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Sex differences in associations between delay discounting and expectancies for alcohol analgesia

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Abstract

Self-medication of pain with alcohol is prevalent, and expectancies for alcohol analgesia likely influence pain relief and alcohol consumption. Hazardous alcohol use has been associated with greater delay discounting rates, however little is known about the relation between delay discounting and expectancies for alcohol analgesia. Therefore, the present study examined sex differences in associations between delay discounting and expectancies for alcohol analgesia. Healthy drinkers without chronic pain (N=53) completed measures of expectancies for alcohol analgesia, alcohol use, and alcohol outcome expectancies. A five-trial adjusting-delay discounting task (DDT) for monetary outcomes was also administered. Regression analyses revealed that sex moderated the relationship between delay discounting and expectancies for alcohol analgesia. Steeper delay discounting rates were associated with weaker expectancies for alcohol analgesia among men when adjusting for average alcohol consumption. Among women, non-significant associations between delay discounting rates and expectancies for alcohol analgesia were observed. These findings provide initial evidence of sex differences in associations between delay discounting and expectancies for alcohol analgesia. The directionality of these associations was unexpected and may have implications for patterns of self-medication with alcohol.

Keywords

pain; delay discounting; expectancies; alcohol; analgesia

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Contributors

BS, JB, MBA designed the study. BS and DV collected data. EF and JB conducted analyses. EF, DV, MW, and JB wrote the manuscript. EF, DV, MW, MBA, LL, JD, BS, and JB critically reviewed and approved the manuscript.

Declarations of Interest

The authors declare no conflicts of interest.

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Introduction

Alcohol use is highly prevalent (Substance Abuse and Mental Health Services Administration, 2018), and associated with significant economic and psychosocial burden (Hanson & Li, 2003). Although opioids are often prescribed to treat pain (Volkow & McLellan, 2016), pain has become an important factor in understanding alcohol consumption, as pain and alcohol use frequently co-occur (Alford et al., 2016; Morasco et al., 2011) and co-occurrence rates increase as a function of pain condition severity (Brennan & SooHoo, 2013; Larson et al., 2007; McDermott et al., 2018). In fact, the majority of patients with an alcohol use disorder (AUD) have chronic non-cancer pain (Boissoneault et al., 2019; John & Wu, 2020), and self-medication with alcohol is common among those with pain (25–38%) (Alford et al., 2016; Boissoneault et al., 2019; Riley III & King, 2009). Notably, self-medication of pain with alcohol is particularly common among men, which is consistent with sex differences in drinking patterns observed in the general population (Riley III & King, 2009; Wilsnack et al., 2009). However, sex differences in factors that may contribute to alcohol use for pain are not fully characterized.

Outcome expectancies, which refer to beliefs about the consequences of a behavior, play an important role in both drinking behaviors and pain relief. In particular, alcohol outcome expectancies are shaped by indirect and direct experiences with alcohol (Jones et al., 2001; Kuntsche & Kuntsche, 2018) and have strong effects on responses to alcohol (Satre & Knight, 2001). Studies have found an association between higher positive alcohol expectancies and hazardous drinking patterns (Brown et al., 1985; Pabst et al., 2014; Van Tyne et al., 2012), as well as a higher likelihood of experiencing positive alcohol-related consequences as a result of drinking during the day (Lee et al., 2020). Additionally, experimental studies have successfully manipulated alcohol expectancies to both increase (Darkes & Goldman, 1993) and decrease alcohol use (Roehrich & Goldman, 1995), suggesting expectancies as a potential treatment target. Importantly, research has previously documented sex differences in alcohol expectancies. However, evidence is equivocal regarding whether men or women are more likely to expect positive effects of alcohol (Brown et al., 1980; Kirmani & Suman, 2010; Satre & Knight, 2001), and other research suggests that women expect less pleasure and tension reduction and more impairment than men (Rohsenow, 1983), while men expect greater aggressive arousal (Brown et al., 1980).

In the context of pain, expectancies may influence the degree to which substance use reduces pain in the short-term (Ditre et al., 2019), with repeated episodes of acute pain relief potentially strengthening outcome expectancies for substance use as an effective coping strategy for pain. Expectancies have long been associated with changes in pain perception and placebo analgesia, providing a strong basis of consideration of expectancies in relation to pain and substance use (Atlas & Wager, 2012; Benedetti et al., 2011). Research has examined substance-use specific expectancies for pain relief among tobacco and cannabis users, concluding that stronger expectancies for pain relief were associated with greater substance use in patients with and without pain (Earleywine & Bolles, 2014; Parkerson & Asmundson, 2016; Slavin et al., 2017). Additionally, the relevance of expectancies to opioid analgesia has been demonstrated experimentally, with stronger expectancy predicting greater pain reductions (Bingel et al., 2011). It is possible these findings extend to alcohol use,

such that positive alcohol expectancies may moderate the effects of pain on alcohol use (for theoretical reviews, see Ferguson et al., 2020; Zale et al., 2015). In fact, recent work has demonstrated associations between expectancies for alcohol analgesia and quantity/frequency of alcohol use, pain severity, and coping-related drinking motives among a chronic pain sample (LaRowe et al., 2021). Sex differences in expectancies for alcohol analgesia were also found in this study, such that men had higher expectancies relative to women. Continued research in this area is needed to build upon these findings and further characterize expectancies for alcohol-related analgesia, which may affect degree of pain relief from alcohol use and alcohol use patterns.

Alcohol use is not only determined by the evaluation of the substance itself, but also by tolerance of delays to reward. Delay discounting describes how much value a commodity (typically a monetary reward) loses when another variable – delay to receiving the reward – increases. More specifically, steep rates of delay discounting indicate a greater sensitivity to delayed rewards and an increased likelihood to engage in unhealthy behaviors. Research on sex differences in delay discounting is heterogeneous, as some evidence suggests women discount delayed monetary rewards at a greater rate than men (Beck & Triplett, 2009; Weafer & de Wit, 2014), and other studies have found that men discount at a greater rate than women (Dittrich & Leipold, 2014) or found no sex differences at all (Cross et al., 2011; Prencipe et al., 2011). Overall, associations have been found between greater delay discounting rates and addictive behaviors, including substance use, as well as severity and quantity-frequency of these behaviors (Amlung et al., 2017; MacKillop et al., 2011). Notably, numerous studies have found that heavy drinkers and those with AUD prefer immediate rewards, including intoxication, and demonstrate steeper discounting rates than those who do not misuse alcohol (Adams et al., 2017; Gowin et al., 2019; Hamilton & Potenza, 2012; Herman & Duka, 2020; MacKillop et al., 2011; Phung et al., 2019).

One previous study suggests a relationship between alcohol expectancies and delay discounting. Specifically, Celio et al. (2016) demonstrated that individuals who exhibit steeper delay discounting are more likely to act on high-risk, sex-related alcohol expectancies (e.g. belief alcohol will enhance sexual behavior); and, in turn, engage in hazardous drinking patterns and condomless sex (Celio et al., 2016). Notably, pain-related expectancies were not assessed in this study, providing support for consideration of the relationship between delay discounting and expectancies for alcohol analgesia, particularly given that both factors are highly implicated in alcohol misuse. In terms of pain self-medication, short-term reduction in pain associated with expectancies for alcohol analgesia and subsequent alcohol intake may be preferred over the avoidance of long-term consequences associated with alcohol use in individuals with greater delay discounting. Examination of this relationship is also critical to potentially identify modifiable targets for tailored alcohol interventions. Accordingly, the purpose of this study was to examine whether delay discounting rates are associated with expectancies for analgesia from alcohol and potential sex differences in this relationship. We hypothesized that higher rates of delay discounting would be associated with greater expectancies for alcohol analgesia. Given existing literature on sex differences in alcohol consumption, we also hypothesized that sex would moderate the relationship between delay discounting and expectancies for alcohol analgesia, such that men would have the strongest positive relationship between delay

discounting and expectancies for alcohol analgesia compared to women. As a secondary and exploratory aim, we also examined the relationship between delay discounting and various domains of positive and negative alcohol expectancies.

Methods

This is a secondary analysis of data derived from a larger parent study investigating the influence of experimentally-induced delayed onset muscle soreness (DOMS) on alcohol demand (Stennett et al., 2021). In brief, this study involved randomization of participants to either a DOMS or control condition and assessment of changes in demand post-pain induction (48 hours after first laboratory session). All procedures were approved by the University of Florida Institutional Review Board, and participants provided written informed consent prior to study participation.

Participant eligibility and recruitment

Participants were recruited using flyers posted in the community. The basic inclusionary criteria were: (1) aged 21–65; (2) average weekly consumption, for the past 6 months, of at least one alcoholic beverage; (3) no history of tobacco use, major psychiatric disorder, kidney dysfunction, muscle damage, or any chronic medical condition which may affect pain perception; (4) no wrist/hand, elbow, or shoulder pain in the past 3 months; (5) no engagement in biceps-specific conditioning (e.g. bicep curls, pull-ups, Olympic weightlifting) in the past 6 months; (6) no caffeine use 4 or fewer hours before a laboratory session; and (7) no substance use which may alter pain perception or hydration status within 24 hours before a laboratory session.

Procedure

Individuals were scheduled for two laboratory sessions, occurring 48 hours apart. At the first session, self-report measures were administered to assess demographics, expectancies regarding pain and alcohol, and alcohol use. Participants also completed a delay discounting task. Because this analysis used data only from screening measures, additional details regarding experimental procedures are omitted.

Self-Report and Behavioral Measures

Demographics—Participants completed a demographics questionnaire, which assessed age, race, sex, years of education, employment, and marital status. Demographic information was used to characterize the sample. Of note, sex refers to biological sex at birth, rather than gender in the present study.

Typical alcohol use—The Alcohol Use Questionnaire (AUQ) is a reliable index of alcohol consumption (Cahalan et al., 1969; Townshend & Duka, 2002) which assesses average alcohol consumption over the past 6 months, as well as preferred beverage choice. Participant responses were used to estimate total quantity-frequency index (total QFI), which represents average daily alcohol consumption in ounces of absolute ethanol consumed per day. Maximum alcohol consumption in a single day (MaxQ) over the previous 6 months was also calculated in ounces of absolute ethanol. Participants were provided with standard

drink definitions when asked to detail their typical and maximum alcohol consumption. One standard drink is equivalent to approximately .6 ounces of absolute ethanol (EtOH).

Subjective alcohol expectancies

Expectancies for alcohol analgesia.: The Expectancies for Alcohol Analgesia Inventory (EAA) is a 5-item measure consisting of alcohol analgesia-related statements (e.g. "I feel like drinking alcohol would help me cope with pain") and 100-point visual analogue scales (VAS) anchored from "completely unlikely" to "completely likely." Broadly, the EAA is a measure of the perceived likelihood that alcohol will decrease or help cope with pain (LaRowe et al., 2021). Although this measure is new, data indicate excellent internal consistency (α=0.97), strong validity, and a one-factor structure (LaRowe et al., 2021). The EAA also demonstrated strong reliability in the current study (α=0.94). An average score on this measure was computed from these items and used as a continuous dependent variable in primary analyses, with higher scores indicating greater expectancies for alcohol analgesia.

Similar to the EAA, the Analgesia Expectancy VAS consists of two alcohol-analgesia related statements and corresponding VAS anchors: (1) "When I'm experiencing pain, I expect alcohol will provide…" (anchors: "no pain relief at all" to "complete pain relief;" AE VAS 1) and (2) "When I drink, I expect my sensitivity to pain to be…" (anchors: "strongly decreased" to "strongly increased;" AE VAS 2). The second item was reverse-scored so that higher scores reflected stronger belief that alcohol would decrease pain sensitivity. The Alcohol Analgesia Expectancy VAS was rationally derived by the research team to assess alcohol analgesia expectancies related to pain relief and sensitivity. Both items were used as dependent variables in primary analyses. Importantly, expectancies for alcohol analgesia is an emerging area of research, and it remains unclear if there are multiple meaningful facets of expectancies for alcohol analgesia. The Alcohol Analgesia Expectancy VAS was included in this study given limited literature related to this topic and because the AE VAS 2 in particular may reflect a theoretically distinct domain of expectancies that alcohol will reduce sensitivity to pain vs. providing relief from pain, *per se*. The AE VAS 1 may also provide a more direct measure of expectancies of pain relief from alcohol compared to the EAA.

Alcohol expectancies.: The Alcohol Effects Questionnaire (AEQ) is a forty-item measure consisting of statements describing possible effects of heavy alcohol consumption (Rohsenow, 1983). Responses of agreement/disagreement are provided on 10-point Likert scale (1 = "mildly believe" and 10 = "strongly believe"). Participants were asked to provide responses based on their experiences with a heavy amount of alcohol (5 or more drinks per occasion). Eight subscales were then derived: 1) global positive, 2) aggression and power, 3) social expressiveness, 4) social and physical pleasure, 5) relaxation and tension reduction, 6) cognitive and physical impairment, 7) careless unconcern, and 8) sexual enhancement (Brown et al., 1987). The reliability of the AEQ has been demonstrated (Ehrenberg et al., 2016; O'Hara et al., 2014). For the purposes of this analysis, all subscales derived from the AEQ were utilized as dependent variables in secondary analyses.

Delay Discounting Task (DDT)—A five-trial adjusting-delay discounting task (DDT) was administered, in which participants made five subsequent choices between an immediate or delayed monetary outcome ("Would you rather have $500 now, or $1000 in ___ days/weeks/months/years?") (Koffarnus & Bickel, 2014). The delay was adjusted up or down using the following model: if the smaller, immediate monetary outcome is chosen, the subsequent choice contained a reduced delay. Conversely, if the participant chose the larger, delayed outcome, the next choice contained an increased delay. For example, participants were first presented with a choice between receiving $500 now or $1,000 in 3 weeks. If a participant chose the immediate option, the delay decreased and the next choice was between receiving $500 now or $1,000 in 1 day. Conversely, if a participant chose the delayed option, the delay increased and the next choice was between receiving $500 now or $1,000 in 2 years. After five choices, the ED_{50} – or the point at which the larger monetary outcome loses half of its subjective value – was determined and the *k* value was calculated (Koffarnus & Bickel, 2014). The inverse of ED_{50} values (*k*) was used as the independent variable in all analyses.

Analysis Strategy

All analyses were conducted using SPSS Version 25. We used descriptive analyses to assess sample characteristics, including socio-demographics and drinking behaviors. Delay discounting (k) rates were normalized by logarithmic transformation. Pearson's *r* correlations were conducted to examine relationships between expectancies for alcohol analgesia, alcohol expectancies, delay discounting, and typical drinking behavior. Multiple linear regression analyses were then used to assess associations between delay discounting rates and expectancies for alcohol analgesia. Sex and log-transformed delay discounting rates were mean-centered before generating interaction terms to account for multicollinearity (Aiken et al., 1991). Post-hoc multiple linear regressions were conducted to decompose significant sex x delay discounting interactions. Regression diagnostics were used to identify influential outliers [(DFFITS values $>2(k+1/n)^{1/2}$; Mahalanobis distance values with $p<.001$ criterion; leverage values $>2(k+1)/n$] (Aguinis et al., 2013; Belsley et al., 2005). To address our secondary aim, multiple linear regression analyses examined relationships between delay discounting rates and alcohol expectancies. Given their exploratory nature, these analyses were adjusted using False Discovery Rate (Benjamini & Hochberg, 1995) correction to reduce the potential for Type I Error. All analyses adjusted for average alcohol consumption in the past six months (total QFI), and bootstrapped moderation analyses were conducted using PROCESS, a custom dialog developed for SPSS (Hayes, 2013). Bootstrapping was performed with 5,000 resamples. Non-systematic responses on the Alcohol Purchase Task in the larger study (Stennett et al., 2021) resulted in exclusion of one participant from analyses (remaining n=53).

Results

Sample Characteristics

In the total sample (N=53), over half (56.6%) were female. Participants were 26.28 years of age (SD=9.91) and had completed 16.32 years of education (SD=2.13) on average. Most of the sample identified as White (83%) and non-Hispanic (83%). The majority of

participants were currently employed (62.3%) and single (71.7%). On average, participants reported drinking 0.843 (SD=.76) oz. of absolute ethanol per day (total QFI; ~1.4 standard drinks), as well as a maximum of 5.34 (SD=2.70) oz. of absolute ethanol within a single day period during the past 6 months (MaxQ; ~8.9 standard drinks). The mean log-transformed delay discounting rate (*k*) was −2.33 (SD=.55). Average scores on expectancy for alcohol analgesia measures adjusted for typical drinking and delay discounting were as follows: EAA (M=44.29, SD=22.71), AE VAS 1 (M=34.19, SD=24.10), AE VAS 2 (M=68.91, SD=16.09). Additionally, expectancy for alcohol analgesia scores ranged from 1–89.40 (EAA), 1–89 (AE VAS 1), and 29–99 (AE VAS 2). Significant differences between men and women were observed for total QFI [t(26.89)= −2.64, p=.01] and MaxQ [t(51)= −2.19, p=.03], such that men had higher typical and maximum absolute ethanol consumption. Years of education was also significantly higher for men compared to women, t(51)= −2.10, p=.04.

Correlations between expectancy measures, delay discounting, and typical drinking behavior

Correlations between expectancies for alcohol analgesia, alcohol expectancies, delay discounting, and QFI and MaxQ are presented in Table 2. All expectancies for alcohol analgesia were significantly correlated (ps<.001), and the eight subscales of alcohol expectancies demonstrated some intercorrelation. There was also some intercorrelation among the expectancies for alcohol analgesia measures and the subscales of alcohol expectancies. Delay discounting rates were not significantly related to expectancies for alcohol analgesia (ps>.05). Of the alcohol expectancy subscales, delay discounting was significantly correlated with Aggression and Power (p=.03) and Careless Unconcern (p=.03). Total QFI and MaxQ were not associated with delay discounting or expectancies for alcohol analgesia. MaxQ was significantly correlated with the AEQ Cognitive and Physical Impairment subscale (p=.05).

Associations between delay discounting and expectancies for alcohol analgesia

Multiple linear regression analyses were conducted using PROCESS to determine the relationship between delay discounting rates and alcohol analgesia expectancies, as well as to assess potential sex differences. Three separate regression models were conducted to investigate associations with each of the measures of expectancies for alcohol analgesia: EAA, AE VAS 1, AE VAS 2.

The overall EAA model was non-significant and accounted for 13.4% of the variance in expectancies for alcohol analgesia [F(4, 48)=1.85, p=.13]. Delay discounting rates (*b*=−2.78, p=.64, 95% CI [−14.65 – 9.08]), total QFI (*b*=4.79, p=.29, 95% CI [−4.25 – 13.82]), and sex (*b*=−1.47, p=.67, 95% CI [−8.33 – 5.38]) did not significantly predict EAA scores. The sex × delay discounting interaction was significant (*b*=−15.55, p=.01, 95% CI [−27.67 – −3.43]).

For AE VAS 1, the regression model was significant and accounted for 18.6% of the variance in expectancies for alcohol analgesia [F(4, 48)=2.74, p=.04]. The main effects of delay discounting rates (*b*=−.46, p=.94, 95% CI [−13.07 – 12.15]), and sex (*b*=−4.07, p=.27, 95% CI [−11.35 – 3.22]) were non-significant, while total QFI (*b*=9.58, p=.05, 95% CI [−.01

– 19.18]) was a significant predictor of AE VAS 1 scores. The sex × delay discounting interaction was also significant (*b*=−16.87, p=.01, 95% CI [−29.75 – −4.00]).

The AE VAS 2 model was non-significant and accounted for 15.3% of the variance in expectancies for alcohol analgesia [F(4, 48)=2.17, p=.09]. The main effects of delay discounting rates (*b*=−6.32, p=.14, 95% CI [−14.74–2.11]) and total QFI (*b*=5.33, p=.10, 95% CI [−1.08–11.74]) were non-significant. Sex was a significant predictor of AE VAS 2 scores (*b*=−5.53, p=.03, 95% CI [−10.40–−.66]), such that women reported higher average scores than men. The sex × delay discounting interaction was not significant (*b*=−8.00, p=.07, 95% CI [−16.60–.61]).

Decomposition of interaction effects indicated differential associations between delay discounting rates and alcohol analgesia expectancies for men and women, while controlling for average alcohol consumption. For women, positive associations between delay discounting rates and EAA (*b*=13.06, p=.07), AE VAS 1 (*b*=15.41, p=.07), and AE VAS 2 (*b*=2.24, p=.67) were non-significant. For men, delay discounting rates were a significant negative predictor of EAA (*b*=−21.60, p=.05), AE VAS 1 (*b*=−20.20, p=.05), and AE VAS 2 (*b*=−16.21, p=.03). [Insert Figures 1, 2, 3].

Mahalanobis distance, leverage, and standardized DF Fit statistics were considered to examine influential outliers, and this resulted in identification of 6 potentially influential cases using their respective cutpoints [(DFFITS values $>2(k + 1/n)^{1/2}$; Mahalanobis distance values with p<.001 criterion; leverage values $>2(k + 1)/n$]. The pattern and significance of results remained unchanged when these cases were removed from analyses. Therefore, the results are presented with all cases included. Analyses excluding influential cases are reported in the Supplemental Materials.

Exploratory Analyses Without Inclusion of Typical Drinking as Covariate

Additional post-hoc multiple linear regression analyses were conducted to determine the relationship between delay discounting and expectancies for alcohol analgesia without adjustment for typical alcohol consumption. Results were similar to those of the original analyses, such that the sex × delay discounting interaction remained significant for the EAA and AE VAS 1 models. Decomposition of interaction effects revealed attenuated negative associations between delay discounting rates and all alcohol analgesia expectancy measures for men (ps>.05). For women, delay discounting rates were a significant positive predictor of AE VAS 1 scores (*b*=15.74, p=.05), while associations with other alcohol analgesia expectancy measures remained non-significant (ps>.05). These analyses are further detailed in the Supplemental Materials.

Associations between delay discounting and alcohol expectancies

Separate multiple linear regressions assessed associations between delay discounting rates and all positive and negative domains of alcohol expectancies derived from responses to the AEQ. Potential sex differences were also examined. Non-significant main effects of sex and delay discounting rates were observed for all domains (ps>.05). Additionally, sex × delay discounting interactions were non-significant for all domains (ps>.05).

Discussion

This study examined the moderating role of sex in the relationship between delay discounting rates and expectancies for alcohol analgesia in a sample of healthy drinkers. Delay discounting and expectancies for alcohol analgesia are each highly relevant to understanding self-medication of pain. We hypothesized that these factors would be positively associated given that short-term reduction of pain with alcohol may be preferred to avoidance of long-term consequences associated with alcohol use in individuals with greater delay discounting rates. We also predicted that this relationship would be strongest in men compared to women. Consistent with hypotheses, findings suggested sex-specific associations between delay discounting and expectancies for alcohol analgesia. However, the directionality of these associations was contrary to our expectation and epidemiological patterns of self-medication of pain with alcohol. Specifically, we found that, after accounting for individual differences in typical drinking behavior, steeper delay discounting rates were associated with weaker expectancies for alcohol analgesia among men. For women, non-significant associations between delay discounting rates and expectancies for alcohol analgesia were observed. This pattern of results was weakened when typical drinking was not included as a covariate (see Supplemental Materials), suggesting alcohol use patterns may be an important contributor to these relationships. Overall, we did not observe a similar pattern of findings in secondary analyses, as no main or interactive effects of sex or delay discounting were found on positive and negative alcohol expectancies unrelated to analgesia. This may suggest that delay discounting is most salient to understanding expectancies for alcohol analgesia vs. other positive and negative domains of alcohol expectancies, at least in this population. It also provides additional evidence that alcohol analgesia may be a distinct dimension of alcohol expectancies.

Women in this study endorsed significantly greater expectancies for alcohol analgesia than men, although this difference was only significant for the AE VAS 2, which pertains to alcohol-related reductions in pain sensitivity. No significant sex differences were observed for the other alcohol analgesia measures (EAA and AE VAS 1), which primarily reflect expectancies of pain reduction and relief from pain respectively. However, sex moderated the relationship between delay discounting rates and expectancies for alcohol analgesia measured by the EAA and AE VAS 1, rather than the AE VAS 2. Subtle differences in the domain of alcohol analgesia expectancies assessed across these measures (e.g. expectancies of pain relief vs. pain sensitivity reduction) may explain discrepancies in associations observed in the present analyses. Of note, the VAS measures were single-item, and additional work is needed to determine whether there may be more than one meaningful component of expectancies for alcohol analgesia. Nonetheless, differences in results across alcohol analgesia measures in this study may be useful for characterizing expectancies for alcohol analgesia and sex differences within potential constituent dimensions.

Overall, our finding is counterintuitive given epidemiological data suggesting that men are more likely to self-medicate their pain with alcohol (Riley III & King, 2009). However, our study cannot address the association between expectancies for alcohol analgesia and likelihood of engaging in self-medication behavior in the context of pain. We are unaware of previous studies addressing the causal relationship between expectancies for alcohol

analgesia and alcohol use for pain, and it is likely that numerous other factors, such pain-related attitudes (Bartley & Fillingim, 2013), willingness to seek healthcare (Robinson et al., 2001), and response to stress (Peltier et al., 2019), contribute to sex differences in decisions to use alcohol for pain self-management. With that said, these factors may help to account for the apparent discrepancy between greater expectancy for alcohol analgesia in women, as measured by the AE VAS 2, and more frequent self-medication of pain in men. Future prospective work should test whether delay discounting predicts the development of expectancies for alcohol analgesia, and whether this leads to increased drinking behavior.

The current study also demonstrated that men reporting greater delay discounting appear to hold weaker alcohol-related expectancies for pain relief and pain coping. In other words, for men, greater sensitivity to delayed rewards was related to weaker belief that alcohol use would be an effective analgesic. This is surprising given research suggesting delay discounting may be a useful behavioral marker for substance use and other maladaptive health concerns (Bickel et al., 2014), and underlying mechanisms are unclear. One possible interpretation is that men may hold stronger expectancies of adverse consequences related to using alcohol for pain (i.e. increased pain, pain as barrier to cessation) (Ditre et al., 2019), which may reduce outcome expectancies for the utility of alcohol use as an effective coping strategy. Although this interpretation contrasts previous findings suggesting greater expectancy for alcohol analgesia scores in men compared to women (LaRowe et al., 2021), differences in our pattern of results may be explained by our recruitment of a sample without chronic pain. It is also possible that an unmeasured third factor underlies this association, such as a personality or trait-level factor. Future research should account for these variables, as well as other potentially important moderating factors, such as negative urgency or history of self-medication with alcohol. Moreover, future studies should attempt to replicate the present findings with larger samples and determine if greater delay discounting rates are related to less self-medication with alcohol among men.

This study did not find relationships between delay discounting rates or expectancies for alcohol analgesia and alcohol use. However, previous research indicates associations between expectancies for alcohol analgesia and quantity/frequency of alcohol use and hazardous alcohol use among individuals with chronic pain (LaRowe et al., 2021). Further, steep delay discounting rates have been associated with alcohol use severity and quantity/frequency (Amlung et al., 2017; MacKillop et al., 2011). Taken together, previous literature suggests two potential intervention targets —delay discounting and expectancies for analgesia— and both have been successfully addressed by prior interventions (Ditre et al., 2010; Rung & Madden, 2018; Scholten et al., 2019). However, results from this study do not provide additional support for these intervention targets. Our use of a healthy sample without chronic pain that reported relatively moderate alcohol use (i.e., at least one drink per week), rather than heavy alcohol use, may explain discrepancies in findings due to restricted range in typical alcohol consumption. It is also possible that our findings did not capture significant associations between delay discounting rates and alcohol use due to the brief adjusting-amounts discounting task for monetary outcomes that was administered in this study. Additionally, studies have demonstrated that drinkers show greater delay discounting with alcohol rewards compared to monetary rewards (Adams et al., 2017; Moody et al., 2017), and discounting of both pain and money losses has been associated with risk for

opioid misuse (Tompkins et al., 2016). These findings suggest that use of cross-commodity or commodity-specific discounting tasks may be an important consideration for future research. Future work should also consider including a full adjusting-amounts discounting task in order to more comprehensively examine the relationship between delay discounting and expectancies for alcohol analgesia.

This study has several notable limitations. Results should be interpreted with caution due to a relatively modest sample size. This study was also cross-sectional in nature, which does not allow for inferences about causality in the delay discounting-expectancies for alcohol analgesia relationship. Further, it is possible that our findings may have limited generalizability to certain key populations, such as middle-aged and older adults, individuals with low socioeconomic status, other races/ethnicities, heavy drinkers, and individuals who use tobacco. This study used a hypothetical measure of delay discounting, rather than actual monetary rewards or alcohol-related rewards. It is possible that use of real commodities may have altered our pattern of results; however, previous research has documented correspondence between discounting of hypothetical and real monetary rewards (Madden et al., 2003).

Importantly, future research would benefit from investigating whether current results correspond to sex differences in associations between delay discounting and alcohol use to manage pain. These relationships should also be examined among individuals with chronic pain, as expectancies for alcohol analgesia may differ between individuals with and without chronic pain (Ditre et al., 2019; LaRowe et al., 2021). Of note, our data suggest that relatively young, healthy drinkers in this study had strong expectancies for alcohol analgesia, making them an appropriate sample for this study. It is likely that they were able to develop expectancies for alcohol analgesia due to experiences/familiarity with alcohol or pain (e.g. headaches, sprains) or sociocultural influences (Asmundson et al., 2014; Johnson et al., 1990). Finally, it is possible that delay discounting in this study may serve as a distinct, behavioral marker of impulsivity (Bickel & Madden, 1999; MacKillop et al., 2011), which is widely considered to be a heterogeneous construct with multiple dimensions (Caswell et al., 2015, 2016; Dick et al., 2010; Reynolds et al., 2006). Future research efforts that attempt to replicate our findings should consider including other measures of impulsivity to understand associations with expectancies for alcohol analgesia.

Taken together, results of this study indicate sex differences in the relationship between delay discounting and expectancies for alcohol analgesia, two factors which may contribute to alcohol misuse. Interestingly, men with greater rates of delay discounting appear to have lower expectancies for alcohol analgesia, which may have implications for alcohol self-medication patterns. Future research is needed to continue to clarify these relationships and improve understanding of sex differences in factors that may underlie self-medication of pain with alcohol.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

Adams S, Attwood AS, & Munafò MR (2017). Drinking status but not acute alcohol consumption influences delay discounting. Human Psychopharmacology: Clinical and Experimental, 32(5), e2617. 10.1002/hup.2617 [PubMed: 28791734]

Aguinis H, Gottfredson RK, & Joo H (2013). Best-Practice Recommendations for Defining, Identifying, and Handling Outliers. Organizational Research Methods, 16(2), 270–301. 10.1177/1094428112470848

Aiken LS, West SG, & Reno RR (1991). Multiple regression: Testing and interpreting interactions. Sage.

Alford DP, German JS, Samet JH, Cheng DM, Lloyd-Travaglini CA, & Saitz R (2016). Primary care patients with drug use report chronic pain and self-medicate with alcohol and other drugs. Journal of General Internal Medicine, 31(5), 486–491. 10.1007/s11606-016-3586-5 [PubMed: 26809204]

Amlung M, Vedelago L, Acker J, Balodis I, & MacKillop J (2017). Steep delay discounting and addictive behavior: A meta-analysis of continuous associations. Addiction, 112(1), 51–62. 10.1111/add.13535

Asmundson GJ, Gomez-Perez L, Richter AA, & Carleton RN (2014). The psychology of pain: Models and targets for comprehensive assessment. In Pain: A Textbook for Health Professionals (2nd ed., pp. 35–48). Churchill Livingstone.

Atlas LY, & Wager TD (2012). How expectations shape pain. Neuroscience Letters, 520(2), 140–148. 10.1016/j.neulet.2012.03.039 [PubMed: 22465136]

Bartley EJ, & Fillingim RB (2013). Sex differences in pain: A brief review of clinical and experimental findings. British Journal of Anaesthesia, 111(1), 52–58. 10.1093/bja/aet127 [PubMed: 23794645]

Beck RC, & Triplett MF (2009). Test–retest reliability of a group-administered paper–pencil measure of delay discounting. Experimental and Clinical Psychopharmacology, 17(5), 345–355. 10.1037/a0017078 [PubMed: 19803634]

Belsley DA, Welsch RE, & Kuh E (2005). Regression Diagnostics: Identifying Influential Data and Sources of Collinearity (Vol. 571). John Wiley & Sons. https://cds.cern.ch/record/997008

Benedetti F, Carlino E, & Pollo A (2011). How placebos change the patient's brain. Neuropsychopharmacology, 36(1), 339–354. 10.1038/npp.2010.81 [PubMed: 20592717]

Benjamini Y, & Hochberg Y (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. Journal of the Royal Statistical Society: Series B (Methodological), 57(1), 289–300. 10.1111/j.2517-6161.1995.tb02031.x

Bickel WK, Koffarnus MN, Moody L, & Wilson AG (2014). The behavioral-and neuro-economic process of temporal discounting: A candidate behavioral marker of addiction. Neuropharmacology, 76, 518–527. 10.1016/j.neuropharm.2013.06.013 [PubMed: 23806805]

Bickel WK, & Madden GJ (1999). A comparison of measures of relative reinforcing efficacy and behavioral economics: Cigarettes and money in smokers. Behavioural Pharmacology, 10(6–7), 627–637. 10.1097/00008877-199908001-00023 [PubMed: 10780504]

Bingel U, Wanigasekera V, Wiech K, Mhuircheartaigh RN, Lee MC, Ploner M, & Tracey I (2011). The effect of treatment expectation on drug efficacy: Imaging the analgesic benefit of the opioid remifentanil. Science Translational Medicine, 3(70), 70ra14–70ra14. 10.1126/scitranslmed.3001244

Boissoneault J, Lewis B, & Nixon SJ (2019). Characterizing chronic pain and alcohol use trajectory among treatment-seeking alcoholics. Alcohol, 75, 47–54. 10.1016/j.alcohol.2018.05.0 [PubMed: 30359794]

Brennan PL, & SooHoo S (2013). Pain and use of alcohol in later life: Prospective evidence from the health and retirement study. Journal of Aging and Health, 25(4), 656–677. 10.1177/0898264313484058 [PubMed: 23640817]

Brown SA, Christiansen BA, & Goldman MS (1987). The Alcohol Expectancy Questionnaire: An instrument for the assessment of adolescent and adult alcohol expectancies. Journal of Studies on Alcohol, 48(5), 483–491. 10.15288/jsa.1987.48.483 [PubMed: 3669677]

Brown SA, Goldman MS, & Christiansen BA (1985). Do alcohol expectancies mediate drinking patterns of adults? Journal of Consulting and Clinical Psychology, 53(4), 512–519. 10.1037/0022-006X.53.4.512 [PubMed: 4031207]

Brown SA, Goldman MS, Inn A, & Anderson LR (1980). Expectations of reinforcement from alcohol: Their domain and relation to drinking patterns. Journal of Consulting and Clinical Psychology, 48(4), 419–426. 10.1037//0022-006x.48.4.419 [PubMed: 7400427]

Cahalan D, Cisin IH, & Crossley HM (1969). American drinking practices: A national study of drinking behavior and attitudes. Monographs of the Rutgers Center of Alcohol Studies, 6, 260–260.

Caswell AJ, Bond R, Duka T, & Morgan MJ (2015). Further evidence of the heterogeneous nature of impulsivity. Personality and Individual Differences, 76, 68–74. 10.1016/j.paid.2014.11.059 [PubMed: 25844002]

Caswell AJ, Celio MA, Morgan MJ, & Duka T (2016). Impulsivity as a multifaceted construct related to excessive drinking among UK students. Alcohol and Alcoholism, 51(1), 77–83. 10.1093/alcalc/agv070 [PubMed: 26115988]

Celio MA, MacKillop J, Caswell AJ, Mastroleo NR, Kahler CW, Barnett NP, Colby SM, Operario D, & Monti PM (2016). Interactive Relationships Between Sex-Related Alcohol Expectancies and Delay Discounting on Risky Sex. Alcoholism: Clinical and Experimental Research, 40(3), 638–646. 10.1111/acer.12988 [PubMed: 26891345]

Cross CP, Copping LT, & Campbell A (2011). Sex differences in impulsivity: A meta-analysis. Psychological Bulletin, 137(1), 97–130. 10.1037/a0021591 [PubMed: 21219058]

Darkes J, & Goldman MS (1993). Expectancy challenge and drinking reduction: Experimental evidence for a mediational process. Journal of Consulting and Clinical Psychology, 61(2), 344–353. 10.1037/0022-006X.61.2.344 [PubMed: 8473588]

Dick DM, Smith G, Olausson P, Mitchell SH, Leeman RF, O'Malley SS, & Sher K (2010). Understanding the construct of impulsivity and its relationship to alcohol use disorders. Addiction Biology, 15(2), 217–226. 10.1111/j.1369-1600.2009.00190.x [PubMed: 20148781]

Ditre JW, Heckman BW, Butts EA, & Brandon TH (2010). Effects of expectancies and coping on pain-induced motivation to smoke. Journal of Abnormal Psychology, 119(3), 524. 10.1037/a0019568 [PubMed: 20677841]

Ditre JW, Zale EL, & LaRowe LR (2019). A reciprocal model of pain and substance use: Transdiagnostic considerations, clinical implications, and future directions. Annual Review of Clinical Psychology, 15, 503–528. 10.1146/annurev-clinpsy-050718-095440

Dittrich M, & Leipold K (2014). Gender differences in time preferences. Economics Letters, 122(3), 413–415. 10.1016/j.econlet.2014.01.002

Earleywine M, & Bolles JR (2014). Marijuana, expectancies, and post-traumatic stress symptoms: A preliminary investigation. Journal of Psychoactive Drugs, 46(3), 171–177. [PubMed: 25052875]

Ehrenberg E, Armeli S, Howland M, & Tennen H (2016). A daily process examination of episode-specific drinking to cope motivation among college students. Addictive Behaviors, 57, 69–75. 10.1016/j.addbeh.2016.02.003 [PubMed: 26894551]

Ferguson E, Zale E, Ditre J, Wesolowicz D, Stennett B, Robinson M, & Boissoneault J (2020). CANUE: A theoretical model of pain as an antecedent for substance use. Annals of Behavioral Medicine. 10.1093/abm/kaaa072

Gowin J, Sloan ME, Swan JE, Momenan R, & Ramchandani VA (2019). The relationship between delay discounting and alcohol dependence in individuals with and without comorbid psychopathology. Psychopharmacology, 236(2), 775–785. 10.1007/s00213-018-5113-3 [PubMed: 30456539]

Hamilton KR, & Potenza MN (2012). Relations among delay discounting, addictions, and money mismanagement: Implications and future directions. The American Journal of Drug and Alcohol Abuse, 38(1), 30–42. 10.3109/00952990.2011.643978 [PubMed: 22211535]

Hanson GR, & Li T-K (2003). Public health implications of excessive alcohol consumption. JAMA, 289(8), 1031–1032. 10.1001/jama.289.8.1031 [PubMed: 12597758]

Hayes A (2013). Introduction to mediation, moderation, and conditional process analysis. Guilford Press.

Herman AM, & Duka T (2020). The Role of Impulsivity Facets on the Incidence and Development of Alcohol Use Disorders. In de Wit H & Jentsch JD (Eds.), Recent Advances in Research on Impulsivity and Impulsive Behaviors (pp. 197–221). Springer International Publishing. 10.1007/7854_2020_137

John WS, & Wu L-T (2020). Chronic non-cancer pain among adults with substance use disorders: Prevalence, characteristics, and association with opioid overdose and healthcare utilization. Drug and Alcohol Dependence, 209, 107902. 10.1016/j.drugalcdep.2020.107902 [PubMed: 32088587]

Johnson RC, Nagoshi CT, Danko GP, Honbo KAM, & Chau LL (1990). Familial transmission of alcohol use norms and expectancies and reported alcohol use. Alcoholism: Clinical and Experimental Research, 14(2), 216–220. 10.1111/j.1530-0277.1990.tb00475.x [PubMed: 2190488]

Jones BT, Corbin W, & Fromme K (2001). A review of expectancy theory and alcohol consumption. Addiction, 96(1), 57–72. 10.1046/j.1360-0443.2001.961575.x [PubMed: 11177520]

Kirmani MN, & Suman LN (2010). Gender differences in alcohol related attitudes and expectancies among college students. Journal of the Indian Academy of Applied Psychology, 36(1), 19–24. 10.13140/RG.2.2.17971.63525

Koffarnus MN, & Bickel WK (2014). A 5-trial adjusting delay discounting task: Accurate discount rates in less than one minute. Experimental and Clinical Psychopharmacology, 22(3), 222–228. 10.1037/a0035973 [PubMed: 24708144]

Kuntsche E, & Kuntsche S (2018). Even in early childhood offspring alcohol expectancies correspond to parental drinking. Drug and Alcohol Dependence, 183, 51–54. 10.1016/j.drugalcdep.2017.10.024 [PubMed: 29227837]

LaRowe LR, Maisto SA, & Ditre JW (2021). A measure of expectancies for alcohol analgesia: Preliminary factor analysis, reliability, and validity. Addictive Behaviors, 116, 106822. 10.1016/j.addbeh.2021.106822 [PubMed: 33460990]

Larson MJ, Paasche-Orlow M, Cheng DM, Lloyd-Travaglini C, Saitz R, & Samet JH (2007). Persistent pain is associated with substance use after detoxification: A prospective cohort analysis. Addiction, 102(5), 752–760. 10.1111/j.1360-0443.2007.01759.x [PubMed: 17506152]

Lee CM, Fairlie AM, Ramirez JJ, Patrick ME, Luk JW, & Lewis MA (2020). Self-fulfilling prophecies: Documentation of real-world daily alcohol expectancy effects on the experience of specific positive and negative alcohol-related consequences. Psychology of Addictive Behaviors, 34(2), 327–334. 10.1037/adb0000537 [PubMed: 31804099]

MacKillop J, Amlung MT, Few LR, Ray LA, Sweet LH, & Munafò MR (2011). Delayed reward discounting and addictive behavior: A meta-analysis. Psychopharmacology, 216(3), 305–321. 10.1007/s00213-011-2229-0 [PubMed: 21373791]

Madden GJ, Begotka AM, Raiff BR, & Kastern LL (2003). Delay discounting of real and hypothetical rewards. Experimental and Clinical Psychopharmacology, 11(2), 139–145. 10.1037/1064-1297.11.2.139 [PubMed: 12755458]

McDermott KA, Joyner KJ, Hakes JK, Okey SA, & Cougle JR (2018). Pain interference and alcohol, nicotine, and cannabis use disorder in a national sample of substance users. Drug and Alcohol Dependence, 186, 53–59. 10.1016/j.drugalcdep.2018.01.011 [PubMed: 29550622]

Moody LN, Tegge AN, & Bickel WK (2017). Cross-commodity delay discounting of alcohol and money in alcohol users. The Psychological Record, 67(2), 285–292. 10.1007/s40732-017-0245-0 [PubMed: 29056767]

Morasco BJ, Gritzner S, Lewis L, Oldham R, Turk DC, & Dobscha SK (2011). Systematic review of prevalence, correlates, and treatment outcomes for chronic non-cancer pain in patients with

comorbid substance use disorder. Pain®, 152(3), 488–497. 10.1016/j.pain.2010.10.009 [PubMed: 21185119]

O'Hara RE, Armeli S, & Tennen H (2014). College students' daily-level reasons for not drinking. Drug and Alcohol Review, 33(4), 412–419. 10.1111/dar.12162 [PubMed: 24976084]

Pabst A, Kraus L, Piontek D, Mueller S, & Demmel R (2014). Direct and indirect effects of alcohol expectancies on alcohol-related problems. Psychology of Addictive Behaviors, 28(1), 20–30. 10.1037/a0031984 [PubMed: 23528193]

Parkerson HA, & Asmundson GJ (2016). The role of pain intensity and smoking expectancies on smoking urge and behavior following experimental pain induction. Drug and Alcohol Dependence, 164, 166–171. 10.1016/j.drugalcdep.2016.05.007 [PubMed: 27234659]

Peltier MR, Verplaetse TL, Mineur YS, Petrakis IL, Cosgrove KP, Picciotto MR, & McKee SA (2019). Sex differences in stress-related alcohol use. Neurobiology of Stress, 10, 100149. 10.1016/j.ynstr.2019.100149 [PubMed: 30949562]

Phung QH, Snider SE, Tegge AN, & Bickel WK (2019). Willing to Work But Not to Wait: Individuals with Greater Alcohol Use Disorder Show Increased Delay Discounting Across Commodities and Less Effort Discounting for Alcohol. Alcoholism: Clinical and Experimental Research, 43(5), 927–936. 10.1111/acer.13996 [PubMed: 30817019]

Prencipe A, Kesek A, Cohen J, Lamm C, Lewis MD, & Zelazo PD (2011). Development of hot and cool executive function during the transition to adolescence. Journal of Experimental Child Psychology, 108(3), 621–637. 10.1016/j.jecp.2010.09.008 [PubMed: 21044790]

Reynolds B, Ortengren A, Richards JB, & De Wit H (2006). Dimensions of impulsive behavior: Personality and behavioral measures. Personality and Individual Differences, 40(2), 305–315. 10.1016/j.paid.2005.03.024

Riley III JL, & King C (2009). Self-report of alcohol use for pain in a multi-ethnic community sample. The Journal of Pain, 10(9), 944–952. 10.1016/j.jpain.2009.03.005 [PubMed: 19712901]

Robinson ME, Riley III JL, Myers CD, Papas RK, Wise EA, Waxenberg LB, & Fillingim RB (2001). Gender role expectations of pain: Relationship to sex differences in pain. The Journal of Pain, 2(5), 251–257. 10.1054/jpai.2001.24551 [PubMed: 14622803]

Roehrich L, & Goldman MS (1995). Implicit priming of alcohol expectancy memory processes and subsequent drinking behavior. Experimental and Clinical Psychopharmacology, 3(4), 402–410. 10.1037/1064-1297.3.4.402

Rohsenow DJ (1983). Drinking habits and expectancies about alcohol's effects for self versus others. Journal of Consulting and Clinical Psychology, 51(5), 752–756. 10.1037/0022-006X.51.5.752 [PubMed: 6630690]

Rung JM, & Madden GJ (2018). Experimental reductions of delay discounting and impulsive choice: A systematic review and meta-analysis. Journal of Experimental Psychology: General, 147(9), 1349–1381. 10.1037/xge0000462 [PubMed: 30148386]

Satre DD, & Knight BG (2001). Alcohol expectancies and their relationship to alcohol use: Age and sex differences. Aging & Mental Health, 5(1), 73–83. 10.1080/13607860020020672 [PubMed: 11513017]

Scholten H, Scheres A, de Water E, Graf U, Granic I, & Luijten M (2019). Behavioral trainings and manipulations to reduce delay discounting: A systematic review. Psychonomic Bulletin & Review, 26(6), 1803–1849. 10.3758/s13423-019-01629-2 [PubMed: 31270766]

Slavin M, Barach E, Farmer S, Luba R, & Earleywine M (2017). Cannabis and symptoms of PMS and PMDD. Addiction Research & Theory, 25(5), 383–389. 10.1080/16066359.2017.1294165

Stennett B, Anderson M, Vitus D, Ferguson E, Dallery J, Alappattu M, Robinson ME, & Boissoneault J (2021). Sex Moderates the Effects of Experimentally Induced Musculoskeletal Pain on Alcohol Demand in Healthy Drinkers. Drug and Alcohol Dependence, 219, 108475. 10.1016/j.drugalcdep.2020.108475 [PubMed: 33385694]

Substance Abuse and Mental Health Services Administration. (2018). Mental Health Services Administration.(2019). Reports and Detailed Tables From from the 2018 National Survey on Drug Use and Health (NSDUH) https://www.samhsa.gov/data/report/2018-nsduh-detailed-tables

Tompkins DA, Johnson PS, Smith MT, Strain EC, Edwards RR, & Johnson MW (2016). Temporal preference in individuals reporting chronic pain: Discounting of delayed pain-related and monetary outcomes. Pain, 157(8), 1724–1732. 10.1097/j.pain.0000000000000576 [PubMed: 27075431]

Townshend JM, & Duka T (2002). Patterns of alcohol drinking in a population of young social drinkers: A comparison of questionnaire and diary measures. Alcohol and Alcoholism, 37(2), 187–192. 10.1093/alcalc/37.2.187 [PubMed: 11912076]

Van Tyne K, Zamboanga BL, Ham LS, Olthuis JV, & Pole N (2012). Drinking Motives as Mediators of the Associations Between Alcohol Expectancies and Risky Drinking Behaviors Among High School Students. Cognitive Therapy and Research, 36(6), 756–767. 10.1007/s10608-011-9400-0

Volkow ND, & McLellan AT (2016). Opioid abuse in chronic pain—Misconceptions and mitigation strategies. New England Journal of Medicine, 374(13), 1253–1263. 10.1056/NEJMra1507771 [PubMed: 27028915]

Weafer J, & de Wit H (2014). Sex differences in impulsive action and impulsive choice. Addictive Behaviors, 39(11), 1573–1579. 10.1016/j.addbeh.2013.10.033 [PubMed: 24286704]

Wilsnack RW, Wilsnack SC, Kristjanson AF, Vogeltanz Holm ND, & Gmel G (2009). Gender and alcohol consumption: Patterns from the multinational GENACIS project. Addiction, 104(9), 1487–1500. 10.1111/j.1360-0443.2009.02696.x [PubMed: 19686518]

Zale EL, Maisto SA, & Ditre JW (2015). Interrelations between pain and alcohol: An integrative review. Clinical Psychology Review, 37, 57–71. 10.1016/j.cpr.2015.02.005 [PubMed: 25766100]

Public Health Significance –

This study suggests differential associations between delay discounting and expectancies for alcohol analgesia for men and women. Results are relevant to understanding patterns of self-medication of pain with alcohol, which is a growing public health concern.

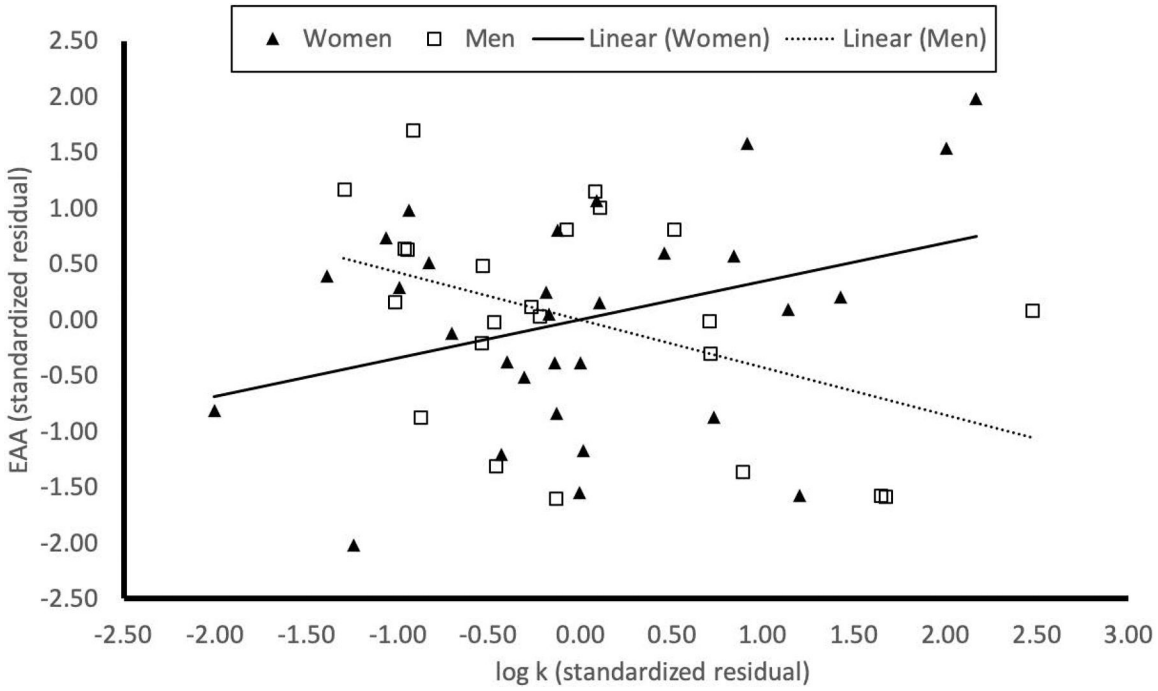

Figure 1.

Scatter plots displaying the significant sex × delay discounting interaction on expectancies of analgesia (EAA) after controlling for average alcohol consumption. A positive linear relationship between delay discounting rates and expectancies of analgesia was observed for women (R^2 = .12, b = 13.06, p = .07), while a negative linear relationship between delay discounting rates and expectancies of analgesia was observed for men (R^2 = .22, b = −21.60, p = .05).

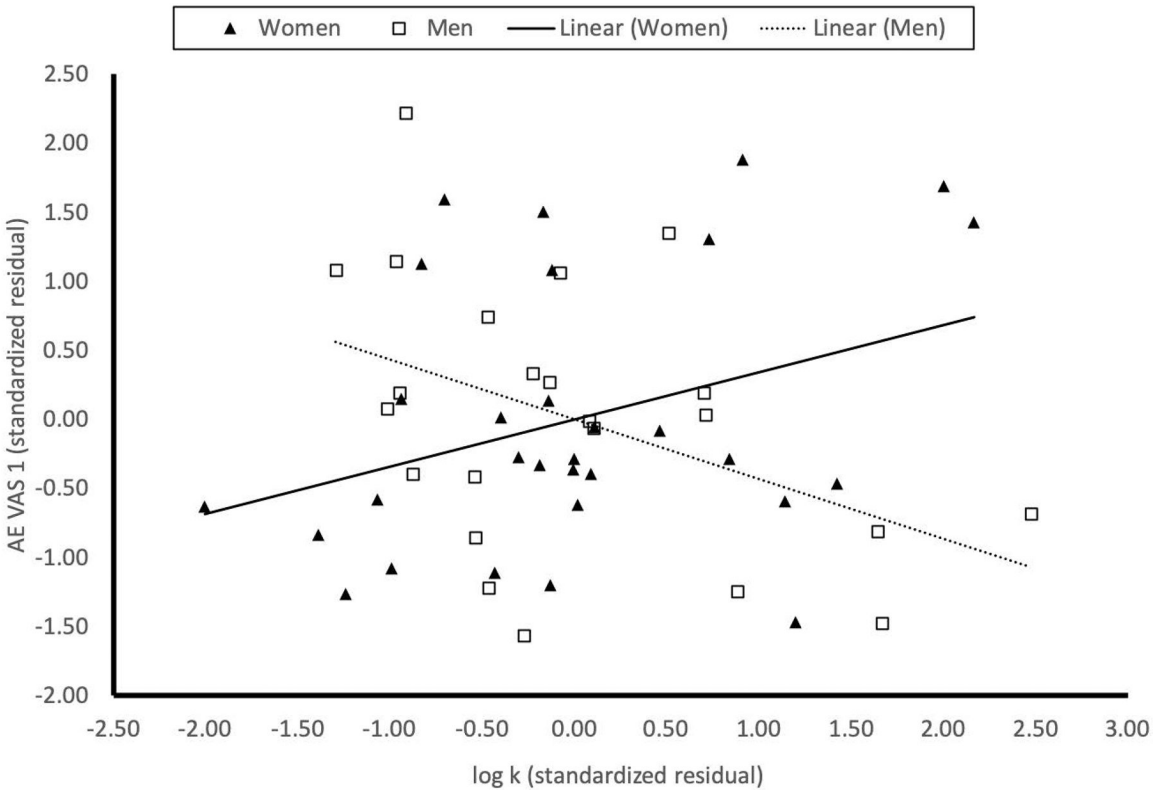

Figure 2.

Scatter plots depicting the significant interaction between sex and delay discounting on expectancies of analgesia (AE VAS 1) after controlling for average alcohol consumption. A positive linear relationship between delay discounting rates and expectancies of analgesia was observed for women (R^2 = .13, b = 15.41, p = .07), while a negative linear relationship between delay discounting rates and expectancies of analgesia was observed for men (R^2 = .30, b = −20.20, p = .05).

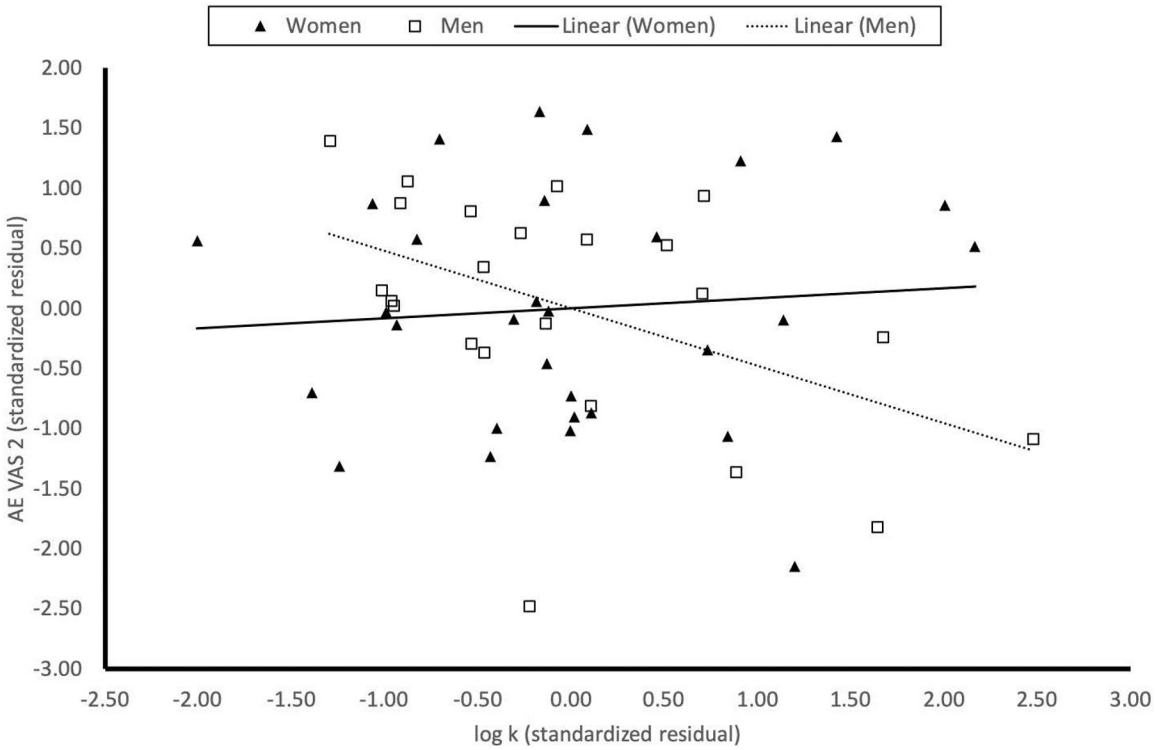

Figure 3.

Scatter plots displaying the sex × delay discounting interaction on expectancies of analgesia (AE VAS 2) after controlling for average alcohol consumption. A positive linear relationship between delay discounting rates and expectancies of analgesia was observed for women (R^2 = .02, b = 2.24, p = .67), while a negative linear relationship between delay discounting rates and expectancies of analgesia was observed for men (R^2 = .31, b = −16.21, p = .03).

Table 1.

Selected demographics of participants

Variable	Entire Sample	Men	Women
	N (% of total), M (SD)	N (% of total) or M (SD)	N (% of total) or M (SD)
	53	23 (43.4)	30 (56.6)
Age (years)	26.3 (9.91)	27.6 (10.4)	25.3 (9.6)
Race, n (%)			
White	44 (83)	19 (35.8)	25 (47.2)
Black	2 (3.8)	0 (0)	2 (3.8)
Asian or Pacific Islander	4 (7.5)	1 (1.9)	3 (5.7)
Other or multiple races	3 (5.7)	1 (1.9)	2 (3.8)
Years of education *	16.32 (2.13)	17 (2.45)	15.8 (1.71)
QFI (oz. EtOH/day) *	0.84 (.76)	1.17 (0.99)	.60 (0.38)
MaxQ (oz. EtOH) *	5.34 (2.70)	6.24 (2.91)	4.66 (2.35)
Log-transformed *k*	−2.33 (0.55)	−2.42 (0.48)	−2.27 (0.6)
EAA	45.67 (22.87)	46.16 (24.29)	45.29 (22.13)
AE VAS 1	36.02 (25.06)	34.96 (23.55)	36.83 (26.53)
AE VAS 2	70.24 (16.42)	66.46 (16.78)	73.15 (15.80)
EAA[a]	44.29 (22.71)	42.81 (23.88)	45.76 (23.17)
AE VAS 1[a]	34.19 (24.10)	30.13 (25.37)	38.26 (24.65)
AE VAS 2[a]	68.91 (16.09)	63.38 (16.93)	74.43 (16.43)

* $p<.05$ in t-test analyses

[a] Marginal means adjusting for delay discounting and QFI

Table 2.

Correlation of expectancies for alcohol analgesia, AEQ subscales, delay discounting, QFI, and MaxQ

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. EAA	-	.680**	.518**	.049	.056	.099	.268	.170	.393**	.280*	.378*	−.027	.292*	.185
2. AE VAS 1	-	-	.512**	.214	.253	.130	.237	.239	.253	.202	.384**	−.011	.278*	.206
3. AE VAS 2	-	-	-	.081	.131	−.076	.390**	.340*	.394**	−.017	.344*	.076	.382**	.314*
4. Total QFI	-	-	-	-	.702**	.130	−.006	.024	.120	.049	.016	−.190	.057	.002
5. MaxQ	-	-	.-	-	-	.094	.061	.126	.128	−.059	.011	−.272*	.121	.040
6. log *k*	-	-	-	-	-	-	−.063	.185	.005	.049	.089	.217	.286*	.000
7. Global Positive	-	-	-	-	-	-	-	.313*	.525**	.249	.410**	−.050	.389**	.722**
8. Aggression and Power	-	-	-	-	-	-	.-	-	.262	−.144	.219	.049	.438**	.382**
9. Social Expressiveness	-	-	-	-	.-	-	-	-	-	.172	.530**	−.172	.435**	.606**
10. Social and Physical Pleasure	-	-	-	-	-	-	-	-	-	-	.405**	−.131	−.145	.307*
11. Relaxation and Tension Reduction	-	-	-	-	-	-	-	-	-	-	-	−.105	.257	.391**
12. Cognitive and physical impairment	-	-	-	-	-	-	.-	.-	-	-	-	-	.373**	−.114
13. Careless unconcern	-	-	-	-	-	-	-	-	-	-	-	-	-	.343*
14. Sexual enhancement	-	-	.-	-	-	-	-	-	-	-	-	-	-	-

** = $p < .01$;

* = $p < .05$