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Depressive symptoms are a vulnerability factor for heavy episodic drinking: A short-term, four-wave longitudinal study of undergraduate women

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HIGHLIGHTS

- The study included 200 young women studied using a 4-wave, 4-week longitudinal design.
- Tested reciprocal relations between depressive symptoms and heavy episodic drinking
- Depressive symptoms influence heavy episodic drinking, but not vice versa.
- Results support the vulnerability model.

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ABSTRACT

Heavy episodic drinking is increasingly common among undergraduate women. Cross-sectional research suggests that depressive symptoms and heavy episodic drinking are related. Nonetheless, surprisingly little is known about whether depressive symptoms are an antecedent of heavy episodic drinking, a consequence of heavy episodic drinking, or both. Such knowledge is essential to the accurate conceptualization of heavy episodic drinking, depressive symptoms, and their interrelations. In the present short-term longitudinal study, depressive symptoms and heavy episodic drinking were proposed to reciprocally influence each other over time, with depressive symptoms predicting changes in heavy episodic drinking over 1 week and vice versa. This reciprocal relations model was tested in 200 undergraduate women using a 4-wave, 4-week longitudinal design. Structural equation modeling was used to conduct cross-lagged analyses testing reciprocal relations between depressive symptoms and heavy episodic drinking. Consistent with hypotheses, both depressive symptoms and heavy episodic drinking were temporally stable, and depressive symptoms predicted changes in heavy episodic drinking over 1 week. Contrary to hypotheses, heavy episodic drinking did not predict changes in depressive symptoms over 1 week. Results are consistent with a vulnerability model suggesting depressive symptoms leave undergraduate women vulnerable to heavy episodic drinking. For undergraduate women who are struggling with feelings of sadness, worthlessness, and hopelessness, heavy episodic drinking may provide a temporary yet maladaptive means of avoiding or alleviating depressive symptoms.

1. Introduction

Traditionally, heavy drinking was viewed more as a problem affecting men and as a result, women are underrepresented in theory and research on the heavy drinking (see Stewart, Gavric, & Collins, 2009 for a review). Disturbingly, rates of heavy drinking in young women are increasing, and becoming comparable to those seen in young men (Stewart et al., 2009). In a recent study, nearly two-thirds of undergraduate women reported heavy episodic drinking (consuming 4 or more drinks in 2 h) in a 2 week period—a level consistent with that of undergraduate men (Mushquash et al., in press). Among undergraduate women, heavy episodic drinking is tied to many problems, including physical injury, academic difficulties, unprotected sex, and sexual assault (Perkins, 2002). Given the lack of research specifically focusing on heavy drinking among undergraduate women, their increasing

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rates of heavy episodic drinking, and the accompanying negative outcomes, research clarifying antecedents and consequences of heavy episodic drinking in undergraduate women is needed.

Cross-sectional studies often show that depressive symptoms (e.g., sadness, irritability, fatigue, and sleep problems) and heavy episodic drinking are related (Archie, Zangeneh Kazemi, & Akhtar-Danesh, 2012). However, the temporal relationship between depressive symptoms and heavy episodic drinking among undergraduate women is less clear. In the present study, we conducted a 4-wave, 4-week longitudinal study testing short-term reciprocal relations between depressive symptoms and heavy episodic drinking to clarify the temporal relationship between these variables. We conceptualized and measured depressive symptoms and heavy episodic drinking using dimensional models in which both depressive symptoms and heavy episodic drinking were viewed as lying along a continuum of severity. Next, we review the available literature on the interrelations of depressive symptoms and heavy episodic drinking.

1.1. Vulnerability models of depressive symptoms and heavy episodic drinking

Vulnerability models suggest that depressive symptoms come before, and contribute to, heavy episodic drinking. This notion appears in various theories, including the self-medication model (Khantzian, 1997) and affect regulation model (Sher & Grekin, 2007). In general, vulnerability models assert that people with depression use alcohol for its negatively reinforcing properties (Stewart, Grant, Mackie, & Conrod, in press). Alcohol may be negatively reinforcing to people with depression since it relieves pain (Stewart & Conrod, 2008) or reduces negative self-awareness (Baumeister, 1991). While this research suggests that depression might be a precursor of alcohol use, less is known about depressive symptoms contributing to heavy episodic drinking specifically. One long-term longitudinal study of young adults does indicate that depressive symptoms (assessed with the Child Behavior Checklist; Achenbach, 1978) confer vulnerability to heavy episodic drinking (defined as the frequency of consuming five drinks in a row during the past year), especially among young women (Chassin, Pitts, & Prost, 2002).

1.2. Complication/scar models of depressive symptoms and heavy episodic drinking

In complication/scar models, depressive symptoms are seen as a consequence of heavy episodic drinking rather than a vulnerability for heavy episodic drinking (Schuckit, 2006). Complication models suggest that heavy episodic drinking results in transient, short-term increases in depressive symptoms, whereas scar models suggest that heavy episodic drinking results in permanent increases in depressive symptoms (Bagby, Quilty, & Ryder, 2008). We focus on the complication model as our research design does not allow us to test long-term changes in depressive symptoms. Some authors assert that depression might be alcohol-induced, with alcohol use preceding and producing depressive symptoms (Schuckit, 2006). Moreover, the physiological effects of alcohol use, or negative psychological outcomes associated with alcohol use, might increase depressive symptoms (Swendsen & Merikangas, 2000). While this research focuses on alcohol use and depression, one long-term longitudinal study of adult community members suggests that heavy episodic drinking (estimated by frequency of intoxication, hangovers, and alcohol-induced pass-outs) predicts depressive symptoms (assessed with the Beck Depression Inventory; Beck, Steer, & Garbin, 1988) 5 years later (Paljarvi et al., 2009). Using an experience sampling design in a sample of undergraduates, Hussong, Hicks, Levy, and Curran (2001) also found that heavier drinking on the weekend (based on the number of drinks consumed) predicted greater negative affect (assessed with the Positive and Negative Affect Schedule Expanded Form; Watson & Clark, 1994) during the week.

1.3. Reciprocal relations model of depressive symptoms and heavy episodic drinking

The reciprocal relations model (Stewart, Grant, Mackie, & Conrod, in press), combines the vulnerability model and the complication model into a single model where depressive symptoms contribute to heavy episodic drinking and heavy episodic drinking contributes to depressive symptoms (see Fig. 1). In this model, depressive symptoms and heavy episodic drinking are seen as co-occurring variables where changes in depressive symptoms are related to changes in heavy episodic drinking and vice versa. Instead of assuming that only unidirectional patterns exist between variables, the reciprocal relationship model tests whether depressive symptoms and heavy episodic drinking exert bidirectional influence on each other over time (see Fig. 1).

1.4. Advancing the literature on depressive symptoms and heavy episodic drinking

Knowing if depressive symptoms contribute to heavy episodic drinking, are a result of heavy episodic drinking, or both, is vital to accurately conceptualizing, assessing, and treating undergraduate women who experience depressive symptoms and/or heavy episodic drinking. The reciprocal relations model is a plausible integrative model for explaining relationships between depressive symptoms and heavy episodic drinking. To rigorously test the reciprocal relations model, improvements are needed. Existing studies on depressive symptoms and heavy episodic drinking often rely on cross-sectional designs (e.g., Archie et al., 2012), or long-term longitudinal designs (e.g., Chassin et al., 2002; Paljarvi et al., 2009). Cross-sectional designs fail to address key issues of temporal precedence and long-term longitudinal designs may overlook meaningful short-term relations between variables. A short-term, multi-wave longitudinal design (as used in the present study) tests the interplay between depressive symptoms and heavy episodic drinking and reduces recall bias by measuring events closer to their actual occurrence.

In measuring heavy episodic drinking, researchers often use a single item assessing heavy episodic drinking frequency over a specific time period (e.g., how many heavy episodic drinking episodes occurred over the last week; National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2003). Though this heavy episodic drinking frequency item does capture useful information, some suggest it is insufficient for assessing heavy episodic drinking among undergraduates (White, Kraus, & Swartzwelder, 2006). For example, undergraduates may drink far beyond the threshold for heavy episodic drinking (i.e., far beyond 4 drinks in 2 h), meaning key information on heavy episodic drinking severity is lost when using only a heavy episodic drinking frequency measure. Undergraduates also tend to underestimate the amount (or number) of drinks they consume—creating problems for heavy episodic drinking frequency and severity measures relying on accurate recall of drinks consumed over a specific time period (White, Kraus, McCracken, & Swartzwelder, 2003). Assessing general self-perceptions of heavy episodic drinking (e.g., "I rapidly drank a very large amount of alcohol") may capture information missed by drink count measures. In the present study, we operationalized heavy episodic drinking using three measures assessing heavy episodic drinking frequency, severity, and self-perceptions. These measures more thoroughly assess how often people engage in heavy episodic drinking, their peak consumption during episodes of heavy episodic drinking, and their perceptions about their heavy episodic drinking. Using multiple measures to create a latent variable also provides more precise estimates by taking measurement error into account and by reducing reliance on the potentially idiosyncratic properties of a single item (Kline, 2005).

1.5. Objectives and hypotheses

We tested the reciprocal relations model as it synthesizes the vulnerability model and the complication model. Based on prior research,

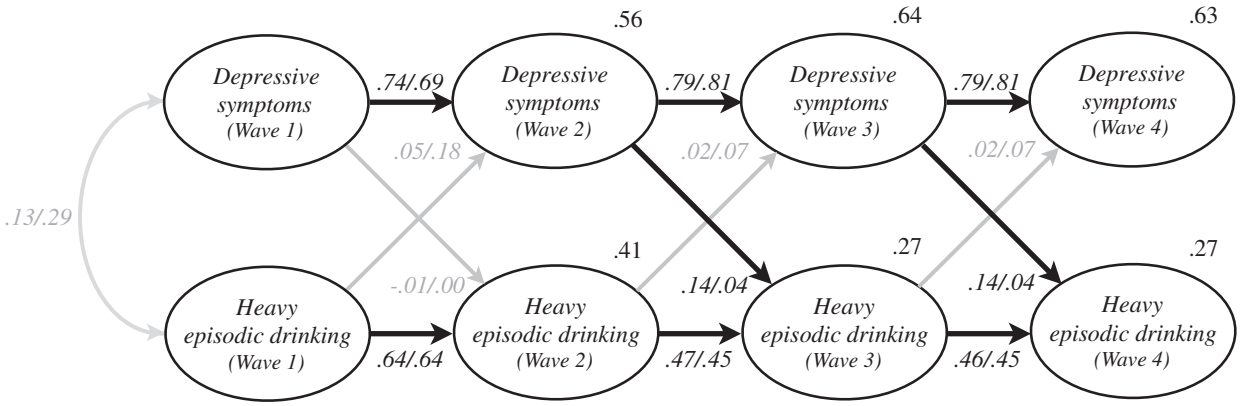

Fig. 1. Cross-lagged analyses testing reciprocal relations between depressive symptoms and heavy episodic drinking. Ovals represent latent variables. Gray paths are nonsignificant ($p > .05$). Black paths are significant ($p < .05$). The double-headed arrow represents a latent correlation. Autoregressive paths are represented by horizontal arrows; cross-lagged paths are represented by diagonal arrows. For each path, the first value presented is the standardized path coefficient and the second value presented is the unstandardized path coefficient. Italicized numbers (e.g., *.63*) appearing in the upper right hand of endogenous variables (e.g., depressive symptoms [Wave 4]) represent the proportion of variance accounted for by associated exogenous variables. In the interest of clarity, manifest variables and error terms are not shown.

we expected that, in undergraduate women, depressive symptoms and heavy episodic drinking will exhibit strong stability (McGrath et al., 2012; Mushquash et al., in press); and depressive symptoms and heavy episodic drinking will reciprocally influence each other over 1 week intervals (see Fig. 1; Chassin et al., 2002; Hussong et al., 2001; Paljarvi et al., 2009).

2. Method

2.1. Participants

We recruited 200 undergraduate women from Dalhousie University. They averaged 19.86 years of age ($SD = 3.02$) and 2.10 years of university education ($SD = 1.16$). Participants lived in Canada for an average of 18.29 years ($SD = 5.76$); 88.0% were Caucasian; and most were single (47.0%) or dating (40.5%). Our sample resembles other samples from Dalhousie University (e.g., Mushquash et al., in press).

2.2. Measures

Each latent variable was measured by three manifest indicators. As in previous short-term, multi-wave longitudinal research (Mackinnon & Sherry, 2012), we used a 7-day timeframe for all measures. Higher scores signify higher levels for all constructs measured. To decrease participant burden, depressive symptoms were measured with short forms of the Profile of Mood States depression subscale (POMS-D-SF; McNair, Lorr, & Droppleman, 1992), Depression Adjective Checklist (DACL-SF; Lubin, 1965), and Center for Epidemiological Studies Depression Scale (CES-D-SF; Radloff, 1977). The 4-item POMS-D-SF and the 4-item DACL-SF were derived from the highest factor loading items of the original scales (Bolger, Zuckerman, & Kessler, 2000). Participants responded to items (e.g., "sad") on a 5-point scale from 0 (*not at all*) to 4 (*extremely*). The 10-item CES-D-SF was derived from the original 20-item CES-D (Cole, Rabin, Smith, & Kaufman, 2004). Participants responded to items (e.g., "I felt lonely") on a 4-point scale from 1 (*rarely*) to 4 (*most or all of the time*). Evidence suggests that these measures are reliable (e.g., $\alpha s > .75$) and correlate strongly with the original scales ($rs > .85$; McGrath et al., 2012; Sherry & Hall, 2009). Cronbach's alphas for these scales are in Table 1.

For all heavy episodic drinking measures, 1 alcoholic drink was defined as a 12-ounce can or glass or bottle of beer or cooler, a 5-ounce glass of wine, or a drink containing 1 shot of liquor or spirits (see Stewart, Morris, Mellings, & Komar, 2006). The first measure assessed heavy episodic drinking frequency with one item recommended by the NIAAA (2003). We slightly modified the timeframe of this item and asked the participants: "During the past 7 days, how often did you have 4 or more drinks containing any kind of alcohol, within a 2 hour period?" Participants responded to this item on a 12-point scale from "0 times" to "10 or more times." Our modified heavy episodic drinking frequency measure is strongly correlated with NIAAA's (2003) original measure ($r = .62$; Sherry, Mushquash, & Stewart, 2012). The second measure was author-generated and assessed heavy episodic drinking severity with an open-ended question: "What is the greatest number of drinks you consumed in a 2 hour period during the past 7 days?" To determine the severity of each episode of heavy episodic drinking, we retained values at or above 4 drinks in 2 h (i.e., the standard definition of heavy episodic drinking) and all values less than 4 drinks were recoded to a value of 0. The third measure was author-generated and assessed participants' perceptions of their heavy episodic drinking using a 3-item scale. Items (i.e., "During the past 7 days, there were times when I rapidly drank a very large amount of alcohol within a 2 hour period;" "The average person would be amazed if s/he knew how much alcohol I consumed within a 2 hour period (during the past 7 days);" and "During the past 7 days, there were times when I drank what other people would regard as an unusually large amount of alcohol within a 2 hour period") were rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Cronbach's alpha for this scale is in Table 1.

2.3. Procedure

The Social Sciences and Humanities Research Ethics Board at Dalhousie University approved our study. Participants were recruited from the psychology participant pool. Participants visited our lab (on various days of the week between Monday and Friday) and completed scales once a week for 4 weeks. Data collection occurred from September to November of 2008, and from January to February of 2009. Demographics were collected at Wave 1; otherwise, scales were the same in all waves. After Wave 4, participants were debriefed and compensated $10 and 3.0% bonus for a course. Attrition was low: 200 participants completed Wave 1; 198 participants (99.0%) completed Wave 2; 189 participants (94.5%) completed Wave 3; and 191 participants (95.5%) completed Wave 4. Weekly reports were provided in a timely manner: Waves 2, 3, and 4 occurred 7.02 ($SD = 0.41$), 14.13 ($SD = 0.67$) and 21.12 ($SD = .96$) days after Wave 1, respectively.

2.4. Data analysis

Using the VARCOMP program in SPSS 15.0, generalizability theory partitioned the variance of depressive symptoms and heavy episodic

Table 1
Means, standard deviations, alpha reliabilities and factor loadings for depressive symptoms and heavy episodic drinking.

Variable	Wave 1				Wave 2				Wave 3				Wave 4			
	M	*SD*	α	Loading	*M*	*SD*	α	Loading	*M*	*SD*	α	Loading	*M*	*SD*	α	Loading
Depressive symptoms																
POMS-D	3.81	3.05	.78	.94	3.43	3.01	.77	.95	3.01	3.00	.78	.93	2.95	3.14	.79	.89
DACL	2.28	3.06	.83	.91	2.00	2.78	.81	.89	1.69	2.69	.82	.94	1.75	2.91	.84	.94
CES-D	16.94	4.89	.71	.78	16.45	4.74	.80	.79	15.86	4.50	.81	.81	15.98	4.85	.82	.79
Heavy episodic drinking																
Frequency	0.74	1.10		.74	0.65	0.92		.87	0.54	0.87		.90	0.54	0.81		.94
Severity	5.75	1.66		.92	5.61	1.60		.93	5.66	2.09		.91	5.47	1.57		.89
Perception	5.08	2.76	.80	.89	4.92	2.86	.83	.88	4.72	2.89	.87	.86	4.59	2.44	.77	.91

Note. POMS-D = Profile of Mood States depression subscale short form (McNair et al., 1992); DACL = Depression Adjective Checklist (Lubin, 1965); CES-D = Center for Epidemiological Studies Depression Scale short form (Cole et al., 2004; Radloff, 1977); Loading = Standardized factor loading for structural model. Only values meeting the criteria for an episode of heavy episodic drinking (i.e., 4 or more drinks in 2 h) were used to calculate the mean and standard deviation for the heavy episodic drinking severity variable. Heavy episodic drinking frequency and heavy episodic drinking severity were measured with a single item; therefore, alpha reliabilities are not available.

drinking across item, person, wave, and their interactions. Confirmatory factor analysis (CFA) tested the measurement model. Structural equation modeling (SEM) was used to conduct cross-lagged analyses testing reciprocal relations between depressive symptoms and heavy episodic drinking. Acceptable model fit is suggested by a χ^2/df around 2, a comparative fit index (CFI) at or exceeding .95, and a root mean square error of approximation (RMSEA) at or below .08 (Byrne, 2006). RMSEA values are reported with 90% confidence intervals (CI). CFA and SEM were performed with AMOS 7.0.

3. Results

3.1. Missing data and multivariate nonnormality

After accounting for attrition, only the heavy episodic drinking severity item had missing data (0.5 to 7.5% missing across all waves). We handled missing data with expectation maximization imputation. Small's omnibus test (DeCarlo, 1997) showed that measures were multivariate nonnormal. We corrected for nonnormality by using bias-corrected bootstraps with 20,000 bootstrap samples (Nevitt & Hancock, 2001).

3.2. Descriptive statistics

Means (see Table 1) for measures of depressive symptoms and heavy episodic drinking frequency were consistent with research involving comparable samples (e.g., Mushquash et al., in press; Sherry & Hall, 2009). As in earlier studies (e.g., Wechsler et al., 2002), many participants in our study engaged in heavy episodic drinking (39.6% at week 1; 40.1% at week 2; 34.1% at week 3; and 35.8% at week 4).

3.3. Variance partitioning

Generalizability theory was used to decompose the variance of depressive symptoms and heavy episodic drinking attributable to each item, each person, each wave, and their interactions (see Cranford et al., 2006). For both depressive symptoms and heavy episodic drinking, person variability and person-by-wave variability accounted for a large proportion of the variance. These results suggest that there are between-person differences in depressive symptoms and heavy episodic drinking across all waves and across all items. Generalizability theory analyses also showed between-person differences in depressive symptoms and heavy episodic drinking at different waves across all items (see person-by-wave interactions in Table 2). Thus, although depressive symptoms and heavy episodic drinking are stable, there is also between-person change in these variables from one week to the next, suggesting a need to explain this variability.

Another noteworthy finding is the 14.6% of the variance in heavy episodic drinking due to differences in item responses. Our heavy episodic drinking latent variable was comprehensive in that we included the traditionally administered heavy episodic drinking frequency item and two other novel measures assessing heavy episodic drinking severity and heavy episodic drinking perception. However, the item variance shown in Table 2 suggests that there is some variability depending on how one measures heavy episodic drinking (e.g., frequency, severity, or perception). This variability might be attributed to differential item salience, differential item means, or unreliability in measurement.

3.4. CFA

Factor loadings for corresponding manifest indicators of each latent variable were constrained to equality over time. We compared the constrained and unconstrained model and found a CFI change of .002, suggesting constraining the factor loadings to equality over time is empirically justified (see Cheung & Rensvold, 2002). The measurement model fits the data well: χ^2 (200, $N = 200$) = 421.28, $p < .001$; $\chi^2/df = 2.11$; CFI = .96; RMSEA = .08 (90% CI: .07, .08). Standardized factor loadings were significant ($p < .001$) across all four waves (.90–.95 for the POMS-D-SF; .89–.94 for the DACL-SF; .78–.82 for the CES-D-SF; .74–.93 for heavy episodic drinking frequency; .88–.93 for heavy episodic drinking severity; and .87–.91 for heavy episodic drinking perception).[1] These results suggest that the latent variables of the reciprocal relations model are measured well by their respective manifest indicators and progression to SEM is indicated.

3.5. SEM

Wave 1 variables establish a baseline and do not assess change (see Burkholder & Harlow, 2003). As such, Wave 1 variables are not discussed. We used autoregressive paths (e.g., Wave 2 heavy episodic drinking ➔ Wave 3 heavy episodic drinking) to test interindividual stability, and we used cross-lagged paths (e.g., Wave 2 depressive symptoms ➔ Wave 3 heavy episodic drinking) to test whether a change in one variable (e.g., Wave 2 depressive symptoms) contributed to a change in another variable (e.g., Wave 3 heavy episodic drinking). Factor loadings for corresponding manifest indicators of each latent variable were expected to be stable from one wave to the next; hence, these paths were constrained to equality across waves. In addition, since we expected autoregressive paths and cross-lagged paths involving Waves 2, 3, and 4 to be consistent across time, these paths were constrained to equality. We compared the constrained and unconstrained model and found a nonsignificant difference with a CFI change of only .002, suggesting equality constraints are justified on empirical grounds (Cheung & Rensvold, 2002). Corresponding error terms were also correlated across waves (Cole & Maxwell, 2003).

[1] All latent correlations were significant and are available upon request.

Table 2
Variance components for depressive symptoms and heavy episodic drinking.

Source of variance	Depressive symptoms (18 items)	Percentage of overall variance	Heavy episodic drinking (5 items)	Percentage of overall variance
Person	182.43	73.11	102.86	41.04
Wave	2.63	1.05	0.00	0.00
Item	0.87	0.36	36.59	14.60
Person-by-wave	63.23	25.34	81.32	32.45
Person-by-item	0.31	0.12	22.46	8.96
Wave-by-item	0.00	0.00	3.45	1.38
Error	0.06	0.02	3.95	1.57
Total	249.53	100.00	250.63	100.00

Note. Person, wave, and item variability were treated as random factors. Person = variance due to between-persons differences across all waves and all items; Wave = variance due to weekly differences across all persons and all items; Item = variance due to responses to scale items across all persons and all waves; Person-by-wave = variance due to between-persons differences at different waves across all items; Person-by-item = variance due to between-persons differences in responses to scale items across all waves; Wave-by-item = variance due to weekly differences in responses to scale items across all persons; Error = systematic error plus random error (Cranford et al., 2006). In estimating variance components, we observed a small (i.e., near zero) negative variance. Such variances are often observed and are typically attributed to sampling error (Brennan, 2001). Negative variances are not theoretically possible; therefore, we followed recommendations to set the negative variance to zero (Brennan, 2001).

The overall reciprocal relations model (see Fig. 1) had acceptable fit: χ^2 (216, N = 200) = 488.47, p < .001; χ^2/df = 2.26; CFI = .95; RMSEA = .08 (90% CI: .07, .09). Consistent with hypotheses, autoregressive paths were significant (p < .001) for depressive symptoms and heavy episodic drinking suggesting these variables are stable over time. Path coefficients for autoregressive paths involving depressive symptoms were stronger than those involving heavy episodic drinking. Cross-lagged paths from depressive symptoms to heavy episodic drinking were significant (p < .01); however, contrary to hypotheses, cross-lagged paths from heavy episodic drinking to depressive symptoms were not significant.[2] These results suggest that depressive symptoms influence future heavy episodic drinking (over a 1 week period), whereas heavy episodic drinking does not influence future depressive symptoms (over a 1 week period).

4. Discussion

Building on past work (e.g., Chassin et al., 2002; Hussong et al., 2001; Paljarvi et al., 2009), we proposed the reciprocal relations model in Fig. 1 and used a stringent research design to test if depressive symptoms and heavy episodic drinking reciprocally influence each other over a 1 week period. Results partly supported our hypotheses: (a) depressive symptoms and heavy episodic drinking were highly stable over 1 week; and (b) depressive symptoms significantly predicted heavy episodic drinking over 1 week. Counter to our hypotheses, heavy episodic drinking did not significantly predict depressive symptoms over 1 week.

In the present study, we introduced a novel heavy episodic drinking latent variable, which was supported by a well-fitting measurement model involving substantial and significant factor loadings. This variable assessed how often participants engaged in heavy episodic drinking, their peak alcohol consumption during an episode of heavy episodic drinking, and their perceptions of their heavy episodic drinking. Researchers wanting a more comprehensive measure of heavy episodic drinking may be interested in using this latent variable.

Auto-regressive paths in Fig. 1 assess interindividual stability (i.e., the degree to which the rank ordering of individuals on a measure is maintained over time). Our results suggested that undergraduate women with depressive symptoms in the past tend to experience depressive symptoms in the future (see also Tram & Cole, 2006), and one of the strongest predictors of whether undergraduate women will engage in future heavy episodic drinking is whether they engaged in past heavy episodic drinking (see also Mushquash et al., in press). While these analyses, and the variability attributed to person in our generalizability theory analyses, suggested both depressive symptoms and heavy episodic drinking are highly stable, significant person-by-wave variability was also observed. Thus, meaningful changes in depressive symptoms and heavy episodic drinking occurred during our short-term longitudinal study, suggesting merit in trying to explain these changes with our reciprocal relations model.

Depressive symptoms are often discussed as a vulnerability factor that predisposes heavy episodic drinking (Chassin et al., 2002). Our results are consistent with the vulnerability model and research suggesting undergraduate women may drink to excess when suffering from depressive symptoms. Undergraduate women struggling with depressive symptoms are faced with frequent self-critical thoughts and feelings of sadness, hopelessness, and worthlessness. For these women, heavy episodic drinking may be negatively reinforcing since it provides an opportunity for temporarily distraction from harsh self-criticism or depressing feelings (Baumeister, 1991; Stewart & Conrod, 2008). These undergraduate women may also possess risky drinking motives (i.e., reasons for drinking), such as coping motives, where people drink alcohol to avoid or alleviate negative emotional states (Cooper, 1994). Research shows that coping with depression motives moderates the link between daily depressed mood and heavy drinking (Grant, Stewart, & Mohr, 2009); thus, an undergraduate woman's motivational system may represent a key underlying mechanism explaining the depressive symptoms–heavy episodic drinking link (Grant et al., 2009). Further research is needed to test these possibilities.

In the present study, heavy episodic drinking did not contribute to increases in depressive symptoms over 1 week, thereby failing to support complication paths in the reciprocal relations model (see Fig. 1). Research consistent with the complication model assessed people across several days (Hussong et al., 2001) or across several years (e.g., 5 years; Paljarvi et al., 2009). Thus, it is possible that complication effects are only evident over very short (daily) timespans in which physiological effects of alcohol use are pertinent (e.g., hangover effects) or over long timespans where the cumulative effects of heavy episodic drinking lead to depressive symptoms over time (Mackie, Conrod, & Brady, 2012). In addition, auto-regressive paths suggest that depressive symptoms exhibit higher interindividual stability than heavy episodic drinking, meaning less variability in depressive symptoms was available to be explained by heavy episodic drinking. Thus, the stability of depressive symptoms may have influenced our results.

4.1. Limitations, future research, and implications

We used two novel measures of heavy episodic drinking. As less is known about these measures and our analyses indicate that some variability in heavy episodic drinking is due to differences in responding to scale items, more research testing the psychometric properties of these novel measures is needed. Our study also relied on self-reported depressive symptoms and heavy episodic drinking. Self-reports may be inaccurate if participants lack insight or inaccurately recall events. Future studies might collect reports from both participants and informants to obtain more comprehensive assessments of depressive symptoms and heavy episodic drinking. In the present study, we included only depressive symptoms and heavy episodic drinking in our model. It is possible that common etiological variables, not measured in the present study,

[2] We also tested the reciprocal relations model using the more traditional NIAAA heavy episodic drinking frequency measure in place of the heavy episodic drinking latent variable. Results closely resembled cross-lagged analyses reported using the heavy episodic drinking latent variable. That is, autoregressive paths were significant (p < .001) and depressive symptoms significantly predicted heavy episodic drinking (p < .01), but not vice versa.

account for the co-occurrence of depressive symptoms and heavy episodic drinking (Stewart & Conrod, 2008). Potential variables include common genetic factors, common personality traits (e.g., hopelessness), or environmental risk factors (Stewart et al., in press). Our sample involved only undergraduate women. It is unclear whether results will generalize to other samples (e.g., undergraduate men, psychiatric patients). Some evidence suggests that the relationship between depressive symptoms and heavy episodic drinking may differ for men and women (Sabourin & Stewart, 2009; Stewart et al., 2009), thus it is important that future research tests the moderating role of gender in the reciprocal relations model.

The present study suggests that a reduction in depressive symptoms may contribute to a corresponding reduction in heavy episodic drinking. Alcohol-use risk-reduction interventions (see Carey, Scott-Sheldon, Carey, & DeMartini, 2007 for a review) might be expanded to include evidence-based psychoeducation and interventions targeting depressive symptoms. That said, we concede that these implications go beyond the data collected in the present study and should be viewed with caution or provide impetus for future treatment research.

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Contributions

Simon B. Sherry, Sherry H. Stewart, and Dayna L. Sherry designed the study and wrote the protocol. Aislin R. Mushquash conducted literature searches, provided summaries of past research studies, conducted statistical analyses (except for the generalizability theory analyses), and wrote the first draft of the manuscript. Dayna L. Sherry conducted the generalizability theory analyses. All authors provided feedback on the manuscript. All authors approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

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