Conduct Problems Moderate Self-Medication and Mood-Related Drinking Consequences in Adolescents

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Abstract

Objective—We tested whether conduct problems moderate the relation between negative mood and drinking in adolescents as consistent with either a self-medication or a drinking consequences model.

Method—The sample included 75 rising ninth graders who completed a two-stage, multi-method, multi-reporter study. We used experience sampling to assess negative mood and drinking over 21 days and Hierarchical Linear Modeling to test our hypotheses.

Results—Counter to predictions, both self-medication and drinking consequence mechanisms were only evident in youth with fewer conduct problems.

Conclusions—Findings provide support for the importance of considering multiple mechanisms as underlying the relation between negative mood and drinking as pertaining to sub-populations of vulnerable youth. Implications for prevention and understanding negative mood-drinking relations in adolescents are discussed.

The relation between negative mood and drinking continues to cultivate notable interest, despite mounting evidence that the two are only weakly associated (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Current approaches to testing this relation may in part explain why stronger effects have not been reported, particularly in adolescents. First, few studies consider alternative mechanisms to self-medication in testing the relation between negative mood and drinking even though such alternatives may be equally powerful in explaining this association (Hussong, Hicks, Levy & Curran, 2001). Second, cross-sectional and long-term prospective research designs used in studies supporting self-medication in adolescents are poorly suited to tests of this mechanism. Whereas studies of adults have used more temporally consistent experience sampling methods (ESM) to examine short-term covariation between mood and drinking (Hussong et al., 2001; Park, Armeli, & Tennen, 2004), no studies have used such methods to test this relation in adolescents. Third, many studies continue to test the main effect of negative mood on adolescent drinking, even though current formulations emphasize individual differences in vulnerability to self-medication (e.g., Cooper, Frone, Russell & Mudar, 1995; Cooper, Russell, Skinner, Frone & Mudar, 1992; Kushner, Sher, Wood & Wood, 1994). In the current study, we addressed these three limitations by testing whether conduct problems moderate the relation between daily negative mood and adolescent drinking through either a self-medication (in which negative mood leads to drinking) or drinking consequences (in which drinking leads to negative mood) model.

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Mechanisms underlying negative mood-drinking relations

Evidence for a weak but consistent prediction of drinking from negative affect (i.e., more stable patterns of negative mood), internalizing symptoms and depression in adolescents is often interpreted as support for a self-medication process in youth (e.g., Halfors, Waller, Bauer, Ford, & Halpern, 2005; Tschann, Adler, Irwin, Millstein et al., 1994). The methods used by these studies test inter-individual differences in mood-drinking relations (i.e., identifying differences between youth in risk for drinking) based on repeated assessments separated by months or years. Such methods are a poor fit to the self-medication hypothesis which posits a short-term process and includes predictions about intra-individual differences (i.e., identifying within-person factors related to risk for drinking). Thus existing studies provide stronger support for alternative interpretations of mood-drinking relations, such as Kaplan's (1980) self-derogation model. This model posits that negative affect related to peer rejection may lead adolescents to seek alternative peer groups often formed of deviant adolescents. Affiliations with such peer groups are then the proximal influence on drinking behavior. Because the intervention implications of self-medication and self-derogation models differ, it is important to differentiate them methodologically. For this reason, designs that capture the timeline and within-person process of self-medication are needed to optimally test this hypothesis.

Studies of adult drinking have used more time-sensitive methods, such as ESM, to examine the short-term covariation between negative mood and drinking that more closely approximates the self-medication process (e.g., Hussong et al., 2001; Park et al., 2004). These methods and related analytic techniques can differentiate intra- and inter-individual differences and test whether daily variation in an individual's negative mood (or intra-individual effects) predict drinking once inter-individual differences in negative affect are considered. Although daily assessment studies of adults report only weak support for intra-individual effects of negative mood on drinking, evidence of meaningful inter-individual variation in these patterns of covariation has also been found. Thus, important moderators are needed to identify those most vulnerable to self-medication as defined through these methods.

In addition, such daily assessment methods are well-suited to testing a drinking consequences model in which negative mood results from drinking experiences. The influence of drinking on negative mood may be physiologically mediated, as previous studies indicate a direct effect of high doses of alcohol on negative mood within a drinking episode, or indirectly mediated, via experiences that occur within drinking episodes (Sher & Grekin, 2007). Such indirect effects may result, for example, from engaging in risky or socially embarrassing behaviors while drinking (e.g., risky sexual behavior or physically dangerous acts) or incurring sanctions for drinking (e.g., legal repercussions or adolescent-parent conflict), each of which may lead to emotional distress secondary to drinking-related behaviors (Windle, 1999). The drinking consequences model may also act in concert with self-medication. That is, negative mood and drinking may show bi-directional relations such that a negative cycle forms in which drinking becomes both a means to cope with triggering negative mood but also a means for increasing subsequent negative mood (Baker et al., 2004).

Conduct problems as a moderator

Previous research shows that conduct problems moderate the relation between depression and substance use in cross-sectional (Capaldi, 1991; Hussong & Chassin, 1994), though not prospective (Capaldi & Stoolmiller, 1999), analyses. However, the lack of prospective evidence for moderation in these studies may again be due to the use of methods poorly

suited to test self-medication. Conduct problems may define sub-populations vulnerable to both self-medication and drinking consequences, though mechanisms of vulnerability may differ over the two models. For example, adolescents with greater conduct problems show deficits in generating and selecting successful options for problem-solving. These deficits may exacerbate distress and increase the likelihood of selecting poor coping alternatives, such as drinking (Fontaine, Burks, & Dodge, 2002). As such, conduct problems may increase risk for self-medication due to cognitive styles that promote risky behaviors as a coping response to negative mood (Hussong & Chassin, 1994; Pardini, Lochman, & Wells, 2004). In addition, negative consequences of drinking, including mood, may be elevated in adolescents high in conduct problems because such problems are associated with a heavier, more problematic style of drinking (Bates & Labouvie, 1995). Few studies have examined whether different forms of conduct problems vary in their relation to drinking and none have considered such differences in these problems as moderating either a self-medication or drinking consequences model.

The Current Study

The current study tested the hypotheses that adolescents with greater conduct problems are more likely to self-medicate, as evidenced by a greater risk for drinking on days subsequent to high negative mood, and to show negative mood-related drinking consequences. We used a multi-method, multi-reporter strategy and ESMs to examine these mechanisms in an elevated risk sample preparing for the transition to high school, a time generally considered stressful for adolescents that offers opportunities for social reorganization (Brown, 2004). Thus, this developmental period may be a time in which mood-drinking associations begin to emerge.

Method

Participants

Participants were recruited through a two-stage design. In the first stage, 399 of 436 8th grade students in participating schools completed classroom-administered surveys. In stage two, we recruited a subset of stage one participants for more intensive assessments conducted in the summer between 8th and 9th grade. We elected summer assessments to accommodate the intensity of the experience sampling paradigm and to avoid privacy concerns with assessing illegal behaviors online in a school setting. To increase reported drinking in stage two, we oversampled participants who reported drinking initiation or friendships with drinking peers in stage one. We determined level of risk for drinking using a six-point scale comprised of self-reported lifetime and current alcohol use as well as peer drinking (e.g., endorsement of all three indicators was the highest risk category). We formed a recruitment list by rank ordering all stage one participants on this risk indicator (i.e., from high to low), ranking at random those sharing equivalent scores. We recruited participants in rank order from this list until the end of our recruitment period. We attempted to contact the first 196 participants on the recruitment list (including all 169 participants who listed any level of risk on the 6-point index as well as 27 participants who indicated no risk on this index), with 81 completing the study (i.e., 41% of those targeted for recruitment, $n = 196$, or 57% of those eligible and contacted for recruitment, $n = 142$). Primary reasons for non-participation were inability to contact (n=33), ineligibility (n=21, language barrier, moving, did not pass grade, child death), limited availability (n=17), discomfort with the sampling paradigm (n=5), and privacy concerns (n=11). (N=28 non-participants provided no reason.)

Participants in stage 2 completed a multi-component battery over three weeks. In the current study, our sample included those who completed all relevant measures in the stage 2 battery, or 75 participants. This sample was 45% male and 55% white, 20% black, 21% multiracial

and 4% other. Adolescents had an average age of 13.6, with 16% of parents having a high school education or less and 55% of parents having at least a college education. 89% of participants reported initiating or having friends who had initiated substance use, reflecting our intention to oversample youth at risk for drinking. As expected, participants in the analysis sample (N=75) differed from their peers in stage 1 (N=324) by reporting more frequent alcohol use ($t(393)=5.01$, $p<.001$; $M=1.48$ vs. 0.67) and more friends who used substances ($t(393)=3.11$, $p<.01$; $M=0.98$ vs. 0.65) as well as higher levels of depressive symptoms ($t(395)=3.58$, $p<.001$; $M=0.65$ vs. 0.44), delinquency ($t(394)=2.62$, $p=.01$; $M=0.50$ vs. 0.32), physical aggression ($t(394)=3.03$, $p<.01$; $M=0.75$ vs. 0.47), and, to some extent, non-physical conduct problems ($t(393)=1.91$, $p=.06$; $M=0.85$ vs. 0.67). There were no gender differences, although stage two participants were more likely to be ethnic minority ($\chi^2(1, N=399)=6.55$, $p=.01$) than were those in stage one. As such, we successfully recruited an elevated risk sample.

Moreover, participants in our analysis sample (N=75) were more likely than the remaining adolescents targeted for stage 2 participation (N=121) to be ethnic minority ($\chi^2(1, N=196)=4.90$, $p<.05$) and female ($\chi^2(1, N=196)=5.20$, $p<.05$) as well as somewhat more likely to be depressed ($t(193)=1.72$, $p<.10$; $M=.65$ vs. 0.52). There were no recruitment biases as a function of peer substance use, adolescent alcohol use, delinquency, physical aggression, or non-physical conduct problems. Thus, our analysis sample is highly representative of our targets for recruitment on key indicators of substance use, though it may over-represent adolescents with depression as well as female and ethnic minority adolescents.

Procedures

Seven of nine schools housing 8th graders in a rural, school district participated in the first stage of the study. Parents were informed about the study through letters mailed to their homes (as well as sent directly home with students) and were asked to contact the PI if they did not want their children invited to participate in the study (3% did so). Information about the study was made available for parents to review in each school. Pairs of research assistants conducted classroom-based assessments of 8th graders in which they explained the study to students, obtained informed consent, and administered surveys. Teachers were invited to stay during testing but were asked not to interact with students to protect confidentiality. Students received a token gift and schools received a financial gift for participating in the study. One make-up day per school was also held to assess students absent on the original testing day.

In the second stage of the study, adolescents and their parents were recruited via mail and phone. Participants completed a three-week protocol that included an initial visit, a 21-day experience sampling protocol, and a final visit (not analyzed here). At the initial visit, pairs of research assistants met with the adolescents and one of their parents either in their homes or at the university. Research assistants obtained written consent and assent and interviewed parents and adolescents in separate rooms, using a white noise machine to protect privacy. Adolescents completed a computer-administered interview in which research assistants read aloud questions and adolescents entered their responses privately. Sensitive questions, concerning substance use, were administered via an audio-casi procedure. Research assistants also read aloud questions to parents who recorded their answers privately using paper-and-pencil methods. Adolescents and their parents each received $15 for completing this interview.

At the end of the interview, adolescents received instructions in an experience sampling paradigm. Research assistants provided adolescents with a watch pre-programmed to sound four times daily over the next three weeks. Attached with velcro to the back of the watch

was a 1" × 1" pouch containing a booklet of (accordion style) folded brief surveys that could be slipped out. Participants used attached stickers to rate their mood for each of three daily alarms. These three alarms were set at randomly selected times between 10AM–2PM, 2PM–6PM, and 6PM–10PM to capture varying mood over the day. The fourth alarm was set at 10PM to remind participants to complete daily substance use ratings, however participants were instructed to fill out these ratings based on use that occurred prior to going to bed (whenever that occurred). For confidentiality, these ratings were obscured (see methods) and stored in a private place in the home identified by the adolescent. (Adolescents were given a small box in which to store these reports that they put in a private location in their bedrooms with the examiner present but not the parent.) At the end of each day, adolescents were encouraged to call the research project toll-free to read their data for the day, as a back-up system for lost data (72% did so on at least 3 days). Adolescents received $1 per day of recordings and were also entered in a lottery for three $30 prizes for each time they called in their data.

More sophisticated ESMs incorporate palm pilot technologies capable of such benefits as timestamping data, increased privacy and more complicated questionnaire administration. At the time of this study, such technology was available but poorly suited to the needs of adolescents on summer schedules in rural communities. Our data collection devices had several advantages to increase compliance, including being waterproof (important to outdoor summer activities), wearable (no pens or pencils necessary, everything was affixed to a watch), easy to use and brief. No participants reported problems using the device and the oversized watches were even considered fashionable by some.

Measures

Demographics—In stage 1, adolescents self-reported gender and ethnicity. In stage 2, parents reported mother and father educational status, with the higher of these two forming a parent education indicator.

Daily mood and drinking—In stage 2, participants completed three mood ratings at randomly sampled times throughout each of 21 days. Using a five-point scale ranging from "not at all" to "very", they rated their mood in the moment with items based on the MAACL-R (Zuckerman & Lubin, 1985) to assess four indicators of negative mood (i.e., "How worried do you feel now" with similar items for stressed, sad and mad). Affect items were based on dimensions most often considered for self-medication research (e.g., Hussong et al., 2001; Park, Armeli, & Tennen, 2004). Item wording was guided by the desire to select age appropriate descriptors of these dimensions such as those in the MAACL-R which has been validated for 6th graders (Zuckerman & Lubin, 1985). We formed indices of daily negative mood by averaging across the maximum rating for each of the four items within each of 21 days. The resulting daily reports of mood were adequately reliable (average = .79).

Adolescents were instructed to complete daily ratings of alcohol use either in response to an alarm at 10 PM or prior to going to bed (to capture late night or early morning use). These reports thus assessed use between waking in the morning and going to bed at night for each day. On a slip of paper for each day, participants placed stickers over a number (0 to 5+) to indicate the quantity of alcoholic drinks they had that day. (To obscure the meaning of the reports for privacy, no actual questions were written on these slips of paper, just the numbers 0 to 5+, the letter "M" to assess marijuana use and the letter "D" to assess other drug use.) For current analyses, daily alcohol use was dichotomized as use versus no use. To increase confidence in the validity of these reports, we examined correspondence between data collected via the recording booklets versus nightly phone calls, patterns of missingness in

the data, between and within person drinking frequencies, and the comparability of these ratings with national norms and our other measures of drinking.

First, we compared data collected from the recording device with that phoned in by our adolescents and developed a quality rating system for each datum. Ratings ranged from "very confident" where the two forms of reported data overlapped (45%) to "skeptical" where only booklet ratings were available and stickers were placed in between response options (less than 1%). For the current analyses, we only used data in which we were "confident" (99.5%), that is in which a participant clearly reported their mood or drinking in at least one form.

In order to have complete data on a given day, an adolescent had to report on at least one of the three daily mood ratings as well as the substance use rating for that evening. We had data for 87% (or 1309 out of 1500) of our days of assessment. The number of days of missing data per participant ranged from 0–20, however 90% of the sample reported at least 14 days of complete data, with an average of 18.3 observations per adolescent. Drinking occurred on 43 out of 1309 observations. Just over one quarter (27%) of adolescents used some alcohol during the sampling period, and the frequency of use ranged from 5–50% of the total days. As expected for this elevated risk sample, these ratings are higher than retrospective thirty day reports of drinking in 8th graders assessed within the Monitoring the Future Study (17.1%; Johnston, O'Malley, Bachman, & Schulenberg, 2006) and are fairly consistent with 3-week retrospective reports of drinking corresponding to the timing of the experience sampling protocol as assessed during the final visit of our stage 2 interview (36%; $^2(1)=25.88$, p<.001).

Analyses examining the self-medication hypothesis required complete daily data for the previous day's negative mood and next day's drinking and analyses examining the drinking consequences model required complete data for previous day's alcohol use and next day's negative mood, resulting in a slightly different pattern of missingness across the two sets of analyses. We had a total of 1238 complete daily assessments from the 75 participants in both sets of analyses. To appropriately align our data for analyses, we created variables indexing previous day's negative mood and next day's alcohol use for tests of self-medication as well as variables for previous day's drinking and next day's negative mood for tests of drinking consequences. Descriptive data and correlations among study variables, including all four daily assessment variables, are reported in Table 1.

In addition to daily measures of negative mood and drinking, our analyses included aggregated measures for each of these constructs, calculated by averaging over all available reports within each person (i.e., the aggregated negative mood and drinking indices in Table 1). Finally, analyses also included an indicator of 'weekday', indexing whether the current assessment day occurred on a weekend (Friday or Saturday night, when drinking rates increase) versus a weekday.

Conduct problems—Three indicators of conduct problems were assessed by adolescents and their parents in stage 2 using the Problem Behavior Frequency Scale (16 items; Farrell, Kung, White & Valois, 2000). Items from this scale pertaining to alcohol use (as overlapping with the outcome) and school incidents (as irrelevant to summer interviews) were dropped. The scale assessed delinquency (2 items; sample item "damaged school or other property that did not belong to you"), physical aggression (7 items; sample item "been in a fight in which someone was hit") and non-physical conduct problems (7 items; sample item "put down someone to their face") in the past three months as rated on a 0- ("never") to 5- ("20 times or more") point response scale. Although the delinquency scales had low reliability, we retained these scales because this index is likely an underestimate given that

few items comprise the scales. Items within subscale were averaged to form the six scales (i.e., delinquency, physical aggression, and non-physical aggression for adolescent and parent report) used in subsequent analyses (see Table 1). 95% of adolescents and 91% of parents reported that teens engaged in some level of at least one of these 16 conduct problems and 8% of adolescents and 6% of parents reported that teens engaged in some level of 10 or more of these problems.

Results

Testing the self-medication model

We used random-coefficients or mixed modeling to test all study hypotheses. This approach can disaggregate between- and within-person effects, critical to our test of the self-medication hypothesis. Previous studies of self-medication in adolescents have focused on between-person effects (or inter-individual differences) that compare across youth to determine whether those with greater negative mood report more drinking involvement. However, the self-medication hypothesis emphasizes within-person effects which examine whether a given adolescent is more likely to drink on days following greater distress than usual for him or her. Our focus is on the moderating influence of conduct problems on self-medication which we tested through the interaction of a within-subjects factor (daily negative mood) and a between-subjects factor (conduct problems) to determine whether adolescents reporting more conduct problems show a greater likelihood of drinking on days after they experience more negative mood than they typically would.

Because alcohol use was a binary outcome, we estimated these models using a log-link function (similar to logistic regression also used to estimate models for binary outcomes) and interpreted unit-specific models with robust standard errors as provided in HLM 6.0 (Raudenbush, Bryk, Cheong, & Congdon, 2004). In constructing our model, we followed guidelines for disaggregating within- and between-person effects provided by Raudenbush and Bryk (2002). Specifically, we predicted daily reports of alcohol use from the within-person predictors (or daily repeated assessments) of weekday status and (person-centered) previous day's negative mood. Between-person predictors included control variables (i.e., child gender, child ethnicity and parent education), the aggregated negative mood index, and conduct problems. All continuous between-person predictors were grand-mean centered.

To test primary hypotheses, we also included a cross-level interaction between daily negative mood and conduct problems. This cross-level interaction tested whether previous day's negative mood and daily alcohol use covaried more strongly in youth reporting greater conduct problems; stated alternatively, this interaction tested whether elevated negative mood increased risk for subsequent drinking particularly for youth reporting more conduct problems. The random effects of the model intercept and the (slope for) daily effect of negative mood were also estimated. We tested each indicator of adolescent conduct problems in a separate model, for a total of six models (see Table 2). (Analyses were repeated dropping cases with few daily observations and outliers, final n=70, and no substantive changes emerged.)

Of the three indicators of parent-reported conduct problems, both physical aggression and non-physical conduct problems significantly moderated the relation between previous day's negative mood and subsequent drinking (OR=0.38, p<.001; OR=0.51, p=.04, respectively). Greater parent-reported delinquency was not related to adolescent drinking. Among indicators of adolescent-reported conduct problems, non-physical conduct problems significantly moderated the negative mood-drinking relation (OR=0.40, p=.03) and delinquency was a marginally significant moderator (OR=0.34, p=.06). Adolescents reporting greater physical aggression were somewhat more likely to drink than their peers

(OR=2.89, p=.10) but did not vary in their risk for self-medication. In these models, the between-person effect of aggregated negative mood was weak (i.e., in three models reaching marginal significance) or non-significant.

We extended techniques for plotting these effects in linear mixed models (Curran, Bauer, & Willoughby, 2006) to the case of dichotomous outcomes. We probed these relations across all observed values of daily negative mood and conduct problems (plotted at approximately .5 SD below the mean, the mean, and .5, 1 and 1.5 SD above the mean). However, given that both of these predictors are somewhat skewed (with few observations at high levels of each predictor), we also highlight the findings for the range of values on daily negative mood and conduct problems more often reported in these data. Thus, Figure 1 depicts the findings (for non-physical conduct problems) both across the full range of observed values for each predictor (the larger plot) and across the more restricted range of values encompassing 80% of our observations (the smaller plot). In both plots, adolescents with fewer conduct problems showed a steeper slope or a stronger relation between negative mood and drinking. At the highest levels of observed daily negative mood, adolescents with fewer conduct problems showed a greater risk for drinking than their peers. Conversely, adolescents with greater conduct problems showed a stable risk for drinking that did not vary dependent on negative mood. Plotting of significant interactions showed a similar pattern across indices of conduct problems. Thus, self-medication was most evident in those with low levels of conduct problems.

Testing the drinking consequences model

We also used mixed modeling to test whether previous day's alcohol use increased the likelihood of negative mood the following day. Because negative mood was approximately normally distributed, we used the usual maximum likelihood estimation in HLM 6.0 and interpreted unit-specific effects with robust standard errors. We again parsed between- and within-person effects. The analysis predicted daily negative mood from the within-person predictors of weekday status and (person-centered) previous day's drinking and the between-person predictors of child gender, child ethnicity, parent education and conduct problems. The cross-level interaction between previous day's drinking and conduct problems tested our specific hypothesis. All continuous between-person predictors were grand-mean centered. The random effects of the model intercept and the (slope for) daily effect of drinking were also estimated. We tested each indicator of conduct problems in a separate model, for a total of six models (see Table 3 for results).

For parent-reports, non-physical conduct problems significantly moderated the effect of previous day's drinking on subsequent mood (=−.41, p=.005), and delinquency was a marginally significant moderator (= −.34, p=.08). Parent-reported physical aggression served to increase risk for elevations in daily negative mood (=.37, p=.01) but did not moderate the drinking-negative mood association. In addition, adolescent-reported non-physical conduct problems moderated the effects of drinking on subsequent negative mood (= −.73, p<.001) and physical aggression and delinquency both increased risk for daily negative mood (=0.20, p=.03 and =0.52, p=.003, respectively). In all models, the between-person effect of aggregated daily drinking was a significant (or marginally significant) predictor of subsequent negative mood, indicating that those adolescents reporting more frequent drinking relative to one another were at increased risk for elevated negative mood on any given day.

Plots of significant interactions showed a similar pattern across parent- and adolescent-reports of non-physical conduct problems (see Figure 2). Specifically, adolescents across varying levels of conduct problems showed similar levels of negative mood on days subsequent to drinking; however, negative mood was higher on days after drinking in youth

with lower non-physical conduct problems. Negative mood was also higher on days after drinking in youth with lower parent-reported delinquency. In other words, delinquency predicted greater negative mood on 'no drinking' days but few differences in negative mood were evident for youth varying in delinquency subsequent to 'drinking' days. Thus, drinking episodes increased subsequent negative mood, as predicted by a drinking consequences model, in youth with relatively few conduct problems. Moreover, drinking appeared to reduce differences in negative mood related to parent-reported delinquency but to lead to differences in negative mood related to parent- and adolescent-reported non-physical conduct problems.

Post-hoc analyses: Gender Differences

We extended these analyses to determine whether the moderating effects of conduct problem on both self-medication and drinking consequences findings differed by gender. For self-medication analyses, we added to each model the three-way interactions between previous day's negative mood, gender, and conduct problems as well as the two-way interactions between negative mood and gender as well as conduct problems and gender. For drinking consequences analyses, we added to each model the three-way interactions between daily drinking, gender and conduct problems as well as the two-way interactions between daily drinking and gender as well as conduct problem and gender. Results showed significant gender differences in only one of the six models testing self-medication (i.e., for adolescent-reported delinquency) and drinking consequences (i.e., adolescent-reported physical aggression). Due to the lack of consistency in these results, we did not further probe these findings.

Discussion

The current study found support for self-medication and drinking consequence models as pertaining to a sub-population of vulnerable youth as defined by lower engagement in conduct problems. The implications of our findings, particularly in relation to previous studies, are best understood in light of our approach to parsing between- and within-person effects and in our focus on conduct problems as a moderator of negative mood-drinking relations. Thus, below we further discuss these two points.

What we learn by parsing inter- and intra-individual differences

Using modeling strategies that parsed between- and within-person effects in negative mood-drinking relations, we found only a weak and inconsistent between-person effect of (aggregated) negative mood on daily drinking. This is consistent with previous studies of internalizing symptoms and drinking in adolescence (Hussong, Curran & Chassin, 1998). Although these findings have largely been interpreted as support for a self-medication process in adolescence, they do not address the temporality of the self-medication hypothesis but indicate that negative mood is a poor sole marker for who is at risk for drinking.

The positive between-person effect of (aggregated) drinking on subsequent negative mood was more consistent in our findings. Few studies have examined short-term consequences of alcohol use in adolescents, though some show that adolescent drinking may be associated with greater accidents (Schulenberg et al., 1996), violence, and victimization (Shepherd, Sutherland, & Newcomb, 2006). Alcohol challenge and daily assessment studies of adults show that heavier alcohol use can result in greater negative mood, particularly in non-risk populations (Newlin & Thomson, 1999). In addition, negative mood may result from risky or social embarrassing events that occur within a drinking experience. Thus, the current findings extend the study of short-term consequences of drinking episodes to adolescence.

Moreover, previous studies of adolescents have not examined within-person effects in negative mood-drinking relations that more directly address the mechanism of self-medication. Notably, we found a consistent within-person main effect of negative mood on drinking, though moderators also identified individual differences in this effect. Just as the between-person effects of drinking identify those more likely to report elevated negative mood, low levels of conduct problems served to identify youth at risk for mechanisms underlying negative mood-drinking covariation.

The role of conduct problems in negative mood-drinking relations

As in previous studies, youth who reported greater conduct problems generally showed greater risk for drinking (Zucker, 2006). Although the role of certain forms of externalizing disorders, such as attention deficit hyperactivity disorder, appear related to drinking only via their relation to conduct disorder (though this remains an area of active research and controversy, Flory, Milich, Lynam, Leukefeld, & Clayton, 2003), few studies have examined the unique associations among various forms of conduct problems per se and drinking in adolescence. In our findings, physical aggression, non-physical conduct problems and delinquency were each positively associated with drinking behavior and negative mood, either directly or as moderated predictors. Given the moderate correlations among these indicators of conduct problems, this finding is perhaps not surprising. These associations are consistent with the predictions of problem behavior theory and externalizing pathways leading to alcohol involvement (Zucker, 2006), both of which indicate that conduct problems and drinking may be alternative manifestations of an underlying propensity toward antisocial or disinhibited behaviors. However, it may also be the case that these varying forms of conduct problems play different roles in adolescents' alcohol use and thus create this risk via separable mechanisms.

This possibility was consistent with findings pertaining to the central interest in the current study, the moderating role of conduct problems in negative mood-drinking relations. Counter to predictions, both self-medication and drinking consequence mechanisms were most evident in youth with little to no conduct problems. These findings may suggest that self-medication and mood-related consequences are an internalized form of drinking that is perhaps less present than more socially-motivated or deviance-related forms of drinking in youth with greater problem behavior. This distinction between internalized and externalized drinking is consistent with subtypes of adult alcoholism based on their comorbidity with depression or antisociality (Zucker, 2006) and indicate the potential for different pathways of risk that lead to these outcomes.

These findings may suggest a cyclical pattern of risk in which negative mood leads to drinking which in turn leads to negative mood. Such a cyclical pattern has been associated with greater risk for addiction (Baker et al., 2004). In the current study, we were unable to directly test this cycle (i.e., test the self-medication and consequences models simultaneously) but evidence consistent with a cyclical pattern was greatest for adolescents with fewer non-physical conduct problems. Non-physical conduct problems included such behaviors as putting down someone to their face, spreading false rumors and excluding another student from a group, thus resembling the constructs of social and relational aggression (Underwood, 2003). Given the relative normality of social and relational forms of conduct problems for youth on the brink of entering high school, youth who display little of these behaviors may be more socially isolated or timid within these sometimes complex social interactions. Thus, low levels of non-physical aggression may be a marker for social withdrawal or shyness, perhaps leaving these youth with fewer social resources for understanding and coping with their negative emotions and, in turn, increasing their risk for self-medication and resulting negative mood-related drinking consequences. A similar cyclical pattern of risk was found for college students with low social support from their

close friends (Hussong et al., 2001), and thus the current findings suggest that such a mechanism may be relevant at an even earlier developmental period.

However, the lack of self-medication and drinking consequence effects in youth with greater conduct problems is also open to other interpretations. Notably, youth with greater conduct problems may show greater impulsivity in their drinking and thus a tendency to drink more immediately (i.e., on the same day) in response to negative emotions. As a result, there may be a decreased risk for drinking on the subsequent day because self-medication has already occurred. Given that we were unable to specify the timing of drinking within day, we were unable to indisputably explore this possibility and further research is clearly needed.

Moreover, whether mood-related drinking consequences promote or inhibit the development of problematic drinking in youth remains unclear. Although as noted by Conger (1956), self-medication as a drinking style is learned and presumably repeated to the extent that drinking is successful at reducing negative mood. However, others have suggested that insensitivity to the negative consequences of alcohol is actually risky in that individuals may engage in increasing levels of drinking over time in the absence of this negative feedback (Newlin & Thomson, 1999). Thus an important avenue for future research is to better understand the role of mood-related drinking consequences in the development of alcohol-related problems and addiction over time.

Implications and conclusions

Although effect sizes were modest in magnitude, these findings have important implications for both prevention and intervention programs. First, they provide initial evidence that a self-medication cycle may operate for a sub-group of vulnerable youth identifiable by their low engagement in conduct problems, particularly non-physical conduct problems. Thus, they suggest a mechanism of risk that may be a target for intervention as well as a population for whom such programs may be most pertinent. Interventions targeting mood regulation, coping strategies, and internalizing symptom reduction may all be relevant to interrupting this risk process. Second, they show that such self-medication processes do not fully account for the effect of negative mood on adolescent drinking. As a result, we need to consider alternate mechanisms for intervention that may also explain negative mood-drinking relations in youth, such as peer-mediated risks as proposed by the self-derogation hypothesis. Third, these findings underscore the importance of differentiating inter- and intra-individual differences in studies that inform risk processes in adolescent psychopathology so as to identify vulnerable populations (through inter-individual differences) but also unfolding mechanisms that identify, for example, when these individuals are likely to drink and thus perhaps why drinking behaviors occur on a given day (through intra-individual differences).

Although confidence in our findings is strengthened by reliance on a multi-method, multi-reporter approach, these implications should also be considered in light of study limitations. Given the modest sample size, these findings are preliminary and, though promising, primarily suggest an important avenue for future research. Importantly, although the current sample was at elevated-risk for drinking behavior, a minority of adolescents drank during the study period. Thus, our findings are not limited in generalizability to a heavy using population. Additional limitations include modest reliability of our delinquency measures, lack of extra-familial reports of adolescent conduct problems, inability to examine ethnic differences, and some uncertainty about within-day temporal precedence between negative mood and alcohol use which resulted in our focus on predictions from one day to the next (rather than within day). Although not consistent in their conclusions, previous studies suggest that various forms of negative mood may operate differently within a self-

medication process (Hussong et al., 2001). Such disaggregation of mood was beyond the scope of this study, but is an interesting direction for future research as well.

In conclusion, the current findings are the first to use methods permitting an online daily analysis of negative mood-drinking relations in adolescents and as such provide the starting point for an important line of research informing both applied and preventive research. Further attention to inter- and intra-individual differences in negative mood-drinking relations in adolescents is clearly needed. By working across these two levels of analysis, we can better understand the multiple dimensions that together identify homogenous vulnerable sub-populations but also the means by which these populations are at-risk. By pursuing our understanding of inter-related mechanisms of risk and vulnerable sub-populations, we can improve prevention and treatment efforts through better identification or risk groups (i.e., vulnerable sub-populations), risk processes (i.e., alternative mechanisms) and protective and vulnerability factors (i.e., moderating factors) to reduce involvement in one of the more dangerous and addictive patterns of alcohol use, negative mood-related drinking.

Acknowledgments

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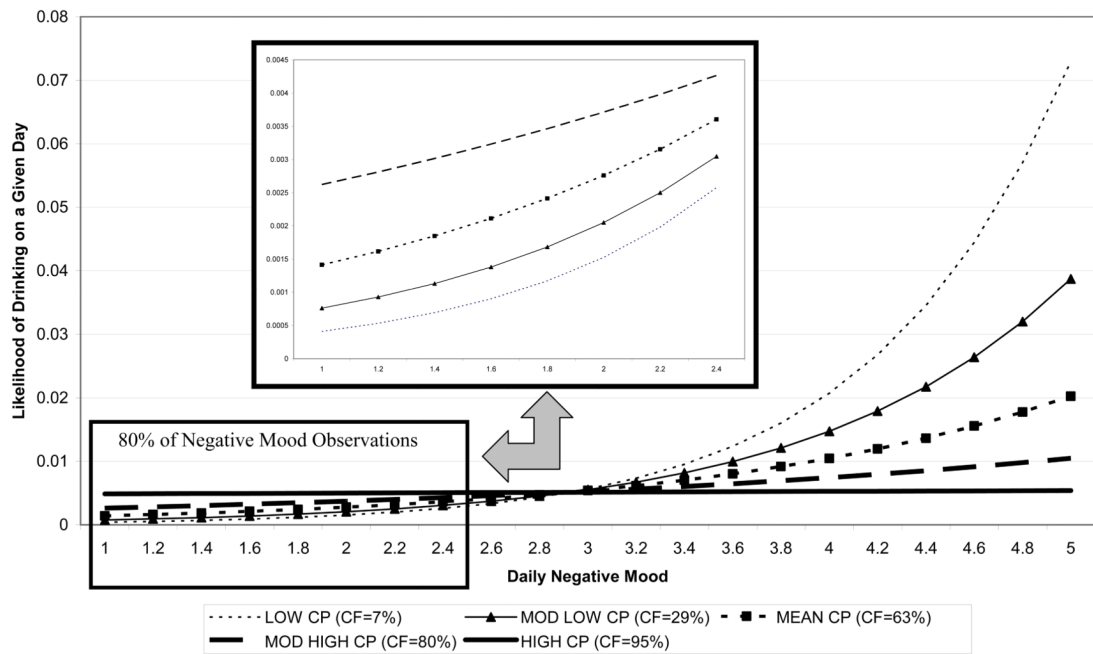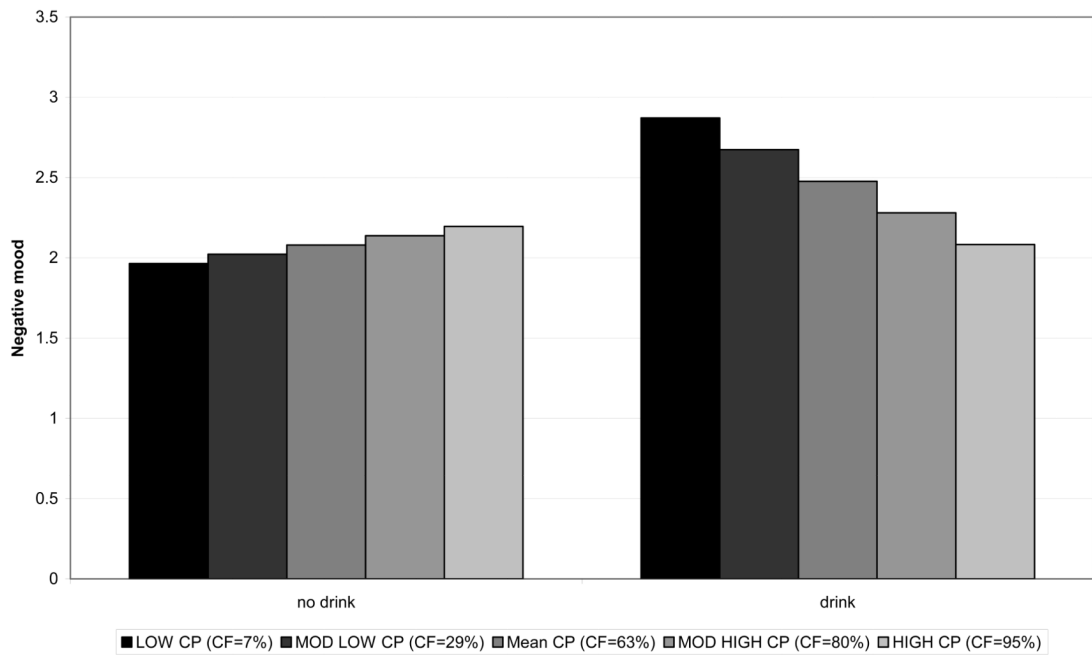
Figure 1. Adolescent-reported non-physical aggression moderates daily negative-mood drinking covariation

Figure Note: CP=Conduct Problems; CF=Cumulative frequency of marginal distribution. Upper box is an enlargement of overall graph but only for values encompassing 80% of observations

Adolescent-reported Non-Physical Conduct Problems Moderate the Impact of Drinking on Negative Mood

Figure 2. Adolescent-reported non-physical aggression moderates the impact of drinking on negative mood

Figure Note: CP=Conduct Problems; CF=Cumulative frequency of marginal distribution

Table 1

Correlations among primary study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Adolescent gender	--															
2 Adolescent ethnicity	-.02	--														
3 Parent education	-.03	-.08	--													
4 Aggregated negative mood[a]	-.18	-.17	.07	--												
5 Aggregated drinking index	-.11	.13	.29	.25	--											
6 Parent Phys Agg	.13	-.06	.00	.34	.11	.84										
7 Parent Non-Phys Agg	.05	-.11	.10	.34	.18	.66	.80									
8 Parent Delinquency	.09	-.07	.00	.33	.15	.63	.48	.66								
9 Adol Phys Agg	.22	.12	-.20	.13	.28	.17	.12	.33	.82							
10 Adol Non-Phys Agg	.04	.04	-.11	.20	.18	.14	.20	.30	.49	.82						
11 Adol Delinquency	.16	-.13	.11	.32	.15	.38	.33	.59	.45	.42	.51					
12 Weekday*	.02	.00	.01	-.02	.01	-.01	-.01	.00	.01	.01	-.01	--				
13 Negative Mood (smed)*[a]	-.11	-.14	.03	.75	.17	.25	.25	.25	.05	.09	.21	.01	.79			
14 Negative Mood (con)*[a]	-.11	-.14	.04	.75	.15	.24	.25	.24	.04	.10	.22	.01	.62	--		
15 Daily drinking (smed)*	.00	.00	.12	.07	.41	.08	.07	.07	.03	.05	.02	.01	.08	.06	--	
16 Previous day drinking (con)*	-.01	.00	.12	.09	.36	.11	.10	.10	.03	.05	.04	-.01	.08	.10	.20	--
MEANS	.45	.45	2.59	1.85	.69	.41	.73	.44	.66	.73	.20	.30	1.82	1.83	.03	.03
STDS	.50	.50	.97	.69	.09	.58	.70	.44	.66	.69	.41	.46	.93	.95	.18	.17

Note: N=75 persons or 1238 observations (for daily measures). Asterisks indicate that variable is a time-varying covariate. Bolded and italicized correlations are significant at $p \leq .05$ and $p \leq .10$, respectively. Cronbach's alpha reliability estimates appear on the diagonal where appropriate. (smed) refers to measures used in self-medication analysesa and (con) refers to measures used in drinking consequences analyses. For gender, girls are coded 0 and boys are coded 1; for ethnicity, Caucasians are coded 0 and Ethnic Minority youth are coded 1.

[a] Daily and aggregated mood measures are each based on a common set of items and thus share the reported reliability for negative mood (smed).

Table 2

Results of HGLM Analyses Testing Self-Medication Model

PREDICTORS	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(SE)	(SE)	(SE)	(SE)	(SE)	(SE)
Adolescent gender	−0.03 (0.76)	−0.06 (0.75)	−0.11 (0.77)	−0.30 (0.81)	−0.12 (0.75)	−0.04 (0.77)
Adolescent ethnicity	0.92 (0.75)	0.89 (0.76)	0.87 (0.76)	0.65 (0.76)	0.82 (0.76)	0.80 (0.76)
Parent education	**0.68 (0.33)**	**0.73 (0.34)**	**0.75 (0.33)**	**1.01 (0.35)**	**0.80 (0.34)**	**0.67 (0.33)**
Aggregated negative mood	1.00 (0.61)	***0.97 (0.58)***	0.97 (0.62)	***0.95 (0.54)***	***0.94 (0.56)***	0.98 (0.61)
Weekday*	−0.05 (0.43)	−0.05 (0.43)	−0.05 (0.43)	−0.06 (0.43)	−0.06 (0.43)	−0.06 (0.43)
Negative Mood*	**0.86 (0.34)**	***0.72 (0.37)***	**0.65 (0.32)**	0.44 (0.31)	**0.67 (0.32)**	**0.76 (0.32)**
Parent Phys Agg	0.50 (0.50)					
Parent Phys Agg x Negative Mood*	**−0.98 (0.27)**					
Parent Non-Phys Conduct Problems (CP)		0.42 (0.47)				
Parent Non-Phys CP x Negative Mood*		***−0.68 (0.33)***				
Parent Delinquency			0.60 (0.58)			
Parent Delinquency x Negative Mood*			−0.57 (0.38)			
Adol Phys Agg				*1.06 (0.64)*		
Adol Phys Agg x Negative Mood*				0.00 (0.51)		
Adol Non-Phys CP					***0.85 (0.47)***	
Adol Non-Phys CP x Negative Mood*					***−0.92 (0.41)***	
Adol Delinquency						0.61 (0.78)
Adol Delinquency x Negative Mood*						***−1.09 (0.57)***

Note: Asterisks indicate that variable is a time-varying covariate. Bolded and italicized test statistics are significant at p<.05 and p<.10, respectively.

Table 3

Results of HLM Analyses Testing Drinking Consequences Model

PREDICTORS	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(SE)	(SE)	(SE)	(SE)	(SE)	(SE)
Adolescent gender	**−0.31 (0.14)**	*−0.27 (0.14)*	**−0.28 (0.14)**	**−0.31 (0.15)**	−0.24 (0.15)	**−0.33 (0.14)**
Adolescent ethnicity	*−0.28 (0.14)*	*−0.26 (0.14)*	**−0.28 (0.14)**	**−0.31 (0.15)**	**−0.32 (0.15)**	*−0.24 (0.15)*
Parent education	−0.02 (0.07)	−0.04 (0.07)	−0.02 (0.07)	0.00 (0.07)	−0.01 (0.07)	−0.05 (0.07)
Aggregated drinking index	*1.73 (0.92)*	**1.73 (0.86)**	*1.71 (0.96)*	*1.76 (0.92)*	**1.96 (0.92)**	*1.82 (0.95)*
Weekday*	0.04 (0.04)	0.04 (0.04)	0.04 (0.04)	0.04 (0.04)	0.04 (0.04)	0.04 (0.04)
Previous day drinking* (PDD)	**0.36 (0.16)**	**0.41 (0.17)**	**0.37 (0.15)**	*0.25 (0.15)*	**0.40 (0.15)**	**0.30 (0.14)**
Parent Phys Agg	**0.37 (0.15)**					
Parent Phys Agg x PDD*	−0.26 (0.16)					
Parent Non-Phys Conduct Problems (CP)		**0.31 (0.10)**				
Parent Non-Phys CP x PDD*		**−0.40 (0.14)**				
Parent Delinquency			**0.45 (0.16)**			
Parent Delinquency x PDD*			*−0.34 (0.19)*			
Adol Phys Agg				**0.20 (0.09)**		
Adol Phys Agg x PDD*				0.34 (0.40)		
Adol Non-Phys CP					0.16 (0.13)	
Adol Non-Phys CP x PDD*					**−0.73 (0.17)**	
Adol Delinquency						**0.52 (0.16)**
Adol Delinquency x PDD*						−0.37 (0.35)
Proportion of variance accounted for in daily negative mood	.1606	.1568	.1452	.0800	.0828	.1455

Note: Asterisks indicate that variable is a time-varying covariate. Bolded and italicized test statistics are significant at p<.05 and p<.10, respectively.