HHS Public Access

Author manuscript

Cogn Emot. Author manuscript; available in PMC 2018 November 01.

Published in final edited form as:

Cogn Emot. 2017 November ; 31(7): 1405–1418. doi:10.1080/02699931.2016.1226162.

Effects of Alcohol, Rumination, and Gender on the Time Course of Negative Affect

Jeffrey S. Simons[a], **Noah N. Emery**[a], **Raluca M. Simons**[a], **Thomas A. Wills**[b], and **Michael K. Webb**[a]

[a]Department of Psychology, University of South Dakota, Vermilion, SD, United States

[b]Prevention and Control Program, University of Hawaii Cancer Center, Honolulu, HI, United States

Abstract

This study modeled associations between gender, ruminative cognitive style, alcohol use, and the time course of negative affect over the course of 43,111 random assessments in the natural environment. Participants (*N*=263) completed 49-days of experience sampling over 1.3 years. The data indicated that rumination at baseline was positively associated with alcohol dependence symptoms at baseline as well as higher negative affect over the course of the study. Consistent with negative reinforcement models, drinking served to decrease the persistence of negative affect from moment to moment. However, this ameliorative effect of drinking was evident only among women, suggesting an increased risk for negative reinforcement driven drinking behavior. In addition, rumination appeared to counteract the desired effects of alcohol on mood among women. This suggests that women who ruminate more may be motivated to consume larger amounts of alcohol to achieve the desired effects. Overall, the results indicate that ruminative cognitive style and the persistence of negative affect from moment to moment may reflect an individual vulnerability for the development of alcohol use disorder especially among women.

Keywords

Experience sampling; Ecological momentary assessment (EMA); alcohol; rumination; gender; negative affect; emotional inertia

Dysregulated negative affect is not only a hallmark feature of mood disorders, but has been linked to alcohol and other substance use disorders as well (Cheetham, Allen, Yucel, & Lubman, 2010; Koob, 2013). The use of alcohol for managing emotional states is a prominent motivation underlying drinking behavior with particular relevance for the development of alcohol use disorder (Cox & Klinger, 1990; McCarthy, Curtin, Piper, & Baker, 2010; Piasecki et al., 2014; Simons, Gaher, Correia, Hansen, & Christopher, 2005a). Nonetheless, the majority of persons do not rely on alcohol to regulate their mood and empirical findings linking negative affect and alcohol use suggest there are complex relationships that vary across time, person, and situation (Greeley & Oei, 1999; Sher &

Correspondence concerning this article should be addressed to Jeffrey S. Simons, Department of Psychology, The University of South Dakota, Vermillion, SD 57069. jsimons@usd.edu.

Grekin, 2007; Simons, Wills, & Neal, 2014).. Ruminative cognitive style is an individual difference variable that may increase risk of maladaptive use of alcohol in an attempt to attenuate the persistence of negative affect. Incorporating the time course of negative affective states and degree of baseline rumination into explanatory models can advance research on associations between negative affect and drinking.

The duration of negative affective experiences varies considerably between individuals, with some having fleeting episodes, while others have episodes that can last months or even years (Nolen-Hoeksema, 1991). Whereas discrete negative affective states are important for adaptive functioning (Kashdan, Feldman-Barrett, & McKnight, 2015), the tendency for negative affect to persist is an important risk factor for psychological disorders, especially depressive disorders (Kuppens, Allen, & Sheeber, 2010; Kuppens et al., 2012; Sadikaj, Russell, Moskowitz, & Paris, 2010). The persistence of affective states reflects a strong autocorrelation in affect from moment-to-moment, a process termed emotional inertia in the literature (Fairbairn & Sayette, 2013; Green, Hillis, & Suls, 1998; Kuppens et al., 2010). In respect to negative affect, this suggests an inward focus on sources of turmoil and a lack of engagement in the social world. The person is not responding to the inherently varied emotionally relevant stimuli they encounter. The Attention Allocation Model (Steele & Josephs, 1988) posits that the effect of alcohol on mood, stems in part from its ability to disrupt focus on internal states and attend to the present moment (Fairbairn & Sayette, 2013).Thus, where ruminative cognitive styles are thought to increase emotional inertia and associated negative affect (Koval, Kuppens, Allen, & Sheeber, 2012; Moberly & Watkins, 2008a, 2008b), alcohol may serve to free one from inertia, and improve mood.

Negative Reinforcement Drinking

Negative reinforcement is inherently a within-person process. As such, experience sampling provides an optimal approach to examining this process in the natural environment. Daily-process research on associations between negative affect and alcohol consumption has predominantly structured the research question to examine whether negative affect serves as a stimulus for increased drinking (e.g., Armeli, Todd, Conner, & Tennen, 2008; Hussong, 2007; Park, Armeli, & Tennen, 2004; Simons, Dvorak, Batien, & Wray, 2010; Simons, Gaher, Oliver, Bush, & Palmer, 2005b; Simons et al., 2014). Fewer daily process studies have tested whether drinking is associated with subsequent reductions in negative affect (Armeli et al., 2003; Jahng et al., 2011; Swendsen et al., 2000). Armeli and colleagues (2003) and Swendsen and colleagues (2000) found that alcohol consumption was concurrently associated with reduced negative affect and Armeli and colleagues (2003) found that alcohol consumption was prospectively associated with reduced negative affect later in the evening. Jahng et al. (2011) examine prospective effects of alcohol use on mood controlling for drinking both during and after the target mood assessment. They did not find evidence of the effects of alcohol on reductions in negative affect. However, their results are difficult to interpret, as the specific effect of drinking on the association between affect assessments across time was not tested.

Rumination

Response Styles Theory (RST; Nolen-Hoeksema, 1991) proposes that rumination is a risk factor for the onset and maintenance of depression and persistent dysphoria. In RST, rumination consists of repetitively thinking about the causes, consequences, and symptoms of one's negative affect. RST further postulates that this tendency to ruminate in response to negative mood is thought to be a stable individual difference factor that contributes to the continuity of negative affect observed in mood and anxiety disorders (Nolen-Hoeksema, 2004). Consistent with this position, experimental studies show that inducing rumination leads to subsequent increases in, and the prolonging of, both depressed and anxious moods (Blagden & Craske, 1996; McLaughlin, Borkovec, & Sibrava, 2007; Nolen-Hoeksema, 2000; Nolen-Hoeksema, Morrow, & Fredrickson, 1993). Prospective studies have found that rumination predicts the onset of major depressive episodes (Just & Alloy, 1997; Nolen-Hoeksema, 2000; Spasojević & Alloy, 2001) and is associated with the severity and chronicity of depressive episodes (Alloy & Robinson, 2003; Kuehner & Weber, 1999; Nolen-Hoeksema, 2000). More broadly, rumination is a transdiagnostic risk factor associated with a variety of disorders (Nolen-Hoeksema & Watkins, 2011). For example, the tendency to ruminate is related to symptoms of generalized anxiety (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; McEvoy, Watson, Watkins, & Nathan, 2013), posttraumatic stress (Ehring, Frank, & Ehlers, 2008; Mayou, Ehlers, & Bryant, 2002), and social anxiety (Brozovich & Heimberg, 2008; Chen, Rapee, & Abbott, 2013; Mellings & Alden, 2000). The current consensus is that rumination leads to increases in negative affect that, in turn, foster further repetitive negative cognitions which propagate greater, more persistent negative affect in a self-perpetuating positive feedback loop (Ciesla & Roberts, 2007; Lyubomirsky & Nolen-Hoeksema, 1995; Nolen-Hoeksema, 1991; Pasyugina, Koval, De Leersnyder, Mesquita, & Kuppens, 2015).

RST proposes that rumination should lead to greater continuity in negative affect from moment-to-moment (Nolen-Hoeksema, 1991, 2004). There has been increased interest in recent years in testing this central tenet of the theory in the natural environment (Brans, Koval, Verduyn, Lim, & Kuppens, 2013; Koval et al., 2012; Koval, Pe, Meers, & Kuppens, 2013; Moberly & Watkins, 2008a, 2008b; Pasyugina et al., 2015; Takano & Tanno, 2011). These experience sampling studies largely operationalized rumination as a time varying process and demonstrated within-person associations between rumination and persistence of negative affective states. They thus shed important light on the hypothesized within-person process of rumination on the time course of negative affect. Despite the strengths of this approach, emotion and cognition are closely entwined and it remains possible that the persistence of negative arousal is "pulling for" rumination rather than vice versa. Indeed, supplemental analyses of one experience sampling study supported this contention in that negative affect predicted rumination at the within-person level (Pasyugina et al., 2015). However, Koval and colleagues (Koval et al., 2012) did test the effects of trait rumination measured at baseline on persistence of negative affect (i.e., emotional inertia) in a brief experience sampling study. Consistent with hypotheses, rumination at baseline predicted marginally stronger autoregressive effects of negative affect and significantly stronger persistence in the specific emotions of dysphoria and sadness.

There are multiple ways in which rumination may contribute to risk for alcohol use disorder. At the most basic level, rumination may increase risk due to the increased persistence of negative affect, which in turn reinforces alcohol use. In addition, the ability of alcohol to disrupt ruminative cognitive style, may suggest that alcohol has stronger effects on emotional inertia for those who ruminate more. Alternatively, given that the effects of alcohol and rumination oppose each other, rumination may serve to attenuate the effects of alcohol on emotional inertia, potentially resulting in higher levels of consumption to obtain the desired effect. The current study addresses this gap in the literature.

Gender effects

Women are at increased risk for depressive and anxiety disorders and decreased risk for alcohol use disorders relative to men (Eaton et al., 2012). There are numerous theoretical models for gender effects on risk for these disorders (Eaton et al., 2012; Nolen-Hoeksema, 2001, 2012). Of relevance to the current study, increased risk for depression seen among women has been tied to the tendency to ruminate about negative emotion and events. Women are more likely than men to ruminate, as assessed both by self-report and laboratory observation (Butler & Nolen-Hoeksema, 1994; Nolen-Hoeksema, Larson, & Grayson, 1999). Furthermore, rumination has been shown to mediate the relationship between female gender and increased negative affect (Butler & Nolen-Hoeksema, 1994; Jose & Brown, 2008; Nolen-Hoeksema, 2012) and there is some evidence that the association between rumination and depression may be stronger for women (Jose & Brown, 2008).

Given the role of negative reinforcement in the development of alcohol use disorder (Baker et al., 2004; McCarthy et al., 2010), and the observed increased risk of alcohol use disorder among men (Eaton et al., 2012), one possibility is that men may experience greater beneficial effects of drinking on negative affect and drink more to cope than women (Nolen-Hoeksema, 2012). However, research has been inconsistent, with results of several studies suggesting that women report drinking to cope more than men (Hussong, 2007; LaBrie, Ehret, Hummer, & Prenovost, 2012; Rice & Van Arsdale, 2010), exhibit stronger associations between coping motives and drinking (Lehavot, Stappenbeck, Luterek, Kaysen, & Simpson, 2014), and exhibit stronger associations between negative affect and relapse to alcohol use (Annis, Sklar, & Moser, 1998; Zywiak, Connors, Maisto, & Westerberg, 1996; Zywiak et al., 2006). Still others report no gender differences in associations between negative affect and alcohol use (Simons et al., 2005b; Walitzer & Dearing, 2006; Witkiewitz & Villarroel, 2009). Reasons for the disparities in the literature likely stem from a number of sources including sample differences in respect to age (Kuntsche, Knibbe, Gmel, & Engels, 2006), socio-cultural factors (Bloomfield, Gmel, & Wilsnack, 2006), and severity of mood or alcohol related problems (Foster et al., 2014; Nolen-Hoeksema & Hilt, 2006). In addition, much of the research does not clearly delineate the effects of gender on the within-person association between alcohol and negative affect or the effects of alcohol on emotional inertia. As discussed previously, laboratory research indicates that alcohol may improve mood by reducing emotional inertia (Fairbairn & Sayette, 2013), but whether this effect varies as a function of gender is unknown.

The Current Study

Understanding of psychopathology can be advanced by research on the time course of negative affective states (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009; Fairbairn & Sayette, 2013; Kuppens et al., 2012; Simons et al., 2014). The experience of negative affect is a dynamic process within the individual and both excessive variability (i.e., lability; Jahng et al., 2011; Simons et al., 2014) as well as excessive stability (i.e., inertia; Fairbairn & Sayette, 2013; Kuppens et al., 2012) appear to be characteristics of different forms of pathology. Ruminative cognitive styles are thought to promote the persistence of negative affective states across time and increase risk for depressive disorders (Moberly & Watkins, 2008a; Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). In contrast, effects of alcohol on disrupting emotional inertia (Fairbairn & Sayette, 2013) and alleviating negative affect (Piasecki et al., 2014; Sher et al., 2007) negatively reinforce alcohol use and potentially contribute to the development of an alcohol use disorder (AUD; Baker et al., 2004; McCarthy et al., 2010). In the current study, we seek to advance understanding of these issues by testing between-person effects of trait rumination and gender, and within-person effects of alcohol consumption, on the persistence of negative affect across random *in situ* assessments (i.e., the strength of autocorrelation across time lags). Furthermore, we test whether emotional inertia is positively associated with negative affectivity. Consistent with negative reinforcement models of drinking, it was hypothesized that drinking would reduce associations between negative affect across successive time points. In line with RST, it was hypothesized that ruminative cognitive style assessed at baseline would predict greater persistence of negative affect, operationalized as a stronger association between negative affect at time t-1 and negative affect at time t. Given the elevated risk of women for depressive and anxiety disorders we test whether women exhibit stronger persistence of negative affect after accounting for the hypothesized effect of rumination and whether the effect of rumination on persistence of negative affect is stronger for women relative to men. In addition, we test whether the effect of drinking on the persistence of negative affect is stronger for men or women. That is, is there evidence of a stronger negative reinforcement process for men or women? Given the inconsistencies in the literature we do not make a directional hypothesis for this effect. Finally, we test associations between rumination and alcohol dependence symptoms at baseline, and whether the within-person effects of drinking on negative affect vary as a function of rumination and gender.

Method

Participants

Participants were 274 undergraduate college students at two Midwest universities. The sample ranged from 18 to 27 years of age (M = 19.88, SD = 1.37) and was 56% female and was 93% White, 1% African American, 1% Asian, 1% Native American, 1% Native Hawaiian/Pacific Islander, and 3% other race or did not respond; 3% of the sample were Hispanic. The sample demographic characteristics are comparable with the university populations, which have approximately 60% women and 6–14% ethnic minorities. Recruitment was conducted through e-mail notices and advertisements in local media. Three

other articles have been published from portions of this dataset as part of a larger study investigating factors associated with heavy drinking (Simons, Wills, Emery, & Marks, 2015; Simons, Wills, Emery, & Spelman, 2015; Simons et al., 2014).

Procedure

Undergraduates who drank at least moderately (i.e., ≥12 standard drinks per week for women and ≥16 standard drinks per week for men; Sanchez-Craig, Wilkinson, & Davila, 1995) were invited to participate in the ESM study. Invited participants provided informed consent for the study, completed a set of baseline questionnaires, and were then trained in the use of the handheld computer. Palm handhelds were programmed with Purdue Momentary Assessment Tool (PMAT) software (Weiss, Beal, Lucy, & MacDermid, 2004), modified by Joel Swendsen and CNRS, France. The program generated prompts for participants to complete brief ~2-minute assessments at random times within 2-hour blocks between 10:00 a.m. and 12:00 midnight. Random assessments items inquired about participants' behavior for the past 30 minutes. Participants were asked to answer questionnaires during waking hours and could turn the machine off when they would be sleeping or otherwise did not wish to be disturbed (e.g., taking an exam). The validity of the proposed sampling design is supported by previous research (Armeli et al., 2003; Simons et al., 2010; Simons et al., 2005b; Swendsen et al., 2000). For a further description of the study's procedure see (Simons et al., 2014). The study was a burst design in which participants carried the handheld computer for 1 to 2 weeks during two periods over 3 semesters, resulting in 6 measurement bursts totaling 49 days of data. Individuals received $20 for the baseline assessment and then received payments contingent on response rates during each burst (up to $25/week). Participants completing all 6 bursts received a $50 bonus. All procedures were approved by the IRBs at the two universities.

Experience Sampling Measures.

Negative affect.—Situational negative affect (i.e., negative affect in the previous 30 minutes) was assessed by items from subscales of the PANAS-X (Watson & Clark, 1994) and Larsen and Diener's affect circumplex model (Larsen & Diener, 1992). Cronbach's alphas were calculated for one signal per person on one day in each burst. We report the mean of the six estimates. Negative affect (α = .80) was assessed by 9-items representing three dimensions: sadness (3 items: sad, blue, downhearted), anxiety (3 items: nervous, jittery, anxious), and hostility (3 items: angry, hostile, irritable). Items were rated on 7-point scales ranging from 1 = *not at all* to 7 = *extremely*. Previous research supports the internal consistency and criterion validity of these and comparable affect scales assessed by experience sampling (Armeli et al., 2003; Csikszentmihalyi & Larson, 1992; Simons et al., 2005b). This measure was reported up to 8 times per day.

Alcohol consumption.—Alcohol consumption was assessed by *in situ* assessments of drinks. Participants reported the number of drinks they consumed over the past 30 minutes on an 8-point scale (0 – 7 or more drinks). Definitions of standard drinks were provided during the palmtop training. In the current model, drinking was a dichotomous variable signifying the presence or absence of drinking at the signal. This measure was reported up to 8 times per day.

Baseline Measures

Rumination.—Dispositional rumination tendency was assessed at baseline with a 6-item composite inventory on dealing with sadness and anger, included in the Sadness and Anger Management Scale (Shipman, Zeman, Penza, & Champion, 2000; Zeman, Shipman, & Penza-Clyve, 2001). Three items assessed sadness rumination. Example item, "When people do something to make me sad, I don't forget about it." Three items assessed anger rumination. Example item "I often find myself thinking about things that have made me angry." These were scored on 5-point scale ranging from "not at all true" to "Very true." Previous research shows that this adapted inventory has adequate internal consistency and convergent validity with other measures of poor emotional control (Wills et al., 2013; Wills, Pokhrel, Morehouse, & Fenster, 2011; Wills, Walker, Mendoza, & Ainette, 2006). Cronbach $\alpha = .83$ in the current sample.

Alcohol dependence symptoms.—The Alcohol Dependence Scale (Skinner & Allen, 1982; Skinner & Horn, 1984) was used to assess symptoms of alcohol dependence syndrome. The scale contains 25 items assessing dyscontrolled drinking ($\alpha = .80$), and exhibits good convergent validity with other indicators of AUD (Doyle & Donovan, 2009). This scale was used to test whether rumination is associated with symptoms of alcohol use disorder.

Results

Attrition and Response Analysis

Of the 274 participants enrolled in the study, 11 were dropped because of poor compliance with the protocol, resulting in an analytic sample of 263. The participants in the analysis sample completed 79% of the random prompts, which is line with data from other experience sampling studies (cf. Piasecki et al., 2011; Shiffman, 2009; Stone & Shiffman, 2002). An average of 268.98 ($SD = 162.26$; Median = 376, range 7 – 562) days elapsed between participants' first and last assessments. On average, the 263 participants provided daily data on 74% of the targeted 49 assessment days. The mean number of assessment days per participant was 36.36 ($SD = 13.91$). Number of assessment days was not correlated with gender or rumination, or mean negative affect during the study ($r's < .03$). The number of assessment days was inversely associated with proportion of signals (i.e., random prompts) drinking was reported ($r = -.20$, $p < .01$). The average time between assessments was 1.69 hours ($SD = 0.80$). We set the maximum allowable time gap to be 4 hours, so all successive assessments are within a day.

Descriptive Statistics

Table 1 reports the means and between-person correlations. Men drank on a higher proportion of assessments and reported less rumination and negative affect relative to women. Rumination score at baseline and mean negative affect reported across *in situ* assessments were moderately correlated. Negative affect, but not rumination, was positively correlated with the proportion of random assessments (i.e., signals) when the person reported drinking. Consistent with expectation, rumination was moderately positively correlated with scores on the Alcohol Dependence Scale at baseline.

Multilevel Analysis

The core of the multilevel model was an autoregression of negative affect (i.e., negative affect at time *t* regressed on negative affect at time *t*-1). The autoregression of negative affect across successive assessments operationalizes the persistence of negative affect through time, otherwise referred to as emotional inertia (Koval et al., 2012). Level 1 (i.e., signal) predictors test whether, for example, drinking at *t*-1 predicts subsequent level of negative affect at time *t* over and above the effect of previous negative affect (i.e., negative affect (NA) *t*-1). The interaction between $drinking_{t-1}$ and NA_{t-1} tests whether drinking reduces the expected association between NA_{t-1} and NA_t. That is, does drinking disrupt the persistence of negative affect across time resulting in reduced distress? The cross-level interactions between baseline rumination or gender and NA_{t-1} test whether the persistence of negative affect from *t*-1 to *t* varies as a function of rumination or gender, respectively The 3-way cross-level interaction between $drinking_{t-1}$, $NA_{t-1,}$ and rumination then tests whether the effect of drinking on persistence of negative affect varies as a function of ruminative cognitive styles.. Similarly, the interaction between $drinking_{t-1}$, NA_{t-1} , and gender tests if the effect of drinking on the persistence of negative affect varies as a function of gender. The interaction between gender, rumination, and NA_{t-1} tests whether the effect of ruminative cognitive style on the persistence of negative affect varies as a function of gender. Finally, the 4-way interaction between gender, rumination, $drinking_{t-1,}$ and NA_{t-1} can be conceptualized as whether men and women differ in the extent to which effects of drinking on persistence of negative affect vary as a function of ruminative cognitive style. Given that the effects of drinking or ruminative cognitive styles on the persistence of negative affective states may vary depending on the severity of negative arousal, we include a quadratic effect in the model and corresponding interaction terms discussed previously. In addition, day of the week (at the daily level) and elapsed days (at the person and daily level) were included in the model as covariates. We tested for a potential quadratic effect of elapsed time, but it was not significant and hence not included.

The model included 43111 observations. The data had a four level structure with signals (Level 1) nested within days (Level 2), nested within measurement burst (Level 3), nested within person (Level 4). We modeled random intercepts at the person, burst, and day level to allow for variation in mean levels of negative affect across time and person. In addition, we tested for potential random slopes. This resulted in modeling a random slope for lagged negative affect and elapsed date at the person level and a random lagged negative affect slope at the burst level. Drinking and negative affect were measured at the signal level. Drinking was a dichotomous indicator, presence or absence of drinking at time *t*-1. Continuous level 1 variables (i.e., negative affect, elapsed date) were centered at the person mean and continuous level 2 variables (e.g., rumination, time in the study (subject mean of elapsed date), subject mean drinking (proportion of drinking signals across assessments)) were centered at the grand mean. Dichotomous variables were not centered. To maintain focus on within-person effects of the level 1 drinking variable, we include the subject mean at level 2 (Enders & Tofighi, 2007). Residuals followed an AR 1 autoregressive structure. All analyses were conducted using Stata 13 (StataCorp, 2013). The initial model included a 5-way NA_{t-1} x NA_{t-1} x $Drinking_{t-1}$ x Rumination x Gender interaction. This was not significant ($p = .852$) and hence was dropped and the model re-estimated. Examining the

higher order interactions revealed that the NA_{t-1} x NA_{t-1} x $Drinking_{t-1}$ x Rumination was also not significant ($p = .665$) and hence was dropped. This resulted in a more parsimonious model including 3 significant 4-way interactions (and their respective lower order components). Hence the model contains the following fixed effects:

At Level 1 (signal)

$$\text{Negative affect (NA)}_{tdbi} = \beta 0 + \beta 1(NA_{t-1dbi}) + \beta 2\,(NA_{t-1dbi} * NA_{t-1dbi}) + \beta 3(Drinking_{t-1dbi}) + \beta 4(Drinking_{t-1dbi} * NA_{t-1dbi}) + \beta 5(Drinking_{t-1dbi} * NA_{t-1dbi} * NA_{t-1dbi}) +$$

Level 2 (day)

$$\beta 6\ (\text{Elapsed date}_{dbi}) + \beta 7\ (\text{Monday}_{dbi}) + \beta 8(\text{Tuesday}_{dbi}) + \beta 9(\text{Wednesday}_{dbi}) + \beta 10\ (\text{Thursday}_{dbi}) + \beta 11(\text{Friday}_{dbi}) + \beta 12(\text{Saturday}_{dbi}) +$$

Level 3 (burst) No level 3 fixed effects

Level 4 (person)

$$\beta 13(\text{Gender}_i) + \beta 14(\text{Rumination}_i) + \beta 15(\text{Gender}_i * \text{Rumination}_i) + \beta 16(\text{Subject mean elapsed date}_i) + \beta 17(\text{Subject mean drinking}_i) +$$

Cross-level interactions

$$\beta 18(\text{Gender}_i * NA_{t-1d}\beta_i) + \beta 19(\text{Gender}_i * NA_{t-1dbi} * NA_{t-1dbi}) + \beta 20(\text{Gender}_i * Drinking_{t-1dbi})$$

$$+ \beta 21(\text{Gender}_i * NA_{t-1dbi} * Drinking_{t-1dbi}) + \beta 22\ (\text{Gender}_i * NA_{t-1dbi} * NA_{t-1dbi} * Drinking_{t-1dbi})$$

$$+ \beta 23(\text{Rumination}_i * NA_{t-1dbi}) + \beta 24(\text{Rumination}_i * NA_{t-1dbi} * NA_{t-1dbi}) + \beta 25(\text{Rumination}_i * Drinking_{t-1dbi}) + \beta 26(\text{Rumination}_i * NA_{t-1dbi} * Drinking_{t-1dbi}) + \beta 27(\text{Rumination}_i * \text{Gender}_i * NA_{t-1dbi}) + \beta 28(\text{Rumination}_i * \text{Gender}_i * NA_{t-1dbi} * NA_{t-1dbi}) + \beta 29(\text{Rumination}_i * \text{Gender}_i * Drinking_{t-1dbi}) + \beta 30(\text{Rumination}_i * \text{Gender}_i * NA_{t-1dbi} * Drinking_{t-1dbi})$$

In addition to the fixed effects, there are several random effects estimated. The model has a random residual component res_{tdbi} at Level 1. The negative $affect_t$ intercept ($\beta 0$) has random variation at Level 2 (day, $u0_{dbi}$), Level 3 (burst, $r0_{bi}$), and Level 4 (person, $e0_i$). The negative $affect_{t-1}$ slope ($\beta 1$) has random variation at level 3 (burst, $r1_{bi}$), and Level 4 (person, $e1_i$). Finally, the elapsed date slope ($\beta 5$) has random variation at Level 4 (person, $e5_i$).

Results are presented in Table 2. As expected, the rumination score from baseline was associated with higher mean levels of negative affect over the course of the study; and there was a clear effect of negative affect on subsequent negative affect assessments (i.e., autocorrelation). There was a significant quadratic NA_{t-1} effect, signifying a decelerating curve indicating that periods of heightened negative affect tended to start to return to baseline. The association between level of negative affect and emotional inertia is evident in

the person-level random effects (see Table 3), where the correlation between the random NA_{t-1} slope and the NA_t intercept was $r = .49$, 95% CI [.23, .68]. This indicates that individuals with higher mean levels of negative affect exhibit stronger associations between negative affect across successive time points (i.e., a stronger autocorrelation, or persistence of negative affective states). In addition, there was a strong correlation between the burst-level random effects, where the correlation between the random NA_{t-1} slope and the NA_t intercept was $r = .57$, 95% CI [.44, .67]. This suggests that periods of heightened negative affect are accompanied by stronger consistency of negative affect across time.

The average marginal effect of rumination on the linear NA_{t-1} effect varied as a function of gender ($b = -0.05$, $p = .026$). In addition, there was a significant effect of gender and rumination on the quadratic NA_{t-1} effect ($b = 0.03$, $p = .001$). On average, drinking was associated with decreased negative affect for women, but not men. There was also a significant interaction between gender, $drinking_{t-1}$, and the NA_{t-1} quadratic effect ($b = 0.07$, $p < .001$). Finally, there was a significant interaction between gender, rumination, $drinking_{t-1}$, and NA_{t-1} ($b = -0.07$, $p = .039$). Hence, the persistence of negative affect across time varied as a function of gender, rumination, and drinking.

The interaction effects are depicted in Figure 1. The figure depicts the association between NA_{t-1} (x-axis) and NA_t (y-axis) as a function of: (A) drinking at t-1, (B) gender, and (C) between-person differences in ruminative cognitive style. Steeper slopes signify a stronger autocorrelation between NA assessments across time. In addition, differences in expected values of NA_t for a given level of NA at t-1 can be seen as a function of levels of the moderators. As shown in the figure, drinking at t-1 had little effect on subsequent negative affect for men. In contrast, drinking at t-1 was associated with decreased negative affect at time t for women and this effect became increasingly pronounced as t-1 negative affect increased. This pattern suggests that drinking is negatively reinforced for women by reduction in subsequent negative affect. The effect of drinking on the negative affect autocorrelation indicates that drinking can attenuate emotional inertia, especially when negative affect is elevated among women. For example, when NA_{t-1} was moderate (i.e., a 4 on the 7-point scale), the linear $Drinking_{t-1}$ x NA_{t-1} interaction was $b = -0.37$, $p < .001$ for women and $b = -0.001$, $p = .980$ for men, indicating that the consistency of NA across successive assessments decreased when women were distressed and consumed alcohol.

When not drinking, women's negative affect led to negative affect and the effects of rumination were fairly consistent across levels of negative affect. In contrast, men reporting low levels of rumination exhibited a steeper return to baseline when experiencing heightened negative affect, irrespective of drinking status. Rumination was associated with diminishing effects of drinking on negative affect among women. When women were moderately distressed, the effect of drinking on negative affect decreased from $b = -0.63$, $p < .001$ to -0.45, $p < .001$ as rumination increased from $M - 1$ SD to $M + 1$ SD. In contrast, the effect of drinking on negative affect for men was insignificant for both those high ($b = 0.07$, $p = .406$) and low ($b = -0.09$, $p = .348$) in rumination.

Discussion

In the past decade, research on the temporal dynamics of affective experience has advanced considerably due to combined advances in technology (e.g., smartphones) and increasing accessibility of sophisticated data analytic approaches. Research has shed new light on the affective dynamics underlying depression (Koval et al., 2012; Koval et al., 2013), borderline personality disorder (Jahng et al., 2011), and alcohol use (Simons et al., 2014). Results of the current study add to existing knowledge on connections between rumination, negative affect, alcohol use, and emotional inertia, highlighting gender differences in these processes. Findings are discussed in the following sections.

Rumination and emotional inertia

As hypothesized, rumination at baseline was associated with higher negative affect over the follow-up period. However, the hypothesized effects of rumination on the persistence of negative affect across successive assessments were inconsistent and varied as a function of gender, drinking, and level of negative affect. As negative affect increased, women continued to experience strong associations between successive negative affect assessments, with rumination predicting heightened negative affect at each level. In contrast, for men, heightened negative affect was often followed by a return to baseline levels, and this was most pronounced for those reporting low tendency to ruminate. The pattern of relationships in Figure 1 is, perhaps, illustrative of the increased risk for depression among women (e.g., Kessler et al., 2007; Kuehner, 2003; Piccinelli & Wilkinson, 2000; Weissman et al., 1996). The effects are complex but the overall pattern is consistent with previous research suggesting that rumination may be a cognitive mechanism accounting for some of the increased risk for depression observed among women (e.g., Butler & Nolen-Hoeksema, 1994; Johnson & Whisman, 2013; Nolen-Hoeksema, 2012). Furthermore, controlling for the other variables, rumination exhibited a somewhat stronger effect on level of negative affect for women than men. However, as is apparent in the Figure, this pattern changes at times of greatest distress.

Emotional inertia may be conceptualized as the strength of associations between affect across time (Fairbairn & Sayette, 2013; Green et al., 1998; Kuppens et al., 2010). The random effects show a strong association between the level of negative affect (intercept) and the random autoregressive slope at the level of both the person and burst. That is, individuals who experience greater mean levels of negative affect exhibit greater autocorrelation of negative affect across time. Similarly, within individual, weeks characterized by heightened distress are associated with stronger associations between negative affect assessments moment to moment. This is consistent with findings from previous research in the laboratory as well as experience sampling (Green et al., 1998; Koval et al., 2013), that is, depression is associated with greater emotional inertia. Koval et al., (2013) examined the role of both affective lability and emotional inertia and found somewhat inconsistent findings in their laboratory and field research. Although we did not control for lability in this study, the results here, with a larger sample than previous studies, suggest that negative emotional inertia (i.e., strength of autocorrelation across time) has a substantial association with level of negative affect and hence risk for depression. Interestingly, the data analysis demonstrates

this effect at both the level of the person, potentially suggesting vulnerability, as well as the level of the measurement burst. The finding at the burst level is consistent with the perspective that peaks of negative affect may tend to be self-perpetuating, as they may signal importance of events. When an individual is having a "bad week," they may become absorbed in focusing on the distress and its cause (Simons & Gaher, 2005), which is observed in stronger consistency in affect across time. This is in contrast to a "good week" where spikes in negative affect may reflect fleeting difficulties and have little bearing on successive emotion as the person remains mindful of the ongoing environment.

These effects of rumination and emotional inertia are hypothesized to increase risk for alcohol use disorder. This premise is supported by three findings. First, rumination was positively associated with alcohol dependence symptoms at baseline. Second, there was evidence that the effect of drinking on emotional inertia varied as a function of rumination. This relationship was complex and varied as a function of gender. For women, but not men, the effect of drinking on emotional inertia was attenuated among those who tended to ruminate more. This pattern could promote increased alcohol consumption in an attempt to achieve the desired effect, underlying the observed association between rumination and alcohol dependence symptoms. Third, the findings indicate that alcohol can disrupt emotional inertia, highlighting the within-person mechanism contributing to the increased risk of alcohol use disorder associated with rumination. Effects of drinking on emotional inertia are discussed next.

Drinking, negative reinforcement, and emotional inertia

The results add to the literature on associations between negative affect and alcohol use by examining the often-overlooked part of negative reinforcement models. That is, whether alcohol consumption in the natural environment is associated with subsequent reductions in negative affect. As is often the case in this area of research, the answer is sometimes, for some people. The results indicate that consuming alcohol was most clearly associated with reductions in negative affect when individuals were experiencing greater distress. Multilevel models are often complex and analyses on associations between negative affect and drinking are rarely structured in such a way as to test nonlinear associations between negative affect and drinking. It is not uncommon for experience sampling studies to report null, or at least modest associations between negative affect and drinking (Hussong, 2007; Mohr, Arpin, & McCabe, 2015; Swendsen et al., 2000). Although the current study examines changes in negative affect rather than changes in drinking as the outcome, the results suggest that greater attention may need to be given to potential non-linear associations between drinking and NA, with the most robust associations occurring when negative affect is elevated. In addition, the results highlight the potential importance of gender as a moderator, as significant effects were observed for women but not men. Consistent with previous research this suggests that negative reinforcement processes may be particularly important for the etiology of alcohol use disorder in women (Hussong, 2007; Lee, Kosterman, McCarty, Hill, & Hawkins, 2012; Lehavot et al., 2014). However, further research on gender effects is needed given the inconsistent findings on this in the literature (cf. Nolen-Hoeksema & Hilt, 2006; Simons et al., 2005b; Witkiewitz & Villarroel, 2009).

Recent laboratory research has indicated that alcohol consumption disrupts emotional inertia, making individuals more responsive to the moment-to-moment stimuli in the social environment (Fairbairn & Sayette, 2013). Whereas rumination was shown to marginally increase emotional inertia in the current data, alcohol consumption served to disrupt emotional inertia, attenuating the autocorrelation of negative affect across time for women. This highlights a potential important aspect of the role of alcohol and affect regulation. The ability of alcohol to disrupt an entrenched pattern of rumination and negative arousal, freeing the person, if only for a while, to experience the external environment and to potentially benefit from positive stimuli in the social environment may be highly reinforcing. Indeed, the idea that alcohol intoxication affects mood by altering attention to salient environmental stimuli, is a core feature of the attention allocation model (Fairbairn & Sayette, 2013; Steele & Josephs, 1988), and is posited to account for the wide ranging effects of alcohol from “crying alone in one’s beer” to being “happy, relaxed, and smiling”

Limitations

Several limitations should be noted. First, although much of the rationale for the proposed analyses is based on vulnerability to depression, our study does not include depression as an outcome. Rather, we focus on level and autocorrelation of negative affectivity. Our measure of rumination was relatively simple and does not capture the multidimensional nature of rumination (Smith & Alloy, 2009). Nonetheless, the pattern of results provides strong evidence for the validity of the measure. Although heavy drinking young adults are a unique population. Further research is needed to determine if the results generalize to other populations that vary in developmental stage, drinking norms, or clinical severity. Finally, negative reinforcement of alcohol use inherently involves both the effects of negative affect on drinking as well as effects of drinking on negative affect. Here, we focus on the latter part of the equation.

Summary

Though it may come as no surprise to the informed reader, the results suggest that rumination perpetuates negative affect and alcohol can provide quick reductions in negative affect. These generalities aside, the results provide an intriguing analysis of the time course of negative affect. During periods of heightened affect, negative affect begets negative affect, emotional experience sinks into inertia. In contrast, during periods of well-being negative affect is changeable moment-to-moment, as the individual is ostensibly engaged in the breadth of experience in the natural environment. The time course of negative affect for women is consistent with the epidemiological data indicating risk for depressive disorders. This vulnerability appears, in part, tied to the effects of rumination. Men in this sample appeared to have negative emotional experiences that were fleeting and less likely to be sustained over time. When men did experience heighted negative affect, rumination had a more pronounced effect with only those endorsing elevated levels of rumination showing a pattern of sustained negative affectivity. The findings regarding alcohol also emphasize the increased risk among women in this sample for drinking for negative reinforcement. The results not only indicate that rumination is correlated with symptoms of alcohol dependence, but illuminate the underlying risk mechanism at the within-person level. The findings suggest that alcohol may disrupt emotional inertia, freeing the individual to experience the

emotional richness of the moment, a potentially highly attractive immediate effect with the consequent liability of contributing to the development of problematic alcohol use patterns.

Acknowledgments

This research was supported by National Institute on Alcohol Abuse and Alcoholism grant R01AA017433 (JSS). Preparation of the manuscript was supported in part by R01AA020519 (JSS) and by National Institute on Drug Abuse grant R01 DA021856 and National Cancer Institute grant P30 CA071789 (TAW).

References

Alloy LB, & Robinson MS (2003). Negative Cognitive Styles and Stress-Reactive Rumination Interact to Predict Depression: A Prospective Study. Cognitive Therapy & Research, 27, 275–291.

Annis HM, Sklar SM, & Moser AE (1998). Gender in relation to relapse crisis situations, coping, and outcome among treated alcoholics. Addictive Behaviors, 23, 127–131. 10.1016/S0306-4603(97)00024-5 [PubMed: 9468752]

Armeli S, Tennen H, Todd M, Carney MA, Mohr C, Affleck G, & Hromi A (2003). A Daily Process Examination of the Stress-Response Dampening Effects of Alcohol Consumption. Psychology of Addictive Behaviors, 17, 266–276. 10.1037/0893-164X.17.4.266 [PubMed: 14640822]

Armeli S, Todd M, Conner TS, & Tennen H (2008). Drinking to Cope With Negative Moods and the Immediacy of Drinking Within the Weekly Cycle Among College Students. Journal of Studies on Alcohol & Drugs, 69, 313–322. [PubMed: 18299774]

Baker TB, Piper ME, McCarthy DE, Majeskie MR, & Fiore MC (2004). Addiction Motivation Reformulated: An Affective Processing Model of Negative Reinforcement. Psychological Review, 111, 33–51. 10.1037/0033-295X.111.1.33 [PubMed: 14756584]

Blagden JC, & Craske MG (1996). Effects of active and passive rumination and distraction: A pilot replication with anxious mood. Journal of Anxiety Disorders, 10, 243–252. 10.1016/0887-6185(96)00009-6

Bloomfield K, Gmel G, & Wilsnack S (2006). Introduction to special issue 'Gender, Culture and Alcohol Problems: a Multi-national Study'. Alcohol And Alcoholism (Oxford, Oxfordshire). Supplement, 41, i3–i7.

Brans K, Koval P, Verduyn P, Lim YL, & Kuppens P (2013). The regulation of negative and positive affect in daily life. Emotion, 13, 926–939. 10.1037/a0032400 [PubMed: 23731436]

Brozovich F, & Heimberg RG (2008). An analysis of post-event processing in social anxiety disorder. Clinical Psychology Review, 28, 891–903. 10.1016/j.cpr.2008.01.002 [PubMed: 18294745]

Butler LD, & Nolen-Hoeksema S (1994). Gender Differences in Responses to Depressed Mood in a College Sample. Sex Roles, 30, 331–346.

Cheetham A, Allen NB, Yucel M, & Lubman DI (2010). The role of affective dysregulation in drug addiction. Clinical Psychology Review, 30, 621–634. 10.1016/j.cpr.2010.04.005 [PubMed: 20546986]

Chen J, Rapee RM, & Abbott MJ (2013). Mediators of the relationship between social anxiety and post-event rumination. Journal of Anxiety Disorders, 27, 1–8. 10.1016/j.janxdis.2012.10.008 [PubMed: 23247198]

Ciesla JA, & Roberts JE (2007). Rumination, negative cognition, and their interactive effects on depressed mood. Emotion, 7, 555–565. 10.1037/1528-3542.7.3.555 [PubMed: 17683212]

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

Cox WM, & Klinger E (1990). Incentive motivation, affective change, and alcohol use: A model. In Cox WM (Ed.), Why people drink: Parameters of alcohol as a reinforcer. New York: Gardner press, Inc.

Cox WM, & Klinger E (2002). Motivational structure: Relationships with substance use and processes of change. Addict Behav, 27, 925–940. [PubMed: 12369476]

Csikszentmihalyi M, & Larson R (1992). Validity and reliability of the Experience Sampling Method. In deVries MW(Ed.), The experience of psychopathology: Investigating mental disorders in their natural settings. (pp. 43–57). New York, NY US: Cambridge University Press.

Curtin JJ, Patrick CJ, Lang AR, Cacioppo JT, & Birbaumer N (2001). Alcohol Affects Emotion Through Cognition. Psychological Science (Wiley-Blackwell), 12, 527.

Donohue KF, Curtin JJ, Patrick CJ, & Lang AR (2007). Intoxication level and emotional response. Emotion, 7, 103–112. 10.1037/1528-3542.7.1.103 [PubMed: 17352567]

Doyle SR, & Donovan DM (2009). A Validation Study of the Alcohol Dependence Scale. Journal of Studies on Alcohol and Drugs, 70, 689–699. [PubMed: 19737493]

Eaton NR, Keyes KM, Krueger RF, Balsis S, Skodol AE, Markon KE, … Hasin DS (2012). An invariant dimensional liability model of gender differences in mental disorder prevalence: Evidence from a national sample. Journal of Abnormal Psychology, 121, 282–288. 10.1037/a0024780 [PubMed: 21842958]

Ebner-Priemer UW, Eid M, Kleindienst N, Stabenow S, & Trull TJ (2009). Analytic strategies for understanding affective (in)stability and other dynamic processes in psychopathology. Journal of Abnormal Psychology, 118, 195–202. 10.1037/a0014868 [PubMed: 19222325]

Ehring T, Frank S, & Ehlers A (2008). The Role of Rumination and Reduced Concreteness in the Maintenance of Posttraumatic Stress Disorder and Depression Following Trauma. Cognitive Therapy & Research, 32, 488–506. 10.1007/s10608-006-9089-7 [PubMed: 20694036]

Enders CK, & Tofighi D (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. Psychological Methods, 12, 121–138. 10.1037/1082-989X.12.2.121 [PubMed: 17563168]

Fairbairn CE, & Sayette MA (2013). The effect of alcohol on emotional inertia: A test of alcohol myopia. Journal of Abnormal Psychology, 122, 770–781. 10.1037/a0032980 [PubMed: 24016015]

Foster DW, Young CM, Steers M-L, Quist MC, Bryan JL, & Neighbors C (2014). Tears in your beer: Gender differences in coping drinking motives, depressive symptoms and drinking. International Journal Of Mental Health And Addiction, 12, 730–746. [PubMed: 25525419]

Fresco DM, Frankel AN, Mennin DS, Turk CL, & Heimberg RG (2002). Distinct and Overlapping Features of Rumination and Worry: The Relationship of Cognitive Production to Negative Affective States. Cognitive Therapy & Research, 26, 179–188.

Greeley J, & Oei T (1999). Alcohol and tension reduction. In Leonard KE & Blane HT (Eds.), Psychological theories of drinking and alcoholism (Vol. 2, pp. 14–53). New York, NY: Guilford Press.

Green P, Hillis S, & Suls J (1998). Emotional Reactivity to Everyday Problems, Affective Inertia, and Neuroticism. Personality and Social Psychology Bulletin, 24, 127.

Hussong AM (2007). Predictors of drinking immediacy following daily sadness: An application of survival analysis to experience sampling data. Addictive Behaviors, 32, 1054–1065. [PubMed: 16934413]

Hussong AM, Galloway CA, & Feagans LA (2005). Coping Motives as a Moderator of Daily Mood-Drinking Covariation. Journal of Studies on Alcohol, 66, 344–353. [PubMed: 16047523]

Hussong AM, Hicks RE, Levy SA, & Curran PJ (2001). Specifying the relations between affect and heavy alcohol use among young adults. Journal of Abnormal Psychology, 110, 449–461. [PubMed: 11502088]

Jahng S, Solhan MB, Tomko RL, Wood PK, Piasecki TM, & Trull TJ (2011). Affect and alcohol use: an ecological momentary assessment study of outpatients with borderline personality disorder. Journal of Abnormal Psychology, 120, 572. [PubMed: 21823761]

Johnson DP, & Whisman MA (2013). Gender differences in rumination: A meta-analysis. Personality and Individual Differences, 55, 367–374. 10.1016/j.paid.2013.03.019 [PubMed: 24089583]

Jose PE, & Brown I (2008). When does the gender difference in rumination begin? Gender and age differences in the use of rumination by adolescents. Journal of Youth and Adolescence, 37, 180–192. 10.1007/s10964-006-9166-y

Just N, & Alloy LB (1997). The response styles theory of depression: Tests and an extension of the theory. Journal of Abnormal Psychology, 106, 221–229. 10.1037/0021-843X.106.2.221 [PubMed: 9131842]

Kashdan TB, Feldman-Barrett L, & McKnight PE (2015). Unpacking Emotion Differentiation: Transforming Unpleasant Experience by Perceiving Distinctions in Negativity. Current Directions in Psychological Science (Sage Publications Inc.), 24, 10–16. 10.1177/0963721414550708

Kassel J, & Veilleux J (2010). Introduction: the complex interplay between substance abuse and emotion. Substance abuse and emotion. Washington, DC: American Psychological Association, 3–12.

Kessler RC, Angermeyer M, Anthony JC, de Graaf R, Demyttenaere K, Gasquet I, . . . Haro JM (2007). Lifetime prevalence and age-of-onset distributions of mental disorders in the World Health Organization's World Mental Health Survey Initiative. World Psychiatry, 6, 168. [PubMed: 18188442]

Khantzian EJ (1985). The self-medication hypothesis of addictive disorders: Focus on heroin and cocaine dependence. The American Journal of Psychiatry, 142, 1259–1264. [PubMed: 3904487]

Khantzian EJ (1997). The self-medication hypothesis of substance use disorders: a reconsideration and recent applications. Harvard Review of Psychiatry, 4, 231–244. [PubMed: 9385000]

Koob GF (2013). Addiction is a Reward Deficit and Stress Surfeit Disorder. Front Psychiatry, 4, 72 10.3389/fpsyt.2013.00072 [PubMed: 23914176]

Koval P, Kuppens P, Allen NB, & Sheeber L (2012). Getting stuck in depression: The roles of rumination and emotional inertia. Cognition & Emotion, 26, 1412–1427. 10.1080/02699931.2012.667392 [PubMed: 22671768]

Koval P, Pe ML, Meers K, & Kuppens P (2013). Affect dynamics in relation to depressive symptoms: Variable, unstable or inert? Emotion, 13, 1132. [PubMed: 23914765]

Kuehner C (2003). Gender differences in unipolar depression: an update of epidemiological findings and possible explanations. Acta Psychiatrica Scandinavica, 108, 163–174. 10.1034/j.1600-0447.2003.00204.x [PubMed: 12890270]

Kuehner C, & Weber I (1999). Responses to depression in unipolar depressed patients: An investigation of Nolen-Hoeksema's response styles theory. Psychological Medicine, 29, 1323–1333. 10.1017/S0033291799001282 [PubMed: 10616938]

Kuntsche E, Knibbe R, Gmel G, & Engels R (2006). Who drinks and why? A review of socio-demographic, personality, and contextual issues behind the drinking motives in young people. Addictive Behaviors, 31, 1844–1857. 10.1016/j.addbeh.2005.12.028 [PubMed: 16460883]

Kuppens P, Allen NB, & Sheeber LB (2010). Emotional Inertia and Psychological Maladjustment. Psychological Science, 21, 984–991. 10.1177/0956797610372634 [PubMed: 20501521]

Kuppens P, Sheeber LB, Yap MBH, Whittle S, Simmons JG, & Allen NB (2012). Emotional inertia prospectively predicts the onset of depressive disorder in adolescence. Emotion, 12, 283–289. 10.1037/a0025046 [PubMed: 21988744]

LaBrie JW, Ehret PJ, Hummer JF, & Prenovost K (2012). Poor adjustment to college life mediates the relationship between drinking motives and alcohol consequences: A look at college adjustment, drinking motives, and drinking outcomes. Addictive Behaviors, 37, 379–386. 10.1016/j.addbeh.2011.11.018 [PubMed: 22177614]

Larsen RJ, & Diener E (1992). Promises and problems with the circumplex model of emotion. In Clark MS(Ed.), Emotion. (pp. 25–59). Thousand Oaks, CA US: Sage Publications, Inc.

Lee JO, Kosterman R, McCarty CA, Hill KG, & Hawkins JD (2012). Can patterns of alcohol use disorder in young adulthood help explain gender differences in depression? Comprehensive Psychiatry, 53, 1071–1077. 10.1016/j.comppsych.2012.03.012 [PubMed: 22521329]

Lehavot K, Stappenbeck CA, Luterek JA, Kaysen D, & Simpson TL (2014). Gender differences in relationships among PTSD severity, drinking motives, and alcohol use in a comorbid alcohol dependence and PTSD sample. Psychology of Addictive Behaviors, 28, 42–52. 10.1037/a0032266 [PubMed: 23647151]

Little HJ (2000). Alcohol as a stimulant drug. Addiction, 95, 1751–1753. [PubMed: 11177488]

Lyubomirsky S, & Nolen-Hoeksema S (1995). Effects of self-focused rumination on negative thinking and interpersonal problem solving. Journal of Personality and Social Psychology, 69, 176–190. 10.1037/0022-3514.69.1.176 [PubMed: 7643299]

Mayou RA, Ehlers A, & Bryant B (2002). Posttraumatic stress disorder after motor vehicle accidents: 3-year follow-up of a prospective longitudinal study. Behaviour Research and Therapy, 40, 665. [PubMed: 12051485]

McCarthy DE, Curtin JJ, Piper ME, & Baker TB (2010). Negative reinforcement: Possible clinical implications of an integrative model. In Kassel JD(Ed.), Substance abuse and emotion. (pp. 15–42). Washington, DC US: American Psychological Association.

McEvoy PM, Watson H, Watkins ER, & Nathan P (2013). The relationship between worry, rumination, and comorbidity: Evidence for repetitive negative thinking as a transdiagnostic construct. Journal of Affective Disorders, 151, 313–320. 10.1016/j.jad.2013.06.014 [PubMed: 23866301]

McLaughlin KA, Borkovec TD, & Sibrava NJ (2007). The Effects of Worry and Rumination on Affect States and Cognitive Activity. Behavior Therapy, 38, 23–38. [PubMed: 17292692]

Mellings TMB, & Alden LE (2000). Cognitive processes in social anxiety: The effects of self-focus, rumination and anticipatory processing. Behaviour Research and Therapy, 38, 243–257. 10.1016/S0005-7967(99)00040-6 [PubMed: 10665158]

Moberly NJ, & Watkins ER (2008a). Ruminative self-focus and negative affect: An experience sampling study. Journal of Abnormal Psychology, 117, 314–323. 10.1037/0021-843X.117.2.314 [PubMed: 18489207]

Moberly NJ, & Watkins ER (2008b). Ruminative self-focus, negative life events, and negative affect. Behaviour Research and Therapy, 46, 1034–1039. 10.1016/j.brat.2008.06.004 [PubMed: 18684437]

Mohr C, Armeli S, Tennen H, & Todd M (2010). The complexities of modeling mood-drinking relationships: Lessons learned from daily process research. In Kassel JD& Kassel JD (Eds.), Substance abuse and emotion. (pp. 189–216). Washington, DC US: American Psychological Association.

Mohr CD, Arpin S, & McCabe CT (2015). Daily affect variability and context-specific alcohol consumption. Drug and Alcohol Review.

Mohr CD, Brannan D, Mohr J, Armeli S, & Tennen H (2008). Evidence for positive mood buffering among college student drinkers. Personality & Social Psychology Bulletin, 34, 1249–1259. [PubMed: 18550862]

Nolen-Hoeksema S (1991). Responses to depression and their effects on the duration of depressive episodes. Journal of Abnormal Psychology, 100, 569–582. 10.1037/0021-843X.100.4.569 [PubMed: 1757671]

Nolen-Hoeksema S (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. Journal of Abnormal Psychology, 109, 504–511. 10.1037/0021-843X.109.3.504 [PubMed: 11016119]

Nolen-Hoeksema S (2001). Gender differences in depression. Current Directions in Psychological Science, 10, 173–176.

Nolen-Hoeksema S (2004). The Response Styles Theory. In Papageorgiou C & Wells A (Eds.), Depressive Rumination: Nature, Theory and Treatment (pp. 107–123). West Sussex, England: John Wiley & Sons.

Nolen-Hoeksema S (2012). Emotion regulation and psychopathology: The role of gender. Annu Rev Clin Psychol, 8, 161–187. 10.1146/annurev-clinpsy-032511-143109 [PubMed: 22035243]

Nolen-Hoeksema S, & Hilt L (2006). Possible Contributors to the Gender Differences in Alcohol Use and Problems. Journal of General Psychology, 133, 357–374. [PubMed: 17128956]

Nolen-Hoeksema S, Larson J, & Grayson C (1999). Explaining the gender difference in depressive symptoms. Journal of Personality and Social Psychology, 77, 1061–1072. 10.1037/0022-3514.77.5.1061 [PubMed: 10573880]

Nolen-Hoeksema S, Morrow J, & Fredrickson BL (1993). Response styles and the duration of episodes of depressed mood. Journal of Abnormal Psychology, 102, 20. [PubMed: 8436695]

Nolen-Hoeksema S, & Watkins ER (2011). A heuristic for developing transdiagnostic models of psychopathology explaining multifinality and divergent trajectories. Perspectives on Psychological Science, 6, 589–609. [PubMed: 26168379]

Nolen-Hoeksema S, Wisco BE, & Lyubomirsky S (2008). Rethinking rumination. Perspectives on Psychological Science, 3, 400–424. 10.1111/j.1745-6924.2008.00088.x [PubMed: 26158958]

Park CL, Armeli S, & Tennen H (2004). The Daily Stress and Coping Process and Alcohol Use among College Students. Journal Of Studies On Alcohol, 65, 126–135. [PubMed: 15000512]

Pasyugina I, Koval P, De Leersnyder J, Mesquita B, & Kuppens P (2015). Distinguishing between level and impact of rumination as predictors of depressive symptoms: An experience sampling study. Cognition & Emotion, 29, 736–746. 10.1080/02699931.2014.932755 [PubMed: 24979309]

Patrick ME, Yeomans-Maldonado G, & Griffin J (2016). Daily Reports of Positive and Negative Affect and Alcohol and Marijuana Use Among College Student and Nonstudent Young Adults. Substance Use and Misuse, 51, 54–61 58p. 10.3109/10826084.2015.1074694 [PubMed: 26683453]

Piasecki TM, Cooper ML, Wood PK, Sher KJ, Shiffman S, & Heath AC (2014). Dispositional drinking motives: Associations with appraised alcohol effects and alcohol consumption in an ecological momentary assessment investigation. Psychological Assessment, 26, 363–369. 10.1037/a0035153 [PubMed: 24274049]

Piasecki TM, Jahng S, Wood PK, Robertson BM, Epler AJ, Cronk NJ, . . . Sher KJ (2011). The subjective effects of alcohol-tobacco co-use: an ecological momentary assessment investigation. J Abnorm Psychol, 120, 557–571. 10.1037/a0023033 [PubMed: 21443289]

Piccinelli M, & Wilkinson G (2000). Gender differences in depression. Critical review. The British Journal of Psychiatry, 177, 486–492. 10.1192/bjp.177.6.486 [PubMed: 11102321]

Rice KG, & Van Arsdale AC (2010). Perfectionism, perceived stress, drinking to cope, and alcohol-related problems among college students. Journal of Counseling Psychology, 57, 439–450. 10.1037/a0020221

Sadikaj G, Russell JJ, Moskowitz DS, & Paris J (2010). Affect Dysregulation in Individuals With Borderline Personality Disorder: Persistence and Interpersonal Triggers. Journal of Personality Assessment, 92, 490–500. 10.1080/00223891.2010.513287 [PubMed: 20954051]

Sanchez-Craig M, Wilkinson A, & Davila R (1995). Empirically Based Guidelines for Moderate Drinking: 1-Year Results from Three Studies with Problem Drinkers. American Journal of Public Health, 85, 823–828. [PubMed: 7762717]

Sayette MA, Creswell KG, Dimoff JD, Fairbairn CE, Cohn JF, Heckman BW, . . . Moreland RL (2012). Alcohol and Group Formation: A Multimodal Investigation of the Effects of Alcohol on Emotion and Social Bonding. Psychological Science (Sage Publications Inc.), 23, 869–878. 10.1177/0956797611435134

Sher KJ, Bartholow BD, Peuser K, Erickson DJ, & Wood MD (2007). Stress-response-dampening effects of alcohol: Attention as a mediator and moderator. Journal of Abnormal Psychology, 116, 362–377. [PubMed: 17516768]

Sher KJ, & Grekin ER (2007). Alcohol and Affect Regulation. In Gross JJ (Ed.), Handbook of emotion regulation. (pp. 560–580). New York, NY, US: Guilford Press.

Shiffman S (2009). Ecological momentary assessment (EMA) in studies of substance use. Psychological Assessment, 21, 486–497. 10.1037/a0017074 [PubMed: 19947783]

Shipman K, Zeman J, Penza S, & Champion K (2000). Emotion management skills in sexually maltreated and nonmaltreated girls: A developmental psychopathology perspective. Development and Psychopathology, 12, 47–62. [PubMed: 10774595]

Simons JS, Dvorak RD, Batien BD, & Wray TB (2010). Event-level associations between affect, alcohol intoxication, and acute dependence symptoms: Effects of urgency, self-control, and drinking experience. Addict Behav, 35, 1045–1053. 10.1016/j.addbeh.2010.07.001 [PubMed: 20685044]

Simons JS, & Gaher RM (2005). The Distress Tolerance Scale: Development and Validation of a Self-Report Measure. Motivation & Emotion, 29, 83–102. 10.1007/s11031-005-7955-3

Simons JS, Gaher RM, Correia CJ, Hansen CL, & Christopher MS (2005a). An Affective-Motivational Model of Marijuana and Alcohol Problems among College Students. Psychology of Addictive Behaviors, 19, 326–334. 10.1037/0893-164X.19.3.326 [PubMed: 16187813]

Simons JS, Gaher RM, Oliver MNI, Bush JA, & Palmer MA (2005b). An Experience Sampling Study of Associations between Affect and Alcohol Use and Problems among College Students. Journal Of Studies On Alcohol, 459–469. [PubMed: 16240553]

Simons JS, Wills TA, Emery NN, & Marks RM (2015). Quantifying alcohol consumption: Self-report, transdermal assessment, and prediction of dependence symptoms. Addictive Behaviors, 50, 205–212. 10.1016/j.addbeh.2015.06.042 [PubMed: 26160523]

Simons JS, Wills TA, Emery NN, & Spelman PJ (2015). Keep calm and carry on: Maintaining self-control when intoxicated, upset, or depleted. Cogn Emot, 1–15. 10.1080/02699931.2015.1069733

Simons JS, Wills TA, & Neal DJ (2014). The many faces of affect: A multilevel model of drinking frequency/quantity and alcohol dependence symptoms among young adults. Journal of Abnormal Psychology, 123, 676–694. 10.1037/a0036926 [PubMed: 24933278]

Skinner HA, & Allen BA (1982). Alcohol dependence syndrome: Measurement and validation. Journal of Abnormal Psychology, 91, 199–209. [PubMed: 7096790]

Skinner HA, & Horn JL (1984). Alcohol Dependence Scale: User's Guide. Toronto: Addiction Research Foundation.

Smith JM, & Alloy LB (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. Clinical Psychology Review, 29, 116–128. 10.1016/j.cpr.2008.10.003 [PubMed: 19128864]

Spasojević J, & Alloy LB (2001). Rumination as a common mechanism relating depressive risk factors to depression. Emotion, 1, 25–37. 10.1037/1528-3542.1.1.25 [PubMed: 12894809]

StataCorp. (2013). Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.

Steele CM, & Josephs RA (1988). Drinking your troubles away: II. An attention-allocation model of alcohol's effect on psychological stress. Journal of Abnormal Psychology, 97, 196. [PubMed: 3385073]

Stone AA, & Shiffman S (2002). Capturing momentary, self-report data: A proposal for reporting guidelines. Annals of Behavioral Medicine, 24, 236–243. 10.1207/S15324796ABM2403_09 [PubMed: 12173681]

Swendsen JD, Tennen H, Carney MA, Affleck G, Willard A, & Hromi A (2000). Mood and alcohol consumption: An experience sampling test of the self-medication hypothesis. Journal of Abnormal Psychology, 109, 198–204. 10.1037/0021-843X.109.2.198 [PubMed: 10895557]

Takano K, & Tanno Y (2011). Diurnal variation in rumination. Emotion, 11, 1046–1058. 10.1037/a0022757 [PubMed: 21517158]

Thomas SE, Merrill JE, von Hofe J, & Magid V (2014). Coping motives for drinking affect stress reactivity but not alcohol consumption in a clinical laboratory setting. Journal of Studies on Alcohol and Drugs, 75, 115–123 119p. [PubMed: 24411803]

Walitzer KS, & Dearing RL (2006). Gender differences in alcohol and substance use relapse. Clinical Psychology Review, 26, 128–148. [PubMed: 16412541]

Watson D, & Clark L (1994). The PANAS-X: Manual for the Positive and Negative Affect Schedule - Expanded Form.

Weiss HM, Beal DJ, Lucy SL, & MacDermid SM (2004). Constructing EMA studies with PMAT: the Purdue Momentary Assessment Tool user's manual. from http://www.mfri.purdue.edu/pages/PMAT/pmatusermanual.pdf.

Weissman MM, Bland RC, Canino GJ, Faravelli C, Greenwald S, Hwu H-G, . . . Lellouch J (1996). Cross-national epidemiology of major depression and bipolar disorder. JAMA, 276, 293–299. [PubMed: 8656541]

Wills TA, Bantum EO, Pokhrel P, Maddock JE, Ainette MG, Morehouse E, & Fenster B (2013). A dual-process model of early substance use: tests in two diverse populations of adolescents. Health Psychology, 32, 533–542. 10.1037/a0027634 [PubMed: 23646836]

Wills TA, Pokhrel P, Morehouse E, & Fenster B (2011). Behavioral and emotional regulation and adolescent substance use problems: A test of moderation effects in a dual-process model. Psychology of Addictive Behaviors, 25, 279–292. 10.1037/a0022870 [PubMed: 21443302]

Wills TA, & Shiffman S (1985). Coping and substance use: A conceptual frmaework. In Wills TA& Shiffman S (Eds.), Coping and substance use (pp. 3–24). Orlando: Academic Press.

Wills TA, Walker C, Mendoza D, & Ainette MG (2006). Behavioral and emotional self-control: relations to substance use in samples of middle and high school students. Psychology of Addictive Behaviors, 20, 265. [PubMed: 16938064]

Witkiewitz K, & Villarroel NA (2009). Dynamic association between negative affect and alcohol lapses following alcohol treatment. Journal of Consulting and Clinical Psychology, 77, 633–644. [PubMed: 19634957]

Zeman J, Shipman K, & Penza-Clyve S (2001). Development and Initial Validation of the Children's Sadness Management Scale. Journal of Nonverbal Behavior, 25, 187–205.

Zywiak WH, Connors GJ, Maisto SA, & Westerberg VS (1996). Relapse research and the Reasons for Drinking Questionnaire: A factor analysis of Marlatt's relapse taxonomy. Addiction, 91, S121–S130. [PubMed: 8997786]

Zywiak WH, Stout RL, Trefry WB, Glasser I, Connors GJ, Maisto SA, & Westerberg VS (2006). Alcohol relapse repetition, gender, and predictive validity. Journal of Substance Abuse Treatment, 30, 349–353. [PubMed: 16716850]

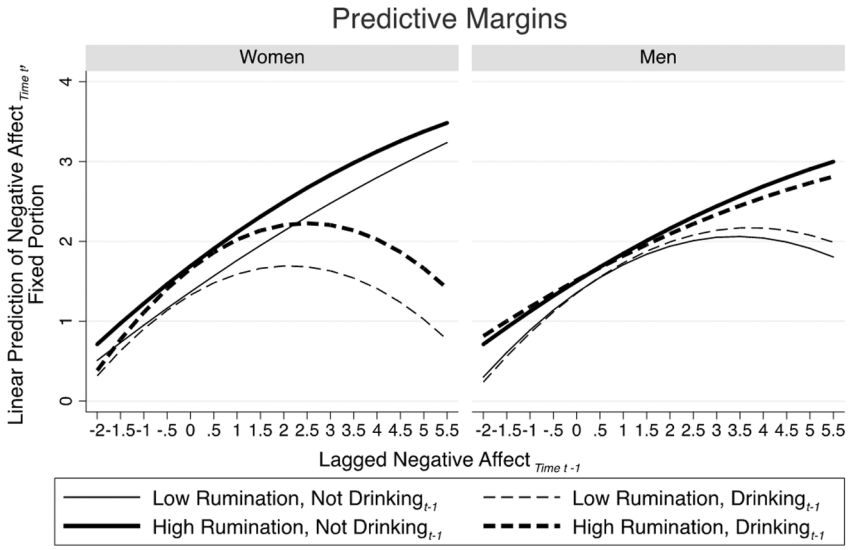

Figure 1.

Within-person effects of negative affect$_{t\text{-}1}$ (x-axis) on negative affect$_{t}$ (y-axis) as a function of rumination, drinking $_{t\text{-}1}$, and gender. Low / High = M −/+ 1 SD, respectively

Table 1.

Descriptive statistics

Variable	Source	Mean (SD) or percent	Skew	Kurtosis	1.	2.	3.	4.
1. Gender	Baseline	44% Men			-			
2. Rumination	Baseline	2.69 (0.98)	0.33	2.34	−.17**			
3. ADS	Baseline	12.74(5.69)	0.57	3.07	−.06	.26***		
3. Negative affect	Signal	1.48 (0.71)	2.37	10.42	−.14**	.31***	.19**	
4. Drinking	Signal	7% of Signals			.21***	−.05	.16*	.16*

Note. 263 persons, 43111 signals. Signals refer to the *in situ* random assessments. Correlations are between the person means. ADS = Alcohol Dependence Scale. Gender is coded 1 = men, 0 = women.

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 2.

Multilevel Autoregression Analysis Predicting Negative Affect at Time t, Fixed effect

Variable	*B*	*SEB*	*z*	*p*
Between-Person Effects (Level 4)				
Gender	−0.10	0.05	−2.10	.036
Rumination	0.16	0.03	5.31	<.001
Gender x Rumination	−0.09	0.05	−1.93	.053
Subject Mean Elapsed Date	0.05	0.03	1.67	.095
Subject Mean Drinking	0.97	0.30	3.21	.001
Within-Person Effects				
Burst level (Level 3, no fixed effects)				
Day level (Level 2)				
Elapsed Date	−0.01	0.00	−3.69	<.001
Signal level (Level 1)				
NA_{t-1}	0.43	0.01	29.93	<.001
NA_{t-1} x NA_{t-1}	−0.02	0.01	−2.79	.005
$Drinking_{t-1}$	−0.04	0.02	−2.02	.044
$Drinking_{t-1}$ x NA_{t-1}	−0.03	0.03	−0.79	.432
$Drinking_{t-1}$ x NA_{t-1} x NA_{t-1}	−0.07	0.01	−4.98	<.001
Cross-Level Interactions				
NA_{t-1} x Gender	−0.04	0.02	−1.78	.075
NA_{t-1} x Rumination	0.02	0.01	1.50	.135
NA_{t-1} x Rumination x Gender	−0.04	0.02	−2.02	.044
NA_{t-1} x NA_{t-1} x Gender	−0.02	0.01	−2.31	.021
NA_{t-1} x NA_{t-1} x Rumination	−0.01	0.01	−0.99	.323
NA_{t-1} x NA_{t-1} x Rumination x Gender	0.03	0.01	3.29	.001
$Drinking_{t-1}$ x Gender	0.04	0.02	1.63	.104
$Drinking_{t-1}$ x Rumination	0.00	0.02	0.18	.854
$Drinking_{t-1}$ x Gender x Rumination	0.01	0.02	0.32	.749
$Drinking_{t-1}$ x NA_{t-1} x Rumination	0.04	0.02	1.49	.136
$Drinking_{t-1}$ x NA_{t-1} x Gender	0.02	0.05	0.41	.685
$Drinking_{t-1}$ x NA_{t-1} x NA_{t-1} x Gender	0.07	0.02	3.82	< .001
$Drinking_{t-1}$ x NA_{t-1} x Gender x Rumination	−0.07	0.04	−2.06	.039

Note. 263 persons, 43,111 signals. 6 orthogonal day-of week indicators were included, Friday and Saturday were associated with reduced negative affect relative to Sunday. Gender is coded 1= men, 0 = Women. Drinking is coded 1=Drinking, 0 = not drinking. Women and not drinking are the base categories

Table 3.

Multilevel Autoregression Analysis Predicting Negative Affect at Time t, random effects

Random-effects Parameters	*Estimate*	*SE*	*95% CI*
Person:			
NA_{t-1} slope σ_1	0.08	0.01	0.06, 0.11
Elapsed date slope σ_2	0.03	0.00	0.02, 0.04
Intercept σ_3	0.36	0.02	0.33, 0.40
$r(\sigma_1, \sigma_2)$	−0.15	0.20	−0.50, 0.25
$r(\sigma_1, \sigma_3)$	0.49	0.11	0.23, 0.68
$r(\sigma_2, \sigma_3)$	−0.24	0.12	−0.46, 0.01
Burst:			
NA_{t-1} slope σ_4	0.17	0.01	0.16, 0.19
Intercept σ_5	0.09	0.01	0.08, 0.10
$r(\sigma_4, \sigma_5)$	0.57	0.06	0.44, 0.67
Day:			
Intercept σ_6	0.07	0.01	0.06, 0.09
Residual: *AR(1)*			
rho	−0.15	0.01	−0.17, −0.13
sd(e)	0.53	0.00	0.53, 0.54