

Accepted Manuscript

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Theresa Adams, Karli K. Rapinda, Jona R. Frohlich, Roisin M. O'Connor, Matthew T. Keough



PII: S0306-4603(18)31505-3
DOI: <https://doi.org/10.1016/j.addbeh.2019.05.025>
Reference: AB 6001
To appear in: *Addictive Behaviors*
Received date: 28 December 2018
Revised date: 20 May 2019
Accepted date: 21 May 2019

Please cite this article as: T. Adams, K.K. Rapinda, J.R. Frohlich, et al., Impulsivity moderates the effect of social anxiety on in-lab alcohol craving, *Addictive Behaviors*, <https://doi.org/10.1016/j.addbeh.2019.05.025>

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Impulsivity Moderates the Effect of Social Anxiety on In-Lab Alcohol Craving

Theresa Adams^{1,1} adamst@myumanitoba.ca, Karli K. Rapinda^{1,1} rapindak@myumanitoba.ca,
Jona R. Frohlich^{1,1} umfrohlj@myumanitoba.ca, Roisin M. O'Connor²
roisin.oconnor@concordia.ca., Matthew T. Keough^{3,*} keoughmt@yorku.ca

¹Department of Psychology, University of Manitoba, 190 Dysart Rd., Winnipeg, MB, Canada, R3T 2N2

²Department of Psychology, Concordia University, 7141 Sherbrooke St. West, Montreal, QC, Canadian, H4B 1R6

³Department of Psychology, Faculty of Health, York University, 4700 Keele St., North York, Ontario, Canada M3J 1P3

*Corresponding author.

¹ Denotes joint first-authorship due to equal contribution from each author.

Abstract

Social anxiety (SA) is thought to relate to alcohol misuse. However, current evidence is inconsistent – especially in young adulthood. Recent non-experimental data show that trait impulsivity moderates the effect of SA on alcohol misuse. Specifically, this work suggests that concurrently elevated impulsivity may draw attention to the immediate, anxiolytic effects of drinking – thus promoting alcohol misuse among those high in SA. Otherwise, without elevated impulsivity, a socially anxious person may not drink due to focusing on alcohol’s possible negative outcomes (e.g., embarrassing behaviours). The next step in this research is to examine if impulsivity impacts *in-the-moment* subjective craving among socially anxious individuals. This was the goal of the present experiment. After baseline measures, undergraduate participants ($N = 110$) completed the Trier Social Stress Test followed by an alcohol (versus neutral) cue exposure. Subjective craving ratings were collected at both baseline and post-cue exposure. Moderation analyses revealed that socially anxious individuals endorsed strong cravings following an alcohol (but not a neutral) cue exposure, but only if they also had elevated impulsivity. In-lab craving was positively correlated with retrospective reports of alcohol misuse. Our findings demonstrate that impulsivity contributes to SA-related risk for alcohol misuse.

Keywords: social anxiety, alcohol, impulsivity, undergraduate students

1. Introduction

1.1 Scope of the Problem

University students drink heavily and experience diverse related problems (Davoren, Demant, Shiely, & Perry, 2016; Isaak, Perkins, & Labatut, 2011; Turrisi, Mallet, Mastroleo, & Larimer, 2006). To illustrate, university students in Canada show very high rates of binge drinking; 69.7% reported binge drinking within the last month (Edkins, Edgerton, & Roberts, 2017). Heavy drinking in university increases the risk of violence, sexual assaults, impaired driving, injury, and unintentional deaths (Abbey, 2002; Hingson et al., 2005; Wechsler, Dowdall, Maenner, Gledhill-Hoyt, & Lee, 2010). Furthermore, heavy drinking is a factor in university dropout (Martinez, Sher, & Wood, 2008) and has also been shown to predict the onset of an alcohol use disorder (AUD) up to 10 years after leaving school (O'Neill, Parra, & Sher, 2001). It is therefore not surprising that universities are investing more resources in programs designed to educate students on the risks associated with drinking, such as the Postsecondary Education Partnership – Alcohol Harms initiative by the Canadian Centre on Substance Use and Addiction. Despite increased efforts in this area, we still have much to learn about central risk factors for alcohol misuse in university students.

One known risk factor for alcohol misuse is having heightened social anxiety (SA; Buckner et al., 2008; Keough, O'Connor, & Colder, 2016; Keough, Battista, O'Connor, Sherry, & Stewart, 2016). SA is often conceptualized as an individual difference or trait – referring to the fear of being negatively judged and rejected by others (American Psychiatric Association, 2013; Kennedy, Schwab, Morris, & Beldia, 2001; Spielberger, Gonzalez-Regiosa, Martinez-Urrutia, Natalicio, & Natalicio, 1971). Socially anxious people tend to avoid social events, but if they cannot, they experience high levels of anxiety and distress. While most students experience some

degree of SA at one point or another, those with elevated trait SA have stable and extreme spikes in anxiety even when in everyday interpersonal settings (Shimizu, Seery, Weisbuch, & Lupien, 2011). Data show that about 10-20% of undergraduates have disordered levels of social anxiety (Hakami, 2018; Kessler, 2005; Purdon, Antony, Monteiro, & Swinson, 2001; Strahan, 2003).

Tension reduction theory (TRT) posits that people high in SA may drink alcohol to cope with negative affect (Conger, 1956). University life is associated with going to many social events and meeting new people. Individuals high in SA may feel pressured to attend these events, or perhaps some are unavoidable, and they may drink to reduce excessive fears of judgment and rejection (Keough, Battista, et al., 2016). They may also drink to become more confident and less self-focused in new social situations (Keough, Battista et al., 2016; O'Grady, Cullum, Armeli, & Tennen, 2011). TRT predicts that socially anxious people learn to associate alcohol with anxiety relief, which over time, increases coping-related drinking in uncomfortable social situations. Supporting theory, data show that adults with social anxiety disorder (SAD) (versus those without SAD) are about three times more likely to have a comorbid alcohol use disorder (AUD; Merikangas & Angst, 1995).

Despite the well-established comorbidity of SAD and AUD in adulthood, research in younger adult samples provides inconsistent support for this association. Some studies have found positive relations between SA and alcohol use behaviours (most notably alcohol problems) (Lewis & Neill, 2000; Stewart, Morris, Mellings, & Komar, 2006), while other studies have demonstrated negative SA-alcohol use associations (Eggleston, Woolaway-Bickel, & Schmidt, 2004; Buckner, Schmidt, & Eggleston, 2006). Null findings are also common in the literature (e.g., Buckner et al., 2013). Moreover, results of a recent meta-analysis demonstrate complex relations between SA and drinking habits among undergraduate students (Schry & White, 2013).

Specifically, while this meta-analysis revealed a very small, statistically significant positive correlation between SA and alcohol problems ($r = .053$; Schry & White, 2013), there were consistent negative correlations between SA and alcohol use variables ($r_s = -.069$ to $-.108$) (Schry & White, 2013). These mixed associations in young adults samples suggests that the effect of SA on alcohol outcomes is not straightforward and may depend on moderating variables.

1.2 The Moderating Effect of Impulsivity

From a theoretical perspective, the association between SA and alcohol outcomes is complex. On the one hand, individuals with elevated SA may drink to cope with their excessive levels of anxiety, which may in turn contribute to alcohol problems (Stewart et al., 2006). However, on the other hand, they may also avoid heavy drinking – especially in social situations – due to alcohol's potentially negative outcomes (Keough, Badawi, et al., 2016). To illustrate, socially anxious individuals may not drink heavily because of the fear that they may do something embarrassing in front of their peers while intoxicated. Therefore, in order for people high in SA to drink alcohol for coping reasons (i.e., immediate relief), they must momentarily disregard the possible negative outcomes of drinking. Accordingly, trait impulsivity may moderate the effect of SA on drinking behaviour. Trait impulsivity is multifaceted, but can generally be defined as a cluster of individual differences that relate to biased attention to rewarding stimuli, and disinhibited behaviour to obtain immediate gratification (Cyders & Smith, 2007; Pihl & Peterson, 1995). Trait impulsivity has also been linked to low distress tolerance and increased risky behaviours when experiencing strong negative emotions (Zuckerman & Kuhlman, 2000). In fact, there is a specific facet of impulsivity that involves acting rashly when emotionally distressed (referred to as negative urgency). The literature shows that high levels of

negative urgency increases risk for alcohol problems (Coskunpinar, Dir, & Cyders, 2013; Wardell, Strang, & Hendershot, 2016).

Only a few studies to date have examined the role of impulsivity in the SA-pathway to alcohol misuse. Research using latent class analyses has revealed two general subtypes of social anxious individuals. One subtype is characterized by strong behavioural inhibition, shyness, and risk-avoidance, mapping on to the *typical* SA profile (Kashdan & Hoffman, 2008). For example, this individual may avoid social interactions, become quiet and reserved around others, overthink their actions, and are at reduced risk for alcohol use. In contrast, the other subtype is defined by high levels of impulsiveness, excessive risk-taking, and elevated levels of substance use and related problems (Kashdan & Hoffman, 2008; Kashdan et al., 2009; Kashdan & McKnight, 2010; Nicholls et al., 2014). For example, this anxious individual would temporarily disregard the potentially negative consequences of drinking due to their increased levels of impulsivity. This has been referred to as the *atypical* impulsive SA subtype and these individuals are believed to be at risk for SAD and AUD comorbidity (Nicholls et al., 2014). Moreover, Keough, Badawi and colleagues (2016) recently examined impulsivity as a moderator of the effect of SA on coping-motivated drinking and related problems in undergraduates. This study was the first to show that students with elevated SA were at increased risk for alcohol problems, but only if they were also high in impulsivity. This study also revealed that elevated coping motives mediated, thus explained this effect. Overall, the evidence points to the potential role of impulsivity in distinguishing between those with SA who are at high versus low risk for alcohol misuse.

1.3 The Current Study

While existing studies provide some support that concurrently high impulsivity increases SA-risk for alcohol misuse (Kashdan & Hoffman, 2008; Kashdan et al., 2009; Keough, Badawi, et al., 2016; Nicholls et al., 2014), this work is limited by an overreliance on non-experimental, cross-sectional research designs. Theory suggests that risk for alcohol misuse should unfold when an individual high in both trait SA and impulsivity is experiencing socially-relevant anxious mood (Conger, 1956; Keough, Badawi, et al., 2016). To illustrate, when attending a party with new people, high concurrent impulsivity may draw attention to the immediate, anxiolytic effects of drinking among those high in SA. As a result, they may begin to crave alcohol and subsequently drink in risky ways for the desired tension-reducing effects. In contrast, TRT would predict far less risk when these students are not experiencing socially-relevant anxious affect. This highlights a main limitation of self-report non-experimental methods, in that they are far-removed from the anxiety that should drive “in-the-moment” craving and alcohol use among those high in SA and impulsivity.

Some studies have examined the link between impulsivity and in lab craving (irrespective of level of social anxiety). A notable study by Papachristou and colleagues (2012) found that heavy drinkers with (versus those without) elevated impulsivity showed greater craving responses following an in-lab alcohol cue exposure. The positive association between impulsivity and in-lab craving has been replicated in similar studies (Leeman, Corbin, & Fromme, 2009; Papachristou, Nederkoorn, Corstjens, & Jansen, 2012). Despite the demonstrated link between impulsivity and in-lab craving, this finding has not yet been demonstrated specifically among individuals with social anxiety.

The main goal of the current study was to fill gaps in previous research by examining whether trait impulsivity moderated the effect of SA on in-lab craving. We used craving as an

outcome in order to capture the in-the-moment cognitive processes that relate to drinking among those high in SA and impulsivity. Indeed, theoretical models and experimental data show that craving is the most proximal predictor of heavy drinking and related problems (Witkiewitz, 2011). Accordingly, we used an experimental design that included a socially-relevant public speaking stress task followed by an alcohol (versus neutral) cue exposure. We hypothesized that when anxious, individuals high in SA would report increased cravings following an alcohol cue exposure, but only if they were also concurrently high on trait impulsivity. Furthermore, we predicted that post-cue exposure cravings would be positively correlated with retrospective measures of harmful drinking and alcohol-related problems.

2. Method

2.1 Participants and Procedure

The data used in this project was from a larger lab study on mood and alcohol cognition (Keough, O'Connor, & Colder, 2016). The sample consisted of 110 (68% female, $M_{age} = 21.40$) undergraduate students from English-speaking universities in Montreal. Participants were between the ages of 18 (legal drinking age) and 25 years old. Participants were screened for eligibility over the phone prior to the study to ensure that they met the following inclusion criteria: fluent in English, not abstaining from alcohol use (i.e., >1 drink per week), and no history of very heavy drinking (i.e., ≥ 35 drinks per week). These inclusion criteria allowed us to examine a broad sample of young adults with varied levels of drinking. The in-lab session lasted approximately two hours, and participants received either course credit or money (10\$/hr) as compensation. Deception was used, as participants were told that the study was exploring how perceptions of food and drink are affected by engaging in a cognitively demanding task. All study procedures were approved by the Research Ethics Board at Concordia University.

After informed consent, participants completed baseline measures of alcohol use, mood, cravings, trait SA, and trait impulsivity. The Trier Social Stress Test (TSST) was then used to manipulate participants' anxious mood. The TSST is a public speaking task where, in front of a panel of mock experts, participants were asked to give a five-minute mock job interview followed by a five-minute mental arithmetic test (see Kirschbaum et al., 1993 for the full procedure). The TSST is shown to reliably increase physiological and subjective indicators of stress and anxiety (Kirschbaum et al., 1993). Anxious mood was reassessed immediately following the TSST.

Next, participants were randomly assigned to receive either an alcohol or a neutral (water) cue. In the alcohol cue condition, participants were exposed to their alcoholic beverage of choice (beer, wine or mixed drink) and the beverage was poured in front of them to increase cue salience. Participants were told they would be able to consume the drink after completing the next set of questionnaires. To further increase cue salience, the study took place in a realistic laboratory bar and although all beverages were in reality non-alcoholic, the rims of the glasses were rubbed with alcohol in order to give the beverage a realistic odour (Keough, O'Connor et al., 2016). The beverage remained in front of the participants as they completed post-cue measures of alcohol cravings. After completing these measures, participants were allowed to consume the drink.

2.2 Measures

2.2.1 Social interaction anxiety scale (SIAS; Mattick & Clarke, 1998). The SIAS is a 20-item scale that assesses one's general fear of social interaction and was used to assess individual differences in SA at baseline. Participants indicated their level of fear of social interaction by answering each question (e.g., "I am nervous mixing with people I don't know

well”) on a response scale ranging from 0 (*not at all*) to 4 (*extremely*). This scale has been shown to have strong internal consistency and good test-retest reliability (Mattick & Clarke, 1998). The internal consistency of the SIAS in this study was good ($\alpha = .88$).

2.2.2 Substance Use Risk Profile Scale (SURPS; Woicik et al., 2009). The SURPS is a 23-item questionnaire used to examine risky personality traits related to substance use. The measure examines four facets of personality: anxiety sensitivity, hopelessness, sensation seeking and impulsivity. For the purpose of the current study, the impulsivity subscale of the SURPS was used to measure level of impulsivity. Participants answered items (5-items on impulsivity; e.g., “I usually act without stopping to think”, “Generally I am an impulsive person”) on a response scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). A sum score was used. The SURPS impulsivity subscale has been shown to have acceptable internal consistency and good concurrent validity (Krank et al., 2011). The internal consistency of this subscale in our sample was good ($\alpha = .81$).

2.2.3 Visual analog scale (VAS; Birch et al., 2004). VAS measures were used to assess mood at baseline and at post-TSST. Participants completed ratings for three emotions (anxious, sad, and happy) on a horizontal line spanning from 0 (*not at all*) to 100 (*very much*). The ratings were collected to conduct a manipulation check on the TSST.

2.2.4 Alcohol cravings questionnaire (ACQ; Singleton et al., 1994; Watt et al., 2009). The ACQ was administered at baseline and post-cue exposure to compare subjective in-the-moment craving for alcohol. The ACQ has 18-items and participants answer each item (e.g., “If I used alcohol, I would feel less tense”, “Drinking would put me in a better mood”, “If I were using alcohol, I would feel less nervous”) on a response scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Mean scores were calculated at baseline and at post-cue exposure. Previous

research shows that the ACQ has high internal consistency and good structural validity (Birch et al., 2004). The internal consistency of the ACQ in our sample was in the acceptable range at baseline ($\alpha = .78$) and was good at post-cue exposure ($\alpha = .89$).

2.2.5 Alcohol use disorders identification test (AUDIT; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). The AUDIT is a 10-item scale that assesses harmful drinking, which includes a measurement of heavy drinking and related problems. The AUDIT was completed during the baseline phase of the study. Participants answered the items (e.g., “Have you or someone else been injured as a result of your drinking?”) on response scales ranging from 0 (*never*) to 4 (*four or more times a week*) for items 1-8, and 0 (*no*) to 2 (*yes, during the last year*) for items 9 and 10. A sum score was used. The AUDIT has been shown to have adequate internal consistency and very good test-retest reliability (Selin, 2003). The internal consistency of the AUDIT total score in our sample was acceptable ($\alpha = .74$).

2.2.6 Young adult alcohol consequences questionnaire (YAACQ; Read et al., 2006). The YAACQ is a 48-item self-report scale that assesses alcohol problems. The YAACQ was completed during the baseline phase of the study. Participants reported either 0 (*no*) or 1 (*yes*) to if they have experienced any of the examples of alcohol problems within the past year (e.g., “I have become very rude, obnoxious or insulting after drinking”). “Yes” responses were then combined to create a sum score for each participant, with higher scores indicating elevated alcohol problems. The YAACQ has been shown to have good reliability ($\alpha = .89$), along with good concurrent and predictive validity (Read et al., 2006). The internal consistency of the YAACQ total score in this current study was good ($\alpha = .89$).

2.3 Data Analysis

We used a moderation analysis to assess the effect of SA on post-cue exposure alcohol cravings among those high versus low in trait impulsivity (Aiken & West, 1991). We controlled for baseline alcohol cravings. Given that the data was underpowered to test the full three-way interaction, only the effect of the two-way interaction of interest was examined (i.e., trait SA by trait impulsivity) on alcohol cravings in the alcohol and water cue conditions, separately. Predictor variables were centered to avoid multicollinearity (Aiken & West, 1991). Significant interactive effects were probed using simple slopes analysis (Aiken & West, 1991), where the effect of SA on subjective post-cue alcohol craving was conditioned at high (+1SD) and at low (-1SD) impulsivity in each experimental condition.

3. Results

3.1 Descriptive Statistics, Correlations, and Manipulation Check

SPSS (version 25.0) was used to run all analyses. See Table 1 for descriptive statistics and bivariate correlations. One participant did not complete the SIAS; otherwise there were no missing data. There were no outliers and all data were normally distributed, with acceptable skew and kurtosis. Our sample reported slightly lower levels of harmful drinking compared to other published findings using Canadian undergraduates (Adlaf et al., 2005; Balodis, Lockwood, Magrys, & Olmstead 2010). Relative to the same body of literature, our sample endorsed comparable levels of alcohol problems in the past year (Keough & O'Connor, 2014; Keough, O'Connor et al., 2016). Participants reported consuming, on average, 5.28 drinks per week ($SD = 4.99$) in the past month. The mean score for the SIAS is slightly above scores found in non-clinical populations (Brown et al., 1997; Carleton et al., 2014; Mattick & Clarke, 1998; Rodebaugh et al., 2006). SA was uncorrelated with alcohol outcomes at the bivariate level (see Table 1). Participants showed a statistically significant and large increase in anxiety following

the TSST compared to baseline ($t_{(109)} = -9.740, p < 0.001, d = -1.22$), indicating that the socially-relevant anxious mood induction was effective.

3.2 Hypothesis Testing

Next, moderation analysis was conducted to examine the interactive effect of SA and impulsivity on post-cue cravings in alcohol versus neutral cue conditions. Post-cue craving was regressed on baseline craving (covariate), SA, impulsivity, and the SA by impulsivity interaction. In the alcohol cue condition, results showed that the interaction between SA and impulsivity was a statistically significant predictor of post-cue craving (see Table 2). In contrast, the impulsivity by SA interaction was not a supported predictor of alcohol cravings in the neutral cue condition.

The next step was to probe the statistically significant SA by impulsivity interaction on post-cue craving in the alcohol condition. As expected, simple slopes analysis revealed that SA positively predicted post-cue alcohol craving at high ($B = 0.018, SE = 0.008, t = 2.356, p = .022$) but not at low ($B = -0.007, SE = 0.009, t = -0.862, p = .393$) levels of impulsivity (Figure 1). This suggests that participants with relatively high (compared to low) levels of SA endorsed strong cravings for alcohol following the cue exposure, but only if they were also high in impulsivity. Finally, post-cue craving was positively related to both harmful drinking ($r = .359, p < 0.01$) and alcohol problems ($r = .361, p < 0.01$).

4. Discussion

The goal of the present study was to test if trait impulsivity moderated the effect of SA on in-the-moment alcohol craving. To this end, we used a strong experimental design, which included a well-validated, socially-relevant anxious mood manipulation and an alcohol cue exposure. Consistent with previous research using self-report methods (Keough, Badawi, et al., 2016), we found that, when anxious, those relatively high in SA reported strong subjective

cravings for alcohol (in response to an alcohol cue), but only if they were also high in trait impulsivity. In contrast, we found no effect of SA on subjective craving at low levels of impulsivity in the alcohol cue condition. We also observed positive correlations between post-cue subjective cravings and retrospective measures of harmful drinking and related problems. Our results demonstrate that the relation between SA and alcohol misuse (including related cognitive processes, like craving) is not straightforward and that level of impulsivity plays an important role.

One novel contribution of the present study is that we are among the first to show – experimentally – that level of impulsivity impacts subjective cravings among socially anxious individuals, as this relationship has previously only been demonstrated among a general drinking population. The effect of impulsiveness on craving among those high in SA can be understood in terms of the Acquired Preparedness Model (APM; Corbin et al., 2011). According to the APM, trait impulsivity biases the learning of alcohol-related information. Specifically, over time, impulsivity should increase the salience of the anxiolytic effects of drinking among those high in SA, leading to the formation of tension-reduction alcohol associations. In turn, when experiencing an anxious (and aversive) mood state, these people should bring these associations to mind. Interestingly, our findings indicate that exposure to alcohol cues, when anxious, is central to triggering subjective cravings among those high in both SA and impulsivity. The absence of an interactive effect in the neutral cue condition demonstrates that simple increases in anxiety were not enough to trigger subjective cravings among these individuals. Craving is one of the strongest proximal risk factors for alcohol misuse (Witkiewitz, 2011), and our study demonstrates that it is heavily influenced by impulsiveness in young adults with relatively high levels of SA. The next step in this research is to examine if those high on both SA and

impulsivity are more likely to act on strong subjective cravings. This can be done by extending the present research design to include an in-lab drinking task (following the cue exposure).

The findings of this study have some clinical implications in that they may aid in the development of effective treatments for those who suffer from both SAD and AUD, or those “at risk” of developing these comorbid disorders. Considering that impulsivity is a key factor influencing alcohol use and related problems in socially anxious young adults, it would be beneficial to create treatment plans that specifically target the reduction of impulsivity. For example, this could involve emphasizing the long-term harms of drinking over the perceived short-term benefits. Incorporating strategies designed to reduce impulsivity may also help to decrease alcohol craving among socially anxious young adults, thus reducing alcohol use and related problems, as well as the likelihood of developing an AUD in the future.

As noted above, there are several novel contributions of our study, but a few limitations should be noted. First, participants completed a cue exposure task only and were not asked to consume actual alcohol in the lab. While craving is a valid predictor of real-world drinking (Jones, Tiplady, Houben, Nederkoorn, & Field, 2018), measuring use in the lab (and in close proximity to anxious mood) would provide an even stronger test of the effect of impulsivity on drinking behaviour among those high in SA. Future research should aim to replicate the current study with the inclusion of an in-lab drinking task. Second, we only measured deliberate craving using an explicit self-report measure. We did not measure automatic aspects of craving using implicit measures. For example, research demonstrates that attentional biases (commonly captured using speeded reaction time measures) are important components of craving. Some studies have found that anxious mood results in more attention towards alcohol-related words during a Stroop test (Grant, Stewart, & Birch, 2007) and others have shown that attentional bias

towards alcohol predicts alcohol craving following an alcohol cue (Manchery, Yarmush, Luehring-Jones, & Erblich, 2017). These studies illustrate the important role of implicit processes involved in craving. Future research should incorporate both explicit and implicit measures to assess craving responses in socially anxious and impulsive people. Third, we used a broad measure of impulsivity, when the construct of impulsivity is multifaceted (Lynam, Smith, Whiteside, & Cyders, 2006). Future research should examine if there are unique aspects of impulsivity, most centrally negative urgency, (Coskunpinar et al., 2013; Cyders & Smith, 2007), that contribute to alcohol misuse risk among individuals high in SA. Alongside impulsivity, it may also be beneficial for future research to include measures of impaired control over drinking, as this is known to be an important component of disordered alcohol use. Fourth, there was a large gender imbalance, with 68% of participants being female. Therefore, we were unable to analyze gender differences with respect to impulsivity and drinking on craving despite demonstrated differences among these constructs in the general population. Research in the future should aim to recruit a more balanced gender sample. Finally, our sample had drinking habits that were in the subclinical range (i.e., mean of AUDIT was < 8), and thus, future research might consider replicating the present study in a sample of individuals with disordered levels of alcohol use.

5. Conclusions

Existing literature supports inconsistent associations between SA and alcohol behaviours (Schry & White, 2013). Recent non-experimental research demonstrates that the effect of SA on coping-related alcohol misuse depends on one's level of trait impulsivity (Kashdan & Hoffman, 2008; Kashdan et al., 2009; Keough, Badawi, et al., 2016; Nicholls et al., 2014). We advanced this literature by showing experimentally that SA predicted alcohol craving in the lab, but only

when impulsivity was also high. Our results suggest that interventions designed to target alcohol misuse among socially anxious individuals should also incorporate strategies for reducing impulsivity.

Funding Sources: This research was supported by a CIHR New investigator Award and a VPRGS Seed Grant awarded to Dr. RM O'Connor.

Conflict of Interest: All authors declare that they have no conflicts of interest.

Role of Funding Sources

This research was supported by a CIHR New investigator Award and a VPRGS Seed Grant awarded to Dr. RMO. The financial support had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the manuscript for publication.

Contributors

All authors contributed meaningfully to the conceptual model presented in the manuscript. MTK and RMO conceptualized and ran the larger study. MTK collected and analyzed the data. TA, KKR, and JF conducted literature searches and wrote the first draft of the manuscript. Drs. RMO and MTK provided constant and significant feedback on all aspects of the paper. The final manuscript reflects the combined substantial effort of all co-authors and together we declare that we approve of this submission.

Acknowledgements

N/A

Declarations of Interest: None

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Footnotes

Abbreviations:

AUD: Alcohol use disorder

SA: social anxiety

SAD: social anxiety disorder

TRT: Tension reduction theory

TSST: Trier Social Stress Test

SIAS: Social interaction anxiety scale

SURPS: Substance Use Risk Profile Scale

VAS: Visual analog scale

ACQ: Alcohol cravings questionnaire

AUDIT: Alcohol use disorders identification test

YAACQ: Young adult alcohol consequences questionnaire

APM: Acquired Preparedness Model

Table 1 Descriptive Statistics and Correlations

Measures	SIAS	Impulsivity	AUDIT	YAACQ
SIAS	-	.157	.103	.083
Impulsivity		-	.255**	.337**
AUDIT			-	.769**
YAACQ				-
<i>M</i>	24.49	8.11	5.75	8.45
<i>SD</i>	16.32	1.98	3.68	6.42
<i>Range</i>	0 - 72	4 - 15	1 - 17	0 - 28

Note. SIAS = Social Interaction Anxiety Scale, AUDIT = Alcohol Use Disorders Identification Test, YAACQ = Young Adult Alcohol Consequences Questionnaire.

* $p < 0.05$; ** $p < 0.01$

Table 2 The Interactive Effects of Social Anxiety and Impulsivity on Post-Cue Exposure Craving

	<i>B</i>	<i>SE</i>	β	<i>R</i> ²	<i>t</i>	<i>p</i>
<u>Alcohol Cue (n = 55)</u>						
Baseline Craving	0.785	0.101	0.720		7.462	<.001
SA	0.005	0.007	0.076		0.788	.434
Impulsivity	0.094	0.050	0.170		1.895	.064
SA by Impulsivity	0.006	0.002	0.237		2.626	.011
				.614 [.464 - .763]		
<u>Water Cue (n = 55)</u>						
Baseline Craving	1.030	0.178	0.635		5.781	.000
SA	0.001	0.008	0.140		1.280	.206
Impulsivity	-0.014	0.070	-0.022		-0.197	.845
SA by Impulsivity	0.004	0.004	0.089		0.792	.432
				.403 [.215 - .590]		

Note. SA=social anxiety.

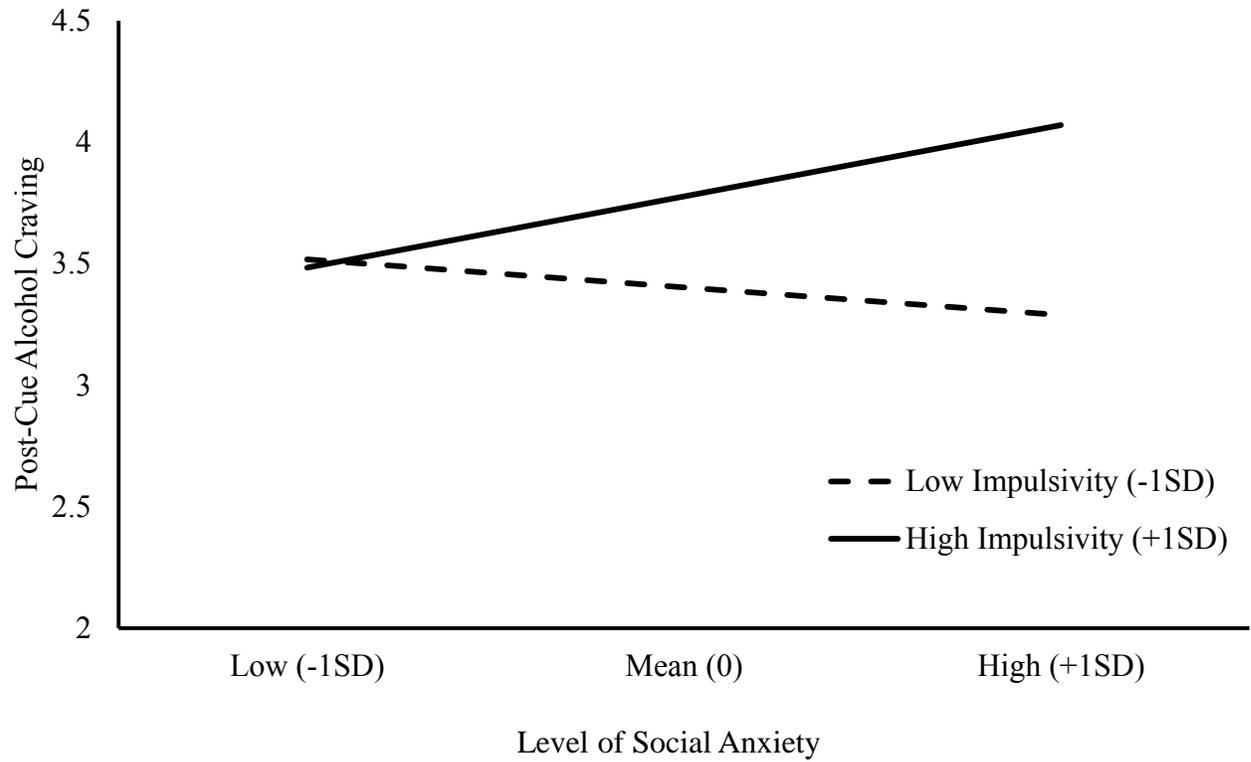


Figure 1. Simple slopes for the effect of social anxiety on post-cue alcohol craving at high and low levels of impulsivity.

Highlights

- We examined whether impulsivity impacts craving among socially anxious young adults
- Impulsivity moderated the effect of social anxiety on craving after an alcohol cue
- Impulsivity did not moderate the impact of SA on craving after a neutral cue
- In-lab craving was significantly related to self-reported alcohol misuse
- Impulsivity influences alcohol use/related problems in socially anxious young adults

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