

Distress Tolerance and Physiological Reactivity to Stress Predict Women's Problematic Alcohol Use

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Research has shown that measures of reactivity to distress—including distress tolerance and physiological reactivity to stress—are dysregulated in women who misuse alcohol. These variables may interact and create a risk profile for young adult women, reflecting patterns of stress reactivity that confer a risk for alcohol misuse. The current study tested this hypothesis by examining the independent and interactive associations of subjective distress tolerance, behavioral distress tolerance, and physiological stress reactivity with women's alcohol misuse. The study was conducted with a sample of 91 college women recruited on a large northeastern university campus. Results showed that subjective levels of distress tolerance and physiological reactivity to stress (skin conductance reactivity, SCR), but not behavioral distress tolerance, were independently associated with alcohol misuse. In addition, subjective distress tolerance moderated the relationship between SCR and negative alcohol-related consequences. Specifically, women with low physiological reactivity (SCR) to a stressful task and greater urge to quickly rid themselves of distress (low subjective distress tolerance) endorsed a significantly greater number of adverse consequences from their alcohol use. These results extend prior findings by showing that, even among a nonclinical sample of women, lower stress reactivity in combination with low subjective distress tolerance is associated with increased risk for various drinking-related negative consequences.

Public Health Significance

This study examined the association between subjective and physiological reactivity to distress, and how these factors are related to problematic alcohol use in women. Results from a moderation model suggested that women who have difficulty regulating distress and also have low physiological reactivity to distressing stimuli may be at enhanced risk for problematic alcohol use, even when they do not have an established alcohol use disorder.

Keywords: women, skin conductance, psychophysiology, distress tolerance, alcohol

Recent research has indicated that almost one fourth of adult women meet *DSM-5* criteria for lifetime alcohol use disorders (AUD; Grant et al., 2015). Despite evidence that this represents a steadily increasing rate (Ruiz & Oscar-Berman, 2013; White et al., 2015), risk factors for AUD in women are less researched than in men (Tuchman, 2010). As men have a greater propensity to misuse alcohol than women, research comparing both genders may limit our ability to understand factors and processes specific to women. Not surprising, to date it remains unclear why women develop alcohol misuse and dependence despite protective factors afforded

by their gender (including gender roles, coping style, personality traits; see Nolen-Hoeksema, 2004, for a discussion). Exploring variables that differentiate women who misuse alcohol from those who do not could provide important information about factors that put women at risk for developing AUD (Tuchman, 2010). Factors that may be particularly salient for better understanding women's alcohol misuse is their regulation and reactivity to stress and distress (Karpyak et al., 2016; Nolen-Hoeksema & Hilt, 2006; Mushquash et al., 2013; Olenick & Chalmers, 1991). The current study sought to examine how two such factors—distress tolerance and physiological reactivity to distress—were independently and interactively associated with problematic alcohol use in women.

Low distress tolerance intensifies the aversiveness of a negative experience and motivates the individual to engage in avoidance or escape behaviors, which can take the form of alcohol abuse (McHugh & Otto, 2012). Although the concept of distress tolerance has appeared in the psychological literature for years and has been integrated into a number of clinical interventions (e.g., Boronova et al., 2012; Daughters et al., 2005), the best way to measure distress tolerance is still unclear. Subjectively, *distress tolerance* is defined as the capacity to withstand negative psychological states (Simons & Gaher, 2005); behaviorally, it is defined

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as the ability to persist in goal-directed activity when faced with psychological distress (Daughters et al., 2009). A number of self-report and behavioral measures of distress tolerance exist (Bardeen et al., 2013; McHugh et al., 2011), but it is not clear how different measures relate to each other or to an overarching construct of distress tolerance. Studies that have explored self-reported versus behavioral measures (e.g., McHugh & Otto, 2012; Schloss & Haaga, 2011) have found that the two measurement types are not correlated but do show intramethod validity—with particular support being found for subjective measures (e.g., Glassman et al., 2016). Because there currently is no “gold standard” for measurement of distress tolerance (McHugh et al., 2011), research is needed to further examine the utility of these different measurements.

Despite complications around the measurement of distress tolerance, there is significant empirical support for its association with substance misuse. This association has been suggested by a number of experimental and correlational studies in clinical substance abusers (Daughters et al., 2005) as well as in social, nonproblematic, and at-risk substance users (Daughters et al., 2009; Bujarski, Norberg, & Copeland, 2012). These studies have demonstrated the association between substance use and distress tolerance based on both subjective and behavioral measures. Furthermore, some preliminary evidence has shown a relationship between low behavioral distress tolerance and alcohol misuse among women (Gorka et al., 2012).

One particular element of subjective distress tolerance—that is, the regulation of distress—may confer risk for abusing alcohol especially in young adult drinkers, if they drink as a means to cope with distressing situations. Research has found that individuals, and particularly college students, with co-occurring internalizing symptoms and coping motives for alcohol use experience more negative consequences from alcohol use, even though they do not necessarily drink at a different rate than their peers (Schry & White, 2013; Gonzalez, Reynolds, & Skewes, 2011; Menary et al., 2015; King, Karyadi, Luk, & Patock-Peckham, 2011). The regulation element of distress tolerance refers to the need to quickly “do something” to alleviate distress-related feelings (i.e., “When I feel distressed or upset I must do something about it immediately”; Simons & Gaher, 2005). Accordingly, the Regulation Subscale of the Distress Tolerance Scale, a well-validated subjective measure of distress tolerance, has been shown to be most closely associated with problematic alcohol use (Simons & Gaher, 2005). This research suggests that, although distress tolerance is known to act as a risk factor for many different psychological disorders (Wolitzky-Taylor et al., 2015), its subjective regulation element may directly relate to problematic alcohol use and related negative consequences. Although women are more prone to internalizing disorders, the need to “act” on relieving distress as quickly as possible may increase their likelihood to relieve their distress by turning to alcohol rather than becoming absorbed in distress and/or ruminating, which is more consistent with depression. Indeed, drinking to cope among young adults has been associated with more symptoms of alcohol dependence and greater consequences from alcohol use (Merrill & Read, 2010; Simons, Wills, & Neal, 2014; Pedrelli, Borsari, Lipson, Heinze, & Eisenberg, 2016).

Research has also shown that physiological reactivity to distressing situations is associated with problematic alcohol use in women. There is particular support for the association between alcohol use and hypothalamic-pituitary-adrenal (HPA) axis reactivity to a stressor, and a dysfunction of the HPA axis has been

found to convey risk for developing AUD (Stephens & Wand, 2012). Dysregulated reactivity to distressing situations has been noted with regard to both cortisol response, reflecting the slower moving reactivity of the HPA system, and in quicker responding sympathetic-adrenal-medullary (SAM) reactivity (e.g., skin conductance reactivity; SCR). Blunted physiological reactivity to stress has been consistently observed among individuals with diagnosable substance use disorders (see Sinha et al., 2009 for review). There is also some evidence to support a possible gender difference—at least among clinical populations of drinkers. For example, Fox et al. (2009) examined reactivity to stress cues in substance abusing individuals and healthy controls. In substance abusing males, they found a generalized suppression of HPA, SAM, and cardiovascular reactivity in response to both stress and alcohol cues; however, in substance abusing women they found a selective SAM suppression to stress cues only. The authors proposed that this SAM suppression to stress cues in women reflects a dysfunctional response to distress that may increase the risk for substance abuse (Fox & Sinha, 2009).

A complicating factor of the association between HPA functioning and alcohol use is that the exact nature of this association may depend on the severity of AUD. For example, individuals who are risky social drinkers but not necessarily diagnosable with AUD have been shown to demonstrate both hyporeactive (blunted) and hyperreactive (enhanced) HPA response to a stressor, which may reflect individual differences, presence of moderating factors, or differences in methodology (Stephens & Wand, 2012; Lovallo, 2006). Much of the research examining reactivity among at-risk individuals has focused on those with a positive family history of AUD. Studies that compared physiological (cortisol) response to an opioid receptor antagonist (considered a stressor) found stronger responses to the antagonist among those with a positive family history (Wand, Mangold, El Deiry, McCaul, & Hoover, 1998; Wand, McCaul, Gotjen, Reynolds, & Lee, 2001). Another study found hyperreactivity of cortisol to a psychosocial stressor in family history positive young adults; however, among these same individuals they also found an inverse association between cortisol response and subjective anxiety in response to the task (greater subjective anxiety, lower cortisol response). This inverse association was unlike those with a negative family history of AUD, who showed a positive association between anxiety and reactivity (Uhart, Oswald, McCaul, Chong, & Wand, 2006).

As mentioned, other research has found substantial support for a hyporesponsive (blunted) HPA reactivity to stress even among at-risk adolescents and young adults (Lovallo, 2006). One such study found decreased cortisol reactivity to stressors in preadolescents with a positive family history, and this hypo-reactivity was associated with more substance use during adolescence (Moss Vanyukov, Yao, & Kirillova, 1999). Another study found an association between blunted reactivity to stress and negative alcohol-related consequences among nonclinical college-aged women (Wemm et al., 2013). The latter study (Wemm et al., 2013) also found that female students who reported drinking to cope, compared to those who did not, had blunted reactivity to a stressor. As discussed above, drinking to cope among young adults is also a risk factor for problem use (Merrill & Read, 2010; Simons, Wills, & Neal, 2014; Pedrelli, Borsari, Lipson, Heinze, & Eisenberg, 2016), in addition to the risk from a positive family history. Based in this and similar research, it has been suggested that this

hyporeactivity to stressors, although found among individuals with diagnosable AUD, may actually predate the onset of an AUD and be an indicator of risk (Carroll, Phillips, & Lavallo, 2012).

Thus, although research with nonclinical but at-risk individuals is somewhat mixed, there is support for dysregulated HPA reactivity to stress may as a risk factor for the development of AUD. Although the mechanisms for this association are not entirely clear, it has been hypothesized that a diminished response to threat cues (i.e., blunted reactivity) may be associated with antisocial tendencies or reduced response to threat cues—which may then increase risk for alcohol misuse (Lavallo, 2006). It has also been hypothesized that hyporeactivity that develops in response to chronic stress may act as an intergenerational risk factor for substance abuse (Moss, Vanyukov, Yao, & Kirillova, 1999).

Given these findings, young women with poor distress regulation and a dysregulated reactivity to stress may be at greater risk for alcohol misuse and experience more negative consequences from drinking when compared to women with regular reactivity to a stressor. Given that dysregulated SCR to distress and drinking to cope with distress may be risk factors for problem drinking, the collective presence of both in young adult women may reflect a profile that distinguishes those who are at risk for problem drinking. That is, the interaction of a preference for quick-acting relief from negative emotions and a dysregulated physiological response to a distressing situation may create a combination of factors that places a certain subgroup of women at risk for developing alcohol use problems, whereby low distress regulation moderates the association between physiological reactivity and alcohol problems (similarly to findings that show a positive family history and dysregulated reactivity are associated with use).

The aim of the current study was to examine whether subjective distress tolerance moderates the association between SCR and alcohol-related consequences. Research has shown mixed findings regarding stress reactivity and alcohol use in adolescent and young adult samples; therefore, the present study sought to examine a potential moderator (low distress regulation) that would benefit our understanding of how stress reactivity might be related to young women's problem drinking. We first explored the relationship between women's subjective distress tolerance, behavioral distress tolerance, and SCR, as there is limited research on how different measures of distress tolerance are associated with physiological reactivity. We also examined how these three measures are directly associated with women's alcohol use and related consequences. We hypothesized that lower subjective and behavioral distress tolerance would be associated with higher SCR to distress and that both factors would be associated with greater alcohol use and self-reported negative consequences. Because of the mixed literature findings on hypo- versus hyperresponsive HPA reactivity to a stressor, we also hypothesized that dysregulated SCR to distress would be associated with greater alcohol-related negative consequences, particularly in women with low subjective distress regulation.

Method

Participants

One hundred participants were drawn from two larger studies conducted at a northeastern university (Holzhauer, 2015). Thirty

female participants were from a study that included college students of both sexes, age 18 and older; 70 were from a study with female students age 21 and older. As nine participants were excluded from analyses due to equipment malfunction or experimenter error, the final sample comprised 91 women.

Measures

Paced Auditory Serial Addition Task, Computerized. The computerized Paced Auditory Serial Addition Task, Computerized (PASAT-C; Lejuez, 2003) served as a behavioral measure of distress tolerance. Participants are presented with a series of single-digit numbers on a computer screen and sum the two most recent numbers by clicking the correct number on a virtual keyboard. On each trial, they must ignore the sum and add the number that was presented last to the following number; [for example, if a 5 was followed by a 2, they would mark the sum ($5 + 2 =$) 7, and if a 4 was presented next, they would ignore the 7 and click on the ($2 + 4 =$) 6. For each correct answer participants receive points; for each wrong or missed answer, they hear an aversive "explosion" sound. The speed of the task increases over three levels, making the task increasingly difficult. In Level 3, participants were told they could quit the task at any time, but that they would receive performance-based raffle tickets for the drawing of a \$50.00 cash prize and that they should therefore try their best. Behavioral distress tolerance was measured by the seconds they persisted in Level 3. Unbeknownst to participants, the third level ended after a maximum of 600 s. The PASAT-C assesses degree of negative affect (anxiety, difficulty concentrating, physical discomfort, frustration, and irritability) on a 0–100 scale at the start of the task and after each of the three levels.

Distress Tolerance Scale. The Distress Tolerance Scale (DTS; Simons & Gaher, 2005) served as a self-report measure of distress tolerance. It comprises 15 items, each scored on a 5-point Likert scale from 1 (*strongly agree*) to 5 (*strongly disagree*), with higher scores indicating higher distress tolerance. The DTS yields four subscales and one higher-order distress tolerance score. The four subscales include perceived ability to tolerate emotional distress (e.g., "I can't handle feeling distressed or upset"), absorption by negative emotions (e.g., "When I feel distressed or upset, I cannot help but concentrate on how bad the distress actually feels"), appraisal of distress (e.g., "My feelings of distress or being upset are not acceptable"), and regulation efforts to alleviate distress (e.g., "When I feel distressed or upset I must do something about it immediately"). In this sample the total measure yielded a Cronbach's alpha of .91, with the subscales ranging from .79 to .87. Although we examined both behavioral and subjective distress tolerance in this study, in an effort to advance research on this distinction, we focused on subjective distress tolerance in our main moderation model, given its more consistent empirically supported validity and reliability as well as its face validity for measuring distress tolerance as needed for this study.

Skin conductance measurement. Electrodermal activity was measured using the Palm Q Sensor, a portable monitor (Affectiva, Inc., Waltham, MA). The sampling rate was set to 16 Hz/s, and the sensor was placed on the hypothenar eminence of the participant's nondominant hand. Data were visually analyzed for any drop-outs or abnormalities. For the purposes of this study, we report phasic

skin conductance responses (SCRs) to nonspecific stimuli in the environment that were generated throughout the baseline data collection, and during Levels 1 and 2 of the PASAT-C task. Phasic SCRs occur in response to either external or internal stimuli and are changes that exceed a threshold value (0.05 microsiemens above individual baseline; Naqvi & Bechara, 2006). Measures of SCR during Level 2 were used because the explosions subsequent to errors were infrequent enough for meaningful responding to occur. In addition, variable quit times in the third level as the measure of behavioral distress tolerance would confound the number of phasic SCRs that could be measured. During Level 1, a number is presented every three seconds, which makes the task of adding two numbers less difficult or distressing. We considered the SCRs during the moderately difficult Level 2 as most representative of reactivity to distress and therefore used these values in our moderation analysis. SCRs were generated using Ledalab (Benedek & Kaernbach, 2010), a software that is run using Matlab, for the decomposition of raw skin conductance data into phasic components.

Young Adult Alcohol Consequences Questionnaire. The Young Adult Alcohol Consequences Questionnaire (YAACQ; Read, Kahler, Strong, & Colder, 2006) is a 48-item self-report questionnaire that assesses negative consequences from drinking in eight domains, all of which load on a higher-order “consequences” factor. These subscales include interpersonal, academic/occupational, risky behavior while drinking, impaired control, poor self-care, diminished self-perception, blackouts, and physiological dependence. Items are answered in a dichotomous fashion (yes/no), but for this study a 4-point Likert scale was used (Devos-Comby & Lange, 2008) to assess whether and how often participants had experienced a given consequence during the past year ranging from 1 (*not at all*) to 5 (*more than 5 times*). The total consequences score yielded a Cronbach’s alpha of .96 for the present sample, with a range of possible scores of 0 (no consequences over the past year) to 144.

Alcohol consumption. Heavy episodic drinking was assessed using a question from the Core Alcohol and Drug Survey, 7th edition (CORE Institute, 2004). It assesses the number of times a student had five or more drinks in one sitting during the past 2 weeks. Then the Timeline Follow-Back (Sobell & Sobell, 1992), a widely used calendar-based measure, was used to assess daily alcohol use during the past four weeks. The total number of days on which students drank alcohol and the average number of drinks consumed on these drinking days were calculated and used in the analyses.

Beck Depression Inventory-II. The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) assesses the severity of depression symptoms, with each of 21 symptoms being rated on a scale from 0 (*not present*) to 3 (*worst severity*); score can range from 0–63. The mean BDI score for this sample was 8.3 ($SD = 8.2$). The Cronbach’s alpha in the current sample was .88. The BDI score was entered as a covariate in our moderation model because depression has been shown to affect physiological reactivity to stress (Bylsma, Morris, & Rottenberg, 2008) and is associated with problematic drinking for women (Gilman & Abraham, 2001; Nolen-Hoeksema & Hilt, 2006; Mushquash et al., 2013).

Procedure

The university’s institutional review board approved study procedures. Thirty women (aged 18+) were recruited as part of a mixed-gender study that purported to examine gender differences in physiological responding while completing a computerized math task (the PASAT-C). Seventy women (aged 21+) participated in a women-only study and were told that the study investigated how right-brain activation might affect taste preferences for alcohol (a method adapted from Carter et al., 1998). These women followed the same procedure as participants from the mixed-gender study (described below), but in addition they completed a beer tasting task after completing the PASAT-C. Participants were debriefed regarding the true nature at study completion.

All participants were fitted with the skin conductance glove monitor upon arrival. A period of calibration for the equipment was then conducted—participants first walked for 3 min, then sat quietly for 15 min, filling out questionnaires and completing the Timeline Follow-Back administered by the experimenter. After 15 min, participants were then asked to sit quietly for 3 min (“doing nothing”) so that we could gather the baseline measure of skin conductance. After three minutes, participants were then given instructions and completed the PASAT-C. All women took part in the study between 15:00 and 21:00 hr.

Results

Demographics and Descriptive Statistics

The mean age of the sample was 21.5 years ($SD = 2.16$), with a range from 17 to 28. The ethnic/racial composition of the sample was as follows: 56 Caucasian (61.5%); 14 Asian (15.4%); 11 “other” or multiple ethnicities (12.1%); eight Black/African American (8.8%); 2 (2.2%) did not specify; 10 women were Hispanic (11.0%). The sample’s average persistence time on the PASAT-C Level 3 (the measure of behavioral distress tolerance) was 338.68 s ($SD = 268.50$), with 40 women (44%) persisting the full 600 s. Paired t tests demonstrated significant increases in negative affect over baseline after Level 2, $t(88) = -27.98$, $p = .00$, and Level 3, $t(88) = -8.34$, $p = .00$, of the PASAT-C. Breaking this down into its component parts, participants reported increased distress from before to after the PASAT-C on all items assessed, including in the areas of anxiety—from a mean of 17.2 ($SD = 21.5$) pre-PASAT to 38.0 ($SD = 30.7$) post-PASAT; difficulty concentrating, 14.7 ($SD = 42.7$) to 42.7 ($SD = 30.8$); physical discomfort, 13.7 ($SD = 17.2$) to 18.9 ($SD = 21.8$); frustration, 7.9 ($SD = 13.5$) to 49.5 ($SD = 31.1$); and irritability, 7.4 ($SD = 10.6$) to 42.1 ($SD = 30.2$); all $p < .05$. See Table 1 for means and standard deviations for the other variables of interest. As 47.3% of this sample consumed an average of more than three drinks per drinking day, almost half of the sample met criteria for risky drinking (National Institute on Alcohol Abuse and Alcoholism, 2016). 36.7% reported using marijuana and 18.4% reported smoking cigarettes in the past 30 days. Few participants reported daily use of marijuana ($n = 2$; 2.0%) or cigarettes ($n = 3$; 3.1%).

Correlational Analyses

We first examined whether behavioral and subjective distress tolerance were correlated with each other and with SCR during

Table 1
Descriptive Statistics for Study Measures

Measure	<i>M</i>	<i>SD</i>	Range
BDI	9.86	8.91	0–38
# HED episodes/past 2 weeks	2.15	1.24	1–5
Average drinks/drinking day	3.08	1.95	0–7.83
# days drank/past 28 days	4.85	4.31	0–23
YAACQ total	21.54	21.64	0–105
PASAT-C quit time (s)	338.68	268.50	0–600
DTS			
Absorption	3.00	1.13	—
Appraisal	3.46	1.04	—
Regulate	3.03	1.09	—
Tolerance	3.17	1.03	—
Total	3.16	.94	—

Note. BDI = Beck Depression Inventory; YAACQ = Young Adult Alcohol Consequences Questionnaire; PASAT-C = Paced Auditory Serial Addition Task, Computerized; DTS = Distress Tolerance Scale; HED = heavy episodic drinking, defined as 5 or more drinks in one sitting.

baseline and Levels 1 and 2 of the PASAT-C (see Table 2). Consistent with findings from past studies, behavioral distress tolerance (i.e., quit time on Level 3 of the PASAT-C) did not significantly correlate ($p > .05$) with subjective distress tolerance (DTS scores). Similarly, behavioral distress tolerance was not significantly correlated with SCR at any level of the PASAT-C (all p values $> .05$; see below for analyses with dichotomized behavioral distress tolerance scores).

We then examined the relationship between subjective and behavioral distress tolerance, SCR, and alcohol-related variables (see Table 3) and noted two patterns: First, SCR at each level of the PASAT-C (baseline, Level 1, and Level 2) correlated positively with drinking quantity (average drinks per drinking day; $p < .05$) and SCR at baseline and Level 2 correlated positively with the number of binge drinking episodes during the past two weeks ($p < .05$). Second, subjective distress tolerance (all subscales and total score) correlated negatively with alcohol consequences (YAACQ total score; $p < .01$). Thus, physiological reactivity to distress was uniquely associated with drinking intensity whereas subjective distress tolerance was uniquely associated with negative consequences from alcohol use. In contrast, behavioral distress tolerance (seconds persisted on the PASAT-C) did not correlate significantly with any of the drinking variables.

Behavioral Distress Tolerance

Because of the ceiling effect of the PASAT-C (44% of women persisting until the end of Level 3), we dichotomized this variable into women who persisted until the end ($n = 40$) and those who quit before the end of the level ($n = 51$) and conducted t tests to examine differences in distress tolerance and drinking variables (Lejuez, 2003; Schloss & Haaga, 2011). Results largely confirmed the correlational analyses; however, the t test comparing groups on the number of SCRs during PASAT-C Level 2 was significant, $t(89) = -2.07$, $p = .04$. Women who persisted until the end of Level 3 (high behavioral distress tolerance) had a significantly higher number of SCRs during Level 2 ($M = 53.6$, $SD = 33.0$) compared to women who quit before the end of the level (low behavioral distress tolerance; $M = 39.9$, $SD = 29.4$). Otherwise,

the participants with high and low behavioral distress tolerance did not significantly differ in terms of their subjective distress tolerance (DTS total and subscale scores), drinking frequency or quantity (days drinking, average drinks per drinking day, binge episodes) or negative drinking consequences (YAACQ total score; (all $p > .10$).

Moderation Model

We then examined the extent to which the Regulation subscale of the Distress Tolerance Scale interacted with SCR during Level 2 of the PASAT-C to predict negative consequences from alcohol use (YAACQ total score). Given that blunted SCR to distress and drinking to cope with distressing situations may be risk factors for problem drinking, the collective presence of both risk factors in young adult women may reflect a profile that may distinguish women who are at risk for problem drinking. Average number of drinks per drinking day, baseline SCR, and total BDI score were entered as covariates. PROCESS (Hayes, 2012) was used to perform the moderation analyses in IBM SPSS 20. This software incorporates many recommended methods, including mean centering of predictor variables, and derivation of conditional regions of significance and simple slopes. Bootstrapping on 1,000 samples was used in the analyses and 95% confidence intervals (CI) are reported. This model explained a significant amount of variance in the outcome variable, $F(6, 82) = 10.18$, $p < .001$ (see Table 4). Level 2 SCR did account for a significant amount of variance in alcohol consequences, $t(89) = -2.20$, $p = .03$, and subjective distress regulation was also a significant predictor, $t(89) = -3.57$, $p = .001$. The interaction term (SCR $\times$ Distress Regulation) was found to increase the R^2 by 0.03, $F(1, 82) = 4.76$, $p = .03$, and the interaction coefficient was therefore significant, $t = 2.18$, $p = .03$.

Probing for simple slope effects indicated that the effect was significant for women with low SCR during Level 2 of the PASAT-C [$p = .00$, 95% CI = $(-16.21, -5.16)$]. Specifically, women with low reactivity (SCR during Level 2) and low distress tolerance (Regulation subscale) experienced significantly more adverse consequences from drinking than women with other combinations of these variables (see Figure 1). Women on the low end of distress regulation spectrum and low SCR had a predicted y value of about 21 points higher on the YAACQ compared to

Table 2
Correlations Among Behavioral Distress Tolerance, Subjective Distress Tolerance, and Skin Conductance Reactivity

Measure	1	2	3	4
Skin conductance				
1. Baseline				
2. PASAT-C Level 1	.63*			
3. PASAT-C Level 2	.58*	.74*		
PASAT-C				
4. Quit time	.09	.06	.15	
Distress Tolerance Scale				
5. Tolerance	-.05	.02	.05	.13
6. Absorption	-.20	-.04	-.05	.02
7. Appraisal	-.19	.02	-.03	-.00
8. Regulate	-.18	-.05	-.11	-.01
9. Total	-.17	-.01	-.04	.04

* Correlation is significant at the .01 level (2-tailed).

Table 3

Correlations Among Distress Tolerance, Skin Conductance Reactivity, and Drinking Variables in Men and Women

	Skin conductance reactivity			Behavioral DT Quit time on PASAT-C	Distress Tolerance Scale/subjective DT				
	Baseline	PASAT-C Level 1	PASAT-C Level 2		Tolerance	Absorption	Appraisal	Regulate	Total
Days drank/past 28 (TLFB)	.17	.01	.11	.11	-.11	-.12	-.17	-.15	-.15
Avg drinks/drinking day (TLFB)	.32**	.22*	.37**	.11	-.04	-.08	-.02	-.03	-.05
YAACQ total score	.20	.01	.04	.10	-.30**	-.37**	-.29**	-.33**	-.37**
Binge episodes, past 2 weeks	.30**	.14	.27*	.06	-.16	-.10	-.12	-.19	-.16

Note. DT = Distress Tolerance; TLFB = Timeline Follow-Back; YAACQ = Young Adult Alcohol Consequences Questionnaire. Skin conductance reflects number of skin conductance responses at each time point of the Paced Auditory Serial Addition Task, Computerized (PASAT-C).

* Correlation is significant at the .05 level (2-tailed). ** Correlation is significant at the .01 level (2-tailed).

women with lower distress regulation and higher SCR (see Figure 1). Therefore, these results show that low distress regulation (high urge to quickly rid oneself of distress) in women is associated with more negative alcohol-related consequences, particularly in women with dampened SCR reactivity to distress.

Discussion

The first aim of this study was to explore the relationship between women's subjective and behavioral distress tolerance, physiological reactivity to distress, alcohol use, and alcohol related consequences. Consistent with previous research (McHugh & Otto, 2012; Schloss & Haaga, 2011), we found no direct association between behavioral and self-reported distress tolerance. Subjective distress tolerance also was not related to physiological reactivity to distress, but women with higher levels of behavioral distress tolerance had higher reactivity to the PASAT-C task when the measure was dichotomized.

Regarding alcohol use, behavioral distress tolerance was not related to any of the drinking-related variables. In contrast, lower subjective distress tolerance on each subscale was associated with more negative consequences from alcohol use. These findings are consistent with past research on various measures of distress tolerance (e.g., McHugh & Otto, 2012; McHugh et al., 2012; Glassman et al., 2016) and suggest the potentially greater usefulness of self-reported distress tolerance in its association with problematic drinking. It is possible that behavioral distress tolerance and particularly the PASAT-C may be more relevant in considering other behavioral outcomes, such as treatment adher-

ence and length of sustained abstinence among individuals with substance use disorders (Daughters et al., 2005; MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008). Given that distress tolerance is strongly associated with a propensity to internalize symptoms (Leyro, Zvolensky, & Bernstein, 2010; Wolitzky-Taylor et al., 2015), the significant associations between subjective distress tolerance and alcohol-related negative consequences support prior research showing that depressed or anxious individuals who use alcohol for coping purposes experience more adverse consequences from their use, which is not necessarily mediated by the amount they drink (Schry & White, 2013; Gonzalez, Reynolds, & Skewes, 2011; Menary et al., 2015; King, Karyadi, Luk, & Patock-Peckham, 2011). As hypothesized, across the entire sample of college women who did not represent a clinical or particularly at-risk population, we found an overall positive association between physiological reactivity to distress and alcohol use.

This finding leads us to the second aim of the study—the proposed model whereby the association between subjective distress tolerance and alcohol-related consequences is moderated by physiological reactivity to stress. In this moderation analysis, we paired the Regulation Subscale of the distress tolerance measure with physiological reactivity. There was a main effect in this model indicating that lower physiological reactivity was associated with greater adverse consequences from drinking. Thus, although higher reactivity was not correlated with negative consequences (but was with alcohol use), once reactivity was entered into a model with subjective distress tolerance (and depression, as a covariate), it became significantly and negatively associated with

Table 4

Regression of Skin Conductance Responses during PASAT-C Level 2 (SCR), Subjective Distress Regulation, and Interaction Term on Alcohol Consequences (YAACQ Total)

Variable	B	SEB	R ²	ΔR ²	F	p	LLCI	ULCI
Model summary			.43		10.18	.000		
SCR	-.17*	.08					-.33	-.02
DTS regulation	-6.97**	1.95					-10.86	-3.09
DTS Regulation × SCR	.12*	.05	.03		4.76	.032	.01	.22
Covariates								
Baseline SCR	.12	.15					-.18	.42
Beck Depression Inventory	.59*	.26					.08	1.11
Average drinks per drinking day	5.53**	1.08					3.37	7.68

Note. LLCI/ULCI = lower/upper limit 95% confidence interval.

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

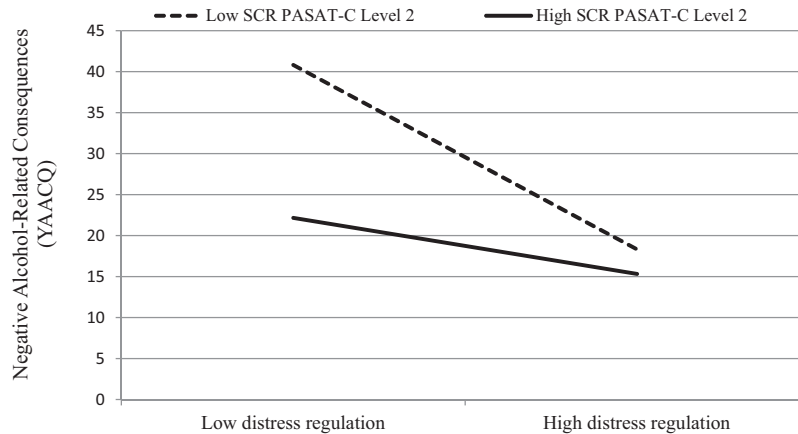


Figure 1. Predicted y-values for women, generated from moderating effects of skin conductance reactivity (SCR; SCR during Paced Auditory Serial Addition Task, Computerized (PASAT-C) Level 2) on the relationship between self-reported distress tolerance (Regulation subscale of Distress Tolerance Scale) and alcohol consequences (total score on Young Adult Alcohol Consequences Questionnaire; YAACQ). Low and high distress tolerance represent 1 *SD* above and below the mean.

adverse alcohol-related consequences. The interaction was also significant, such that women with the urge to quickly rid themselves of distress and lower reactivity to distress suffered more negative consequences from their alcohol use. Although all the women in this sample consumed alcohol, these women appeared to experience more consequences from their use—even after controlling for levels of depression, which itself is associated with low distress tolerance, lower physiological reactivity to stress, and more alcohol-related negative consequences (Wolitzky-Taylor et al., 2015; Gotlib, Joormann, Minor, & Hallmayer, 2008; Gonzalez, Reynolds, & Skewes, 2011). Thus, the unique interaction of these constructs (poor distress regulation and reduced physiological reactivity to stress) in women that may put them at particular risk for problematic alcohol use. Independently, reduced reactivity to stress has been shown to be a risk factor for depression (Gotlib et al., 2008), and low distress tolerance has been shown to be a risk factor for a number of emotional and substance-related disorders (Leyro et al., 2010). The current study shows that—when present in the same subset of women—these variables may interact to act as risk factors for alcohol misuse.

Limitations

The present findings should be considered within the context of some limitations. The current study was not experimental in nature, precluding any causal assumptions about our findings. Because the data were collected cross-sectionally, we cannot conclude that our predictor variables (poor distress regulation and reduced physiological reactivity to stress) preceded alcohol-related consequences. It is possible that a history of heavier drinking affected the women's ability to regulate distress—subjectively and physiologically. Furthermore, for the reasons highlighted in the introduction, we focused on women and therefore caution that the findings may not be applicable to men. Another limitation was that we used only single measures of subjective and behavioral distress tolerance. We can therefore not rule out that other measures might have identified different relationships. Thus, we restate the claim

that the measurement of distress tolerance is an area for continued research, and continued definitional clarifications and specifications of distress tolerance may be beneficial (Leyro et al., 2010). We did not assess for women's use of other substances prior to participating in the study session. However, the low levels of additional substances used and particularly the low rates of any daily use in this sample may mitigate this limitation with regard to its effect on the physiological measures the day of the experiment. Lastly, although the study aimed to explore potential risk factors for young adult women's excessive alcohol use, the sample was comprised of university students. It would seem important to repeat the current study with women who engage in more problematic alcohol use, or in a community rather than a college student sample, as this may lead to a further clarification of the role that the factors identified here play. However, based on the typical amount of alcohol consumed and the binge drinking episodes reported, almost half of the women in our sample drank at a risky level. This level of consumption allowed us to meet one of the goals of the study, that is, to identify factors associated with the risk for problematic drinking.

Future Directions

Subjective and physiological reactivity to distressing situations may be particularly relevant factors for women who misuse alcohol and/or experience adverse consequences from their alcohol use. As such, a clearer understanding of how various measures of reactivity to, and regulation of, distress work in concert and convey risk for problem drinking could inform treatment and prevention approaches for women. In addition, although there is substantial support for a suppressed physiological response to stress in women with AUD (Sinha et al., 2009), this study helped extend these findings to young adult women—and specifically to those who subjectively feel the need to quickly rid themselves of distressing feelings. We have suggested throughout the paper that the interactive association of low distress regulation and physiological reactivity to distress with consequences from alcohol use

may be mediated by coping motives for use. However, we did not assess whether these women consciously choose to drink in order to cope with their distress. Relatedly, we only measured negative and no positive consequences that women may experience from their alcohol use (e.g., relaxation from drinking). As mentioned in the introduction, research has shown that coping motives are tied to greater negative consequences from use and symptoms of dependence (Merrill & Read, 2010; Simons, Wills, & Neal, 2014; Pedrelli, Borsari, Lipson, Heinze, & Eisenberg, 2016), and we assume that women with low distress tolerance and dysregulated reactivity to distress are drinking to cope with distress and that they subsequently experience more adverse consequences from their drinking. This is an area for future research. In addition, these women's lower reactivity to a stressor and its association with alcohol use is not fully understood and is an area for continued research, not only in women with a diagnosable AUD but also more generally in young adults who are at risk for alcohol misuse.

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