejected, I will often say things that I later regret. 35. Others are shocked or worried about the things I do when I am feeling very excited. 36. I would like to learn to fly an airplane. 37. I am a person who always gets the job done. 38. I am a cautious person. 39. It is hard for me to resist acting on my feelings. 40. When I get really happy about something, I tend to do things that can have bad consequences. 41. I sometimes like doing things that are a bit frightening. 42. I almost always finish projects that I start. 43. Before I get into a new situation I like to find out what to expect from it. 44. I often make matters worse because I act without thinking when I am upset. 45. When overjoyed, I feel like I can't stop myself from going overboard. 46. I would enjoy the sensation of skiing very fast down a high mountain slope. 47. Sometimes there are so many little things to be done that I just ignore them all. 48. I usually think carefully before doing anything. 49. When I am really excited, I tend not to think of the consequences of my actions. 50. In the heat of an argument, I will often say things that I later regret. 51. I would like to go scuba diving. 52. I tend to act without thinking when I am really excited. 53. I always keep my feelings under control. 54. When I am really happy, I often find myself in situations that I normally wouldn't be comfortable with. 55. Before making up my mind, I consider all the advantages and disadvantages. 56. I would enjoy fast driving. 57. When I am very happy, I feel like it is ok to give in to cravings or overindulge. 58. Sometimes I do impulsive things that I later regret. 59. I am surprised at the things I do while in a great mood.				

APPENDIX C

TIMELINE FOLLOWBACK CALENDAR

Start Date (Day 1): _____

End Date (yesterday):_____

	SUN	MON	TUES	WED	THURS	FRI	SAT
		1 New Year's	2	3	4	5	6
	7	8	9	10	11	12	13
J	14	15 M. Luther King	16	17	18	19	20
A							
N	21	22	23	24	25	26	27
	28	29	30	31	1	2	3
F	4	5	6	7	8	9	10
E	11	12	13	14 Valentine	15	16	17
B	18	19 Pres. Day	20	21 Ash Wednesday	22	23	24
	25	26	27	28	1	2	3
M	4	5	6	7	8	9	10
A	11	12	13	14	15	16	17 St. Patrick
R	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
A	1	2	3 Passover	4	5	6 Good Friday	7
P	8 Easter	9	10	11	12	13	14
R	15	16	17	18	19	20	21
	22	23	24	25	26	27	28

	29	30	1	2	3	4	5
M	6	7	8	9	10	11	12
A	13 Mother's Day	14	15	16	17	18	19
Y	20	21	22	23	24	25	26
	27	28 Memorial Day	29	30	31		

	SUN	MON	TUES	WED	THURS	FRI	SAT
						1	2
	3	4	5	6	7	8	9
U	10	11	12	13	14	15	16
N	17 Father's Day	18	19	20	21	22	23
	24	25	26	27	28	29	30
J	1	2	3	4 Independence Day	5	6	7
U	8	9	10	11	12	13	14
L	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31	1	2	3	4
A	5	6	7	8	9	10	11
U	12	13	14	15	16	17	18
G	19	20	21	22	23	24	25
	26	27	28	29	30	31	1
S	2	3 Labor Day	4	5	6	7	8
E	9	10	11	12	13 Rosh Hashanah	14	15

P	16	17	18	19	20	21	22 Yom Kippur
	23	24	25	26	27	28	29
	30	1	2	3	4	5	6
O	7	8 Columbus Day	9	10	11	12	13
C	14	15	16	17	18	19	20
T	21	22	23	24	25	26	27
	28	29	30	31 Halloween	1	2	3
N	4	5	6 Election Day	7	8	9	10
O	11	12 Veterans Day Obsv	13	14	15	16	17
V	18	19	20	21	22 Thanksgiving	23	24
	25	26	27	28	29	30	1
D	2	3	4	5 Hanukkah	6	7	8
E	9	10	11	12	13	14	15
C	16	17	18	19	20	21	22
	23	24	25 Christmas	26	27	28	29
	30	31 New Year's Eve					

APPENDIX D

YOUNF ADULT ALCOHOL CONSEQUENCES QUESTIONNAIRE (YAACQ)

Below is a list of things that sometimes happen to people either during, or after they have been drinking alcohol. Next to each item below, please mark an "X" in either the YES or NO column to indicate whether that item describes something that has happened to you **IN THE PAST YEAR.**

In the **PAST YEAR…**

		NO	YES
1.	While drinking, I have said or done embarrassing things.		
2.	The quality of my work or schoolwork has suffered because of my drinking.		
3.	I have felt badly about myself because of my drinking.		
4.	I have driven a car when I knew I had too much to drink to drive safely.		
5.	I have had a hangover (headache, sick stomach) the morning after I had been drinking.		
6.	I have passed out from drinking.		
7.	I have taken foolish risks when I have been drinking.		
8.	I have felt very sick to my stomach or thrown up after drinking.		
9.	I have gotten into trouble at work or school because of drinking.		
10.	I often drank more than I originally had planned.		
11.	My drinking has created problems between myself and my boyfriend/girlfriend/spouse, parents, or other near relatives.		
12.	I have been unhappy because of my drinking.		
13.	I have gotten into physical fights because of drinking.		
14.	I have spent too much time drinking.		
15.	I have not gone to work or missed classes at school because of drinking, a hangover, or illness caused by drinking.		
16.	I have felt like I needed a drink after I'd gotten up (that is, before breakfast).		
17.	I have become very rude, obnoxious or insulting after drinking.		
18.	I have felt guilty about my drinking.		
19.	I have damaged property, or done something disruptive such as setting off a false fire alarm, or other things like that after I had been drinking.		
20.	Because of my drinking, I have not eaten properly.		
21.	I have been less physically active because of drinking.		
22.	I have had "the shakes" after stopping or cutting down on drinking (eg., hands shake so that coffee cup rattles in the saucer or have trouble lighting a cigarette).		
23.	My boyfriend/girlfriend/spouse/parents have complained to me about my drinking.		
In the **PAST YEAR…**		**NO**	**YES**
24.	I have woken up in an unexpected place after heavy drinking.		
25.	I have found that I needed larger amounts of alcohol to feel any effect, or that I could no longer get high or drunk on the amount that used to get me high or drunk.		

26.	As a result of drinking, I neglected to protect myself or my partner from a sexually transmitted disease (STD) or an unwanted pregnancy.		
27.	I have neglected my obligations to family, work, or school because of drinking.		
28.	I often have ended up drinking on nights when I had planned not to drink.		
29.	When drinking, I have done impulsive things that I regretted later.		
30.	I have often found it difficult to limit how much I drink.		
31.	My drinking has gotten me into sexual situations I later regretted.		
32.	I've not been able to remember large stretches of time while drinking heavily.		
33.	While drinking, I have said harsh or cruel things to someone.		
34.	Because of my drinking I have not slept properly.		
35.	My physical appearance has been harmed by my drinking.		
36.	I have said things while drinking that I later regretted.		
37.	I have awakened the day after drinking and found that I could not remember a part of the evening before.		
38.	I have been overweight because of drinking.		
39.	I haven't been as sharp mentally because of my drinking.		
40.	I have received a lower grade on an exam or paper than I ordinarily could have because of my drinking.		
41.	I have tried to quit drinking because I thought I was drinking too much.		
42.	I have felt anxious, agitated, or restless after stopping or cutting down on drinking.		
43.	I have not had as much time to pursue activities or recreation because of drinking.		
44.	I have injured someone else while drinking or intoxicated.		
45.	I often have thought about needing to cut down or stop drinking.		
46.	I have had less energy or felt tired because of my drinking.		
47.	I have had a blackout after drinking heavily (i.e., could not remember hours at a time).		
48.	Drinking has made me feel depressed or sad.		

APPENDIX E

DRINKING MOTIVES QUESTIONNAIRE (DMQ)

Instructions: The following is a list of reasons that some people give for drinking alcohol. Thinking of all the times you drink, how often would you say that you drink for each of the following reasons? (If you don't drink, mark the "almost never/never" column for each question.)

	Almost never/ never	Some of the time	Half of the time	Most of the time	All of the time
1. To forget your worries.	1	2	3	4	5
2. Because your friends pressure you to drink.	1	2	3	4	5
3. Because it helps you to enjoy a party.	1	2	3	4	5
4. Because it helps you when you feel depressed or nervous.	1	2	3	4	5
5. To be sociable.	1	2	3	4	5
6. To cheer up when you are in a bad mood.	1	2	3	4	5
7. Because you like the feeling.	1	2	3	4	5
8. So that others won't kid you about not drinking.	1	2	3	4	5
9. Because it's exciting.	1	2	3	4	5
10. To get high.	1	2	3	4	5
11. Because it makes social gatherings more fun.	1	2	3	4	5
12. To fit in with a group you like.	1	2	3	4	5
13. Because it gives you a pleasant feeling.	1	2	3	4	5
14. Because it improves parties and celebrations.	1	2	3	4	5
15. Because you feel more self-confident and sure of yourself.	1	2	3	4	5
16. To celebrate special occasions with friends.	1	2	3	4	5
17. To forget about your problems.	1	2	3	4	5
18. Because it's fun.	1	2	3	4	5
19. To be liked.	1	2	3	4	5
20. So you won't feel left out.	1	2	3	4	5

APPENDIX F

DESCRIPTIVE NORMS

The following questions have to do with alcohol use for **YOUR THREE CLOSEST FRIENDS OF THE SAME GENDER**. For these questions, please choose the answer that best describes your closest friends' drinking in the **past 12 months**.

Note: 1 Drink = 1 Beer (12 ounces)
1 Wine Cooler (12 ounces)
1 Glass of Wine (5 ounces)
1 Shot of Liquor (1 to 1.5 ounces)
1 Mixed Drink (1 to 1.5 ounces of liquor)
1 Malt Liquor (12 ounces) – e.g., Mike's Hard Lemonade, Skyy Blue, Zima, Smirnoff Ice, etc.

Please think about your 3 closest friends that are the same gender as you. Think about their typical drinking over the **PAST 12 MONTHS**. On a typical day, how many drinks do you think they have, and over how many hours would they have them? That is, how many drinks would they usually have on each day of the week in the past year? How long (in hours) would a typical drinking occasion last on that day?

Over the PAST 12 MONTHS, on a…

	TYPICAL MONDAY	TYPICAL TUESDAY	TYPICAL WEDNESDAY	TYPICAL THURSDAY	TYPICAL FRIDAY	TYPICAL SATURDAY	TYPICAL SUNDAY
DRINKS							
HRS							

APPENDIX G

COMPREHENSIVE EFFECTS OF ALCOHOL (CEOA)

The following section assesses what you would expect to happen if you were under the influence of alcohol.

Check from disagree to agree – depending on whether you expect the effect to happen to you if you were under the influence of alcohol. These effects will vary, depending upon the amount of alcohol you typically consume.

> This is not a personality assessment. We want to know what you expect to happen if you were to drink alcohol, not how you are when you are sober. Example: If you are always emotional, you would not check agree as your answer unless you expected to become MORE EMOTIONAL if you drank.

If I were under the influence from alcohol:

	Disagree	Slightly disagree	Slightly agree	Agree
1. I would be outgoing	_____	_____	_____	_____
2. My senses would be dulled	_____	_____	_____	_____
3. I would be humorous	_____	_____	_____	_____
4. My problems would seem worse	_____	_____	_____	_____
5. It would be easier to express my feelings	_____	_____	_____	_____
6. My writing would be impaired	_____	_____	_____	_____
7. I would feel sexy	_____	_____	_____	_____
8. I would have difficulty thinking	_____	_____	_____	_____
9. I would neglect my obligations	_____	_____	_____	_____
10. I would be dominant	_____	_____	_____	_____
11. My head would feel fuzzy	_____	_____	_____	_____
12. I would enjoy sex more	_____	_____	_____	_____
13. I would feel dizzy	_____	_____	_____	_____
14. I would be friendly	_____	_____	_____	_____
15. I would be clumsy	_____	_____	_____	_____

16. It would be easier to act out my fantasies	_____	_____	_____	_____
17. I would be loud, boisterous, or noisy	_____	_____	_____	_____
18. I would feel peaceful	_____	_____	_____	_____
19. I would be brave and daring	_____	_____	_____	_____
20. I would feel unafraid	_____	_____	_____	_____
21. I would feel creative	_____	_____	_____	_____
22. I would be courageous	_____	_____	_____	_____
23. I would feel shaky or jittery the next day	_____	_____	_____	_____
24. I would feel energetic	_____	_____	_____	_____
25. I would act aggressively	_____	_____	_____	_____
26. My responses would be slow	_____	_____	_____	_____
27. My body will be relaxed	_____	_____	_____	_____
28. I would feel guilty	_____	_____	_____	_____
29. I would feel calm	_____	_____	_____	_____
30. I would feel moody	_____	_____	_____	_____
31. It would be easier to talk to people	_____	_____	_____	_____
32. I would be a better lover	_____	_____	_____	_____
33. I would feel self-critical	_____	_____	_____	_____
34. I would be talkative	_____	_____	_____	_____
35. I would act tough	_____	_____	_____	_____
36. I would take risks	_____	_____	_____	_____
37. I would feel powerful	_____	_____	_____	_____
38. I would act sociable	_____	_____	_____	_____

APPENDIX H

GENERAL BACKGROUND QUESTIONNAIRE

It is important to know something about our participants as a whole, so we request some demographic information. Only grouped data will be used, and you will never be identified.

1. Your Sex: MALE □ FEMALE □
2. Your Age: _____
3. Your Height: _____ feet _____ inches
4. Your Weight: _____ lbs.

5. Ethnic Background:

□ Caucasian/White
□ Native American/Indian
□ African American/Black
□ Asian/Pacific American
□ Hispanic/Latino
□ Other (please specify): _____

6. Where is your current residence?
   - □ A parent's or relative's home
   - □ A dormitory, residence hall, or apartment on a college campus
   - □ A house, apartment, or room (not affiliated with a college/university)
   - □ A fraternity or sorority house
   - □ Other: _____ (please specify)

7. What is your relationship status:

□Single/Never Married □ Married
□Living with partner □Separated/Divorced □Widowed

8. Are you employed now?

□YES, part-time only □YES, full-time only
□YES, full and part-time □NO

9. Yearly total <u>individual</u> income:
   - □$0,000
   - □$1-$5,000
   - □$5,001-$10,000
   - □$10,001 - $15,000
   - □$15,001-20,000
   - □$20,001-$25,000
   - □$25,001-$30,000
   - □$30,001-$35,000
   - □$35,001-$40,000
   - □$40,001-$45,000
   - □$45,001-$50,000

□Over $50,000

10. What is your current class standing in school?
    - □college freshman
    - □college sophomore
    - □college junior
    - □college senior
    - □other

11. What is your current GPA? _____ (on 4.0 scale)
12. Are you affiliated with a Greek organization on campus? □ YES □No
13. What is your sexual orientation?
    a. Heterosexual
    b. Lesbian
    c. Gay
    d. Bisexual
    e. Other:_____

APPENDIX I

CONTEXT

1. Where if your current location? Select the location that most fits where you are right now.
    a. Home
    b. Work
    c. School
    d. Bar/Club
    e. At a party in another person's home or some private venue
    f. Restaurant
    g. Outside
    h. Vehicle/Driving
    i. Other location

2. In the past 15 minutes, who have you been with? Select all that apply.
    a. I've been by myself and with no one else
    b. With my significant other (e.g., boyfriend, girlfriend, wife, husband)
    c. With my friend
    d. With my co-worker
    e. With my child
    f. With my parent
    g. With other family
    h. With someone I just met
    i. With other person

3. If you are drinking, approximately how many other people are you with?
    Range from 0 (by myself) to 50+

4. If you are drinking, are the group of people that you are drinking with:
    a. Mostly males
    b. Mostly females
    c. About the same males and females
    d. I'm drinking alone

APPENDIX J

MOMENTARY IMPULSIVITY SCALE

Below includes a list of items that you may have felt since the last prompt. Please rate the extent that you felt the following:

Since the last prompt…

	1 very slightly or not at all	**2 a little**	**3 moderately**	**4 quite a bit**	**5 extremely**
1. I said things without thinking.					
2. I spent more money than I meant to.					
3. I have felt impatient.					
4. I made a spur of the moment decision.					

APPENDIX K

DRINKING MOTIVES

Below includes a list of reasons why you may drink tonight. Please from "Strongly disagree" to "Strongly agree" the extent that you agree with each statement.

"If you were to drink today, what would be your reason?"

	0	**1**	**2**	**3**	**4**
1. I want to drink to forget my worries, or because it helps me when I feel depressed.					
2. I want to drink tonight to reduce my anxiety, and because it helps me when I'm feeling nervous.					
3. I want to drink tonight because it is fun, and I like the way I feel when I drink.					

**Note that during a drinking occasion, these will be altered to reflect their current motives for drinking.*

APPENDIX L

POSITIVE AND NEGATIVE ALCOHOL EXPECTANCIES AND EVALUATIONS

"If you were to drink today, how likely would you feel or do the following things?" For each items, select a number from 1 to 9 where 1 is very unlikely and 9 is very likely.

	1 Very unlikely	**2**	**3**	**4**	**5 Neutral**	**6**	**7**	**8**	**9 Very likely**
1. Feel more relaxed.									
2. Have a hangover									
3. Be more sociable									
4. Become aggressive									
5. Be in a better mood									
6. Feel nauseated or vomit									
7. Hurt or injure yourself by accident									
8. Get a buzz									
9. Be unable to remember what you did while drinking									
10. Feel more energetic									
11. Be rude or obnoxious									
12. Be able to express your feeling more easily									
14. Do something that embarrassed you									

**Note that during a drinking occasion, these will be altered to reflect their current motives for drinking.*

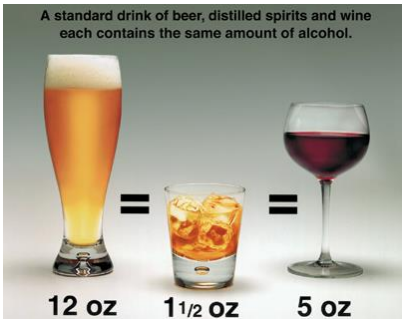
APPENDIX M

NORMS

1) Is the company that you are with drinking alcohol?
    a. Yes
    b. No

2) If yes, what is the average number of alcoholic drinks overall that your company has consumed since you **started** drinking today?

    a. Drop-down list from 0-50+ drinks

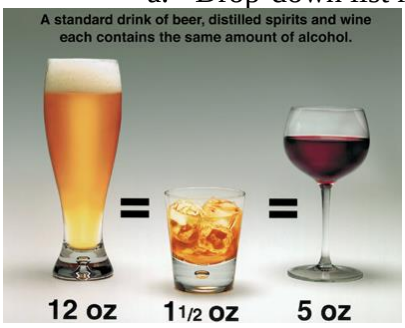


APPENDIX N

ALCOHOL USE (CURRENT USE)

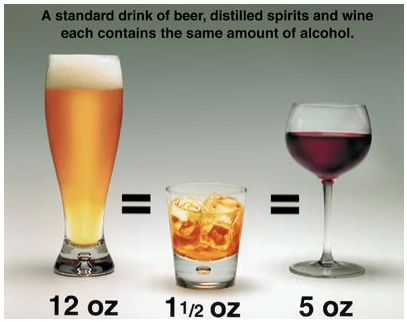
1) Since your last survey recording, have you consumed alcohol?
    a. Yes
    b. No

2) If "Yes", how many drinks have you had since your last survey recording?
    a. Drop-down list ranging from 0-50+ drinks



ALCOHOL USE (MORNING REPORT)

Now, we would like for you to think about your behaviors YESTERDAY. Keep in mind, with respect to alcohol consumption, 1 standard drink is equivalent to 12 oz beer OR 5 oz wine OR 1.5 oz shot of liquor straight or in a mixed drink.



1. How many standard drinks did you consume YESTERDAY?
2. How many hours did you spend consuming alcohol YESTERDAY?
3. At approximately what time did you **START** drinking yesterday?

    At approximately what time did you **STOP** drinking yesterday?

APPENDIX O

DAILY POSITIVE CONSEQUENCES QUESTIONNAIRE

"Did any of the following things happen to you as a result of your drinking yesterday?"

	Yes	**No**
I was able to express my feelings more easily		
I felt more energetic		
I got a buzz		
I was in a better mood		
I was more sociable		
I felt relaxed		
I did something that embarrassed me		
I was rude or obnoxious		
I couldn't remember what I did while I was drinking		
I hurt or injured myself by accident		
I felt nauseated or vomited		
I became aggressive		
I had/have a hangover		

APPENDIX P

DECOY ITEMS

Below are a list of reasons for why you may not have consumed alcohol yesterday. Please respond to each statement by indicating Yes or No as to whether it is a reason why you did not consume alcohol yesterday.

	Yes	**No**
I had to work at my job		
I had too much school work to do		
I had nobody to drink with		
I couldn't obtain alcohol		
I had no desire to drink		
I don't usually drink on this night of the week		

VITA

Amy L. Stamates

Old Dominion University
Department of Psychology
Norfolk, VA 23529

Education and Training

Ph.D. **Old Dominion University,** *Norfolk, VA*
Applied Experimental Psychology, 2019
Advisor: Cathy Lau-Barraco, Ph.D.

M.S. **Old Dominion University,** *Norfolk, VA*
Experimental Psychology, 2015
Advisor: Cathy Lau-Barraco, Ph.D.

B.S. **Northern Kentucky University,** *Highland Heights, KY*
Psychological Science (Honors), 2010
Advisor: Cecile A. Marczinski, Ph.D.

Background

Amy L. Stamates is a sixth-year doctoral candidate in the Applied Experimental Psychology doctoral program at Old Dominion University. Her dissertation research was supported by the American Psychological Association Dissertation Award. Amy's research interests include examining the role that impulsivity plays in predisposing one to use substances as well as how using substances influences impulsivity. She is interested in the contextual factors (e.g., peer drinking environments, drinking location) that elicit changes in impulsivity, which may lead to greater risks for young adults.

Selected Publications

Stamates, A. L., Linden-Carmichael, A. N., Preonas, P. D., & Lau-Barraco, C. (2018). Testing daily associations between impulsivity, affect, and alcohol use outcomes: A pilot study. *Addiction, Research & Theory, 3,* 242-248.

Stamates, A. L., & Lau-Barraco, C. (2017). Environmental context effects on craving among consumers of caffeinated alcohol beverages: Associations with aspects of impulsivity. *Experimental and Clinical Psychopharmacology, 25,* 503-511.

Stamates, A. L., & Lau-Barraco, C. (2017). The dimensionality of impulsivity: Perspectives and implications for emerging adult drinking. *Experimental and Clinical Psychopharmacology, 25,* 521-533.