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Reinforcement Sensitivity Theory and Alcohol Outcome Expectancies in Early Adolescence

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Abstract

Background—Little research has examined the development of alcohol expectancies in childhood, a notable omission as expectancies are viable targets for prevention programs. Moreover, limited alcohol expectancies research has been conducted from the perspective of psychobiological models of motivation despite the strong conceptual links between such models and cognitive models of alcohol use.

Objective—To examine if the associations between individual differences from the revised reinforcement sensitivity theory and alcohol use is mediated by alcohol expectancies in a large community sample of early adolescents using a prospective design.

Methods—378 families (1 caregiver; 1 child) were recruited via random digit phone call using a prospective design.

Results—Our findings suggest that both a strong behavioral approach system and fight-flight or freeze system were associated with high levels of positive outcome expectancies, which subsequently predicted an increase in likelihood of alcohol use. There was also some evidence that drive (an aspect of behavioral approach system) was also positively associated with negative expectancies, which subsequently predicted a low probability of alcohol use.

Conclusions and Scientific Significance—Individual differences in reinforcement sensitivity may influence the acquisition of positive and negative outcome expectancies, thereby potentially influencing the likelihood of alcohol use in early adolescence. Thus, reinforcement sensitivity theory is a promising theory to account for the link between neural models of addiction and early acquisition of alcohol use in humans.

Keywords

BAS; BIS; FFFS; substance use initiation; expectancies; adolescence

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Introduction

Cognitive models of alcohol abuse posit that alcohol expectancies (beliefs about the effects of drinking alcohol) are robust correlates of both initiation and maintenance of alcohol use, mediating the influence of a variety of risk factors (1). Evidence suggests that alcohol expectancies develop prior to actual use (2) and follow a developmental progression. Children perceive negative effects of drinking (negative expectancies) as more likely than the positive effects (positive expectancies) (3), and with age, these perceptions shift with positive expectancies increasing and negative expectancies declining (3,4). Few studies have investigated the early development of alcohol expectancies, particularly from the perspective of psychobiological models of motivation.

Psychobiological models of motivation have been employed to describe liability for substance abuse (5). According to these models, behavior is a function of constitutional individual differences in sensitivity to reward and punishment, which can affect the positive and negative reinforcing properties of drugs of abuse (6,7). Reinforcement sensitivity theory (RST; 8) has been one of the most influential of these models. The focus of this article is on the association between RST, children’s alcohol expectancies, and alcohol use.

The revised RST (8) postulates three motivational systems that are distributed among several neural structures. The *behavioral approach system* (BAS) mediates reactions to appetitive stimuli, and its neurobiology consists of input from the basal ganglia, mesolimbic dopamine projections from the ventral tegmental area to the ventral striatum, the nucleus accumbens, and mesocortical dopamine projections to the prefrontal cortex. The *behavioral inhibition system* (BIS) inhibits behavior and increases arousal and risk assessment in response to stimuli signaling the loss of expected reward, novelty, uncertainty, and goal conflict. Its neurobiology involves input from the septohippocampal system, the amygdala, the posterior cingulate cortex, and the dorsal stream of prefrontal cortex. The *fight-flight or freeze sys- tem* (FFFS) mediates responses to aversive stimuli, and its neurobiology consists of input from the periaqueductal gray, the medial hypothalamus, the amygdala, the anterior cingulated cortex, and the ventral stream of prefrontal cortex. These systems map onto motivational models of substance use that emphasize the role of positive and negative reinforcement, and thus RST provides a useful framework for understanding vulnerability for alcohol abuse. One mechanism explaining how these neural systems impact alcohol abuse is through their influence on acquisition of expectancies.

According to the acquired preparedness model, personality traits, such as disinhibition, bias individuals toward focusing on reward-related information making it more likely to learn positive rather than negative alcohol expectancies (9,10). It is likely that trait individual differences can also bias individuals toward learning negative expectancies. We propose that the BIS, BAS, and FFFS bias individuals toward focusing on different consequences of alcohol use, thus influencing acquisition of positive and negative expectancies.

It is important to note that RST was revised to account for two decades of new data since the original theory was developed (8,11). This revision has largely been ignored in the addictions field, yet it has implications for the role of the FFFS and BIS. In the revised theory, the FFFS mediates sensitivity to aversive stimuli, and may be associated with alcohol use via a negative reinforcement pathway, a pathway associated with the BIS based on the original theory. In the revised RST, the BIS is conceptualized as a conflict resolution system that increases arousal for the purposes of risk assessment. Hence, it can be argued that the BIS may be associated with negative alcohol expectancies because of its risk assessment function, and with positive alcohol expectancies because the increased arousal may make the sedating effects of alcohol especially appealing. The BAS remains largely unchanged in the revised RST. Our study is based on the revised RST.

Based on a large literature suggesting that appetitive motivation is central to addictive behaviors (12) and adult research linking the BAS to strong motivations to drink for enhancement of positive affect (13), we hypothesize that a strong BAS will be associated with high levels of positive expectancies, which will subsequently predict alcohol use. Hypotheses regarding the FFFS and BIS are more tentative given the paucity of research on the revised RST. The FFFS mediates reactions to aversive stimuli, thus a strong FFFS might be indirectly associated with alcohol use via its association with high levels of positive alcohol expectancies (e.g., negative reinforcing effects of drinking). The BIS was hypothesized to be associated with positive alcohol expectancies because this system partly functions to increase arousal, which may increase the salience of the sedating effects of alcohol, and with negative expectancies because as part of the defensive/avoidance network it is also responsible for risk assessment.

Methods

Participants and Procedures

The sample was drawn from a project examining children's SU, and includes 378 families (1 caregiver; 1child) recruited via random digit dial phone calls in Erie County, NY. Eligibility criteria required the child to be 10–12 years old and have no disabilities that affected the completion of questionnaires. Fifty-two percent of the children were female (time 1 mean age = 11.1, SD = 0.85). Most children were Caucasian (75%), 15% were Black/African American, 3% were Hispanic, 2% were Asian/Pacific Islander, and 5% reported another race/ethnicity. Mean age of caregivers was 42.2 (SD = 7.3), and the majority were women (85%) and biological parents (93%). Consent/assent forms were read aloud by interviewers and signed by the participants. To enhance confidentiality and privacy, caregivers and children were interviewed in separate rooms; children entered their own response to sensitive questions (e.g., alcohol use) into a computer, and we obtained a Certificate of Confidentiality from the Department of Health and Human Services. One year later, families completed the time 2 assessment. Families were compensated $75 at time 1 and $85 at time 2. The retention rate from time 1 to 2 was 93%, and no attrition differences were observed in age, gender, temperament, alcohol use, or expectancies.

Measures

Caregivers reported on the child's reinforcement sensitivity at time 1 using the Sensitivity to Punishment Sensitivity to Reward Questionnaire for Children – Revised (14,15). This measure includes three BAS sub- scales: drive (α = .70), social approval (α = .71), and impulsivity/fun seeking (α = .72), a BIS (Anxiety) scale (α = .66), and an FFFS (Fear/Shyness) scale (α = .83).

Expectancies were assessed with a measure designed for children with limited drinking experience (3). Children reported their perceived likelihood of alcohol out- comes (1 = 0% no chance to 11 = 100% for sure) using 10 items representing positive outcomes (α = .87) and 10 items representing negative outcomes (α = .89). Children reported lifetime and past year alcohol use (yes/no) at times 1 and 2, respectively.

Results

Hypotheses were tested using structural equation models estimated in Mplus (16). Weighted least squares estimation with mean and variance adjustment was used because we were predicting a dichotomous outcome (alcohol use). BIS (anxiety), BAS (drive and impulsivity/fun seeking), and FFFS (fear/shyness) at time 1 (the proposed independent variables) and positive and negative expectancies at time 1 (the proposed mediators) were specified as latent variables indicated by the questionnaire items that corresponded to each of the scales. Alcohol use at times 1 and 2 were observed dichotomous variables. The model specified BIS, BAS, and FFFS as predictors of expectancies, expectancies as predictors of time 1 alcohol use, and time 1 alcohol use as a predictor of time 2 use, respectively. Age and gender were included as control variables predicting expectancies and alcohol use. Covariances between exogenous variables and between expectancies latent variables were estimated. Our initial model included direct effects from the BIS, BAS, and FFFS latent variables to times 1 and 2 alcohol use, and the direct effect from expectancies latent variables to time 2 alcohol use. Nested model tests suggested that removing the direct paths from the RST factors to the alcohol use variables did not result in a decrement in model fit ($\chi 2$ (7) = 5.76, p = .67). Therefore, these paths were trimmed from the final model. The final model provided a good fit to the data ($\chi 2$ (1094) = 1316.95, $p < .01$, comparative fit index =.90, root mean square error of approximation = .02). All factor loadings were statistically significant (p < .001) and substantial (standardized loadings = .40 to .76).

Structural paths are presented in Figure 1. High levels of drive and fear/shyness were associated with high levels of positive expectancies. Contrary to expectation, high levels of impulsivity/fun seeking were associated with low levels of positive expectancies. Among the temperament factors, only drive was associated with negative expectancies. High levels of drive were associated with high levels of negative expectancies. As expected, high levels of positive expectancies were associated with increased probability of alcohol use at time 1, and time 1 alcohol use predicted time 2 use. Negative expectancies predicted time 2 alcohol use, such that high levels of expectancies were associated with a low probability of alcohol use at time 2. The general pattern of associations suggests several meditational paths of interest, including indirect effects from drive, fear/shyness, and impulsivity operating through positive expectancies to time 1 alcohol use, an indirect effect from drive operating through negative expectancies to time 2 alcohol use, and a three-chain indirect effect whereby these temperament variables operate through positive expectancies to predict time 1 alcohol use, which subsequently predicts time 2 use. There are currently no methods for testing three-chain indirect effects with dichotomous outcomes. Accordingly, we tested the indirect effects from temperament to time 1 alcohol use mediated through positive expectancies, and the effect of positive expectancies on time 2 alcohol use mediated through time 1 use. The ProdClin SAS macro (17) was used to compute indirect effects and 95% asymmetric confidence bands. All of the indirect paths tested were statistically reliable (see Table 1). High levels of drive and fear/shyness were associated with high levels of positive expectancies, which subsequently were associated with an increased probability of time 1 alcohol use. High levels of impulsivity/fun seeking were associated with low levels of positive expectancies, which subsequently were associated with a decreased probability of time 1 alcohol use. High levels of positive expectancies were associated with increased probability of time 1 alcohol use, which was associated with an increased probability of time 2 alcohol use. Finally, high levels of drive were associated with high levels of negative expectancies, which were subsequently associated with a decreased probability of time 2 alcohol use.

Discussion

This study is the first to evaluate the associations between the revised RST, alcohol expectancies, and alcohol use in early adolescence. Consistent with adult research suggesting that the BAS predicts alcohol use (13,18), we found a strong BAS-Drive to be indirectly related to alcohol use through positive expectancies. This is consistent with RST, which postulates that cues signaling potential reinforcement are more salient for individuals with a strong BAS. Thus, observed or vicariously experienced positive alcohol outcomes may be particularly salient for children characterized by a strong BAS. This is also consistent with acquired preparedness models, which suggest that personality influences drinking behavior by influencing alcohol-related learning (9,10).

BAS-Drive was also associated with high levels of negative expectancies, which were associated with low probability of drinking. This was not hypothesized. Youth characterized by a strong BAS may be viewed as “at risk,” motivating parents to communicate strong anti-drinking messages. If so, youth characterized by a strong BAS may elicit socialization experiences that promote high perceived likelihood of negative drinking outcomes, and subsequently reduced risk for drinking. Accordingly, future research may consider potential moderators of acquired preparedness, such as alcohol-specific socialization experiences. Such research may be particularly important for understanding the development of negative expectancies.

Contrary to expectation, BAS-Impulsivity/Fun Seeking predicted low levels of positive expectancies. Impulsivity is a complex construct (19) and adult research suggests that different facets of impulsivity are associated with substance use through different expectancy mechanisms (20,21). Our measure of impulsivity/fun seeking represented poor inhibition in the context of reward or desirable activities often when failure to inhibit was problematic. This is in contrast to other measures of impulsivity that focus on the emotional concomitants of impulsivity, such as positive and negative affect (9,10). Dawe (22) argued that “rash impulsiveness” relates to poor executive functioning and does not represent a behavioral expression of a strong BAS. Accordingly, impulsivity/fun seeking in our study may represent higher order cognitive functions, such as deficits in executive functioning, more so than the BAS. Consistent with this interpretation, prior research suggests that deficits in higher order cognitive abilities are associated with decreased risk for alcohol use, but increased risk for alcohol-related problems (23). Thus, impulsivity/ fun seeking (or associated cognitive deficits) may only increase risk for alcohol-related problems in adolescence.

Consistent with hypotheses, there was evidence that positive expectancies mediated the relationship between the FFFS and alcohol use. Presumably, the negative reinforcing properties of alcohol are more salient to children with a strong FFFS. Studies using RST in the field of addictions have largely neglected the FFFS, and it may be important for future studies to focus on this system because it may help further develop negative reinforcement models of addictions. Finally, we found no association between the BIS and expectancies. The BIS has been considered a potential risk factor for the negative reinforcement effects of alcohol use (1), but this conceptualization is based on the original theory. Our findings suggest that according to the revised RST, the FFFS, and not the BIS, may be germane to negative reinforcement. It is important for future research to distinguish the FFFS and BIS according to the revised theory.

It should be noted that our results are based on cross-reporter associations, and this has strengths and weaknesses. Although this approach eliminates concerns about shared method variance and reviews of the literature suggest that parental reports provide useful and unique information about child temperament/personality (24), parents may have limited access to children’s internal experiences such as fear and anxiety. Thus, using a parent report measure of reinforcement sensitivity may have attenuated some associations. Another limitation of our study is that the two-wave longitudinal design precluded a full longitudinal examination of the proposed mediational mechanisms.

In summary, our study makes an important theoretical contribution to the understanding of liability for alcohol use and suggests that psychobiological models of motivation are germane to the development of early alcohol expectancies and use. It will be important for future research to prospectively investigate the revised RST and the meditational role of expectancies across multiple stages of alcohol use. This will help inform theory and intervention

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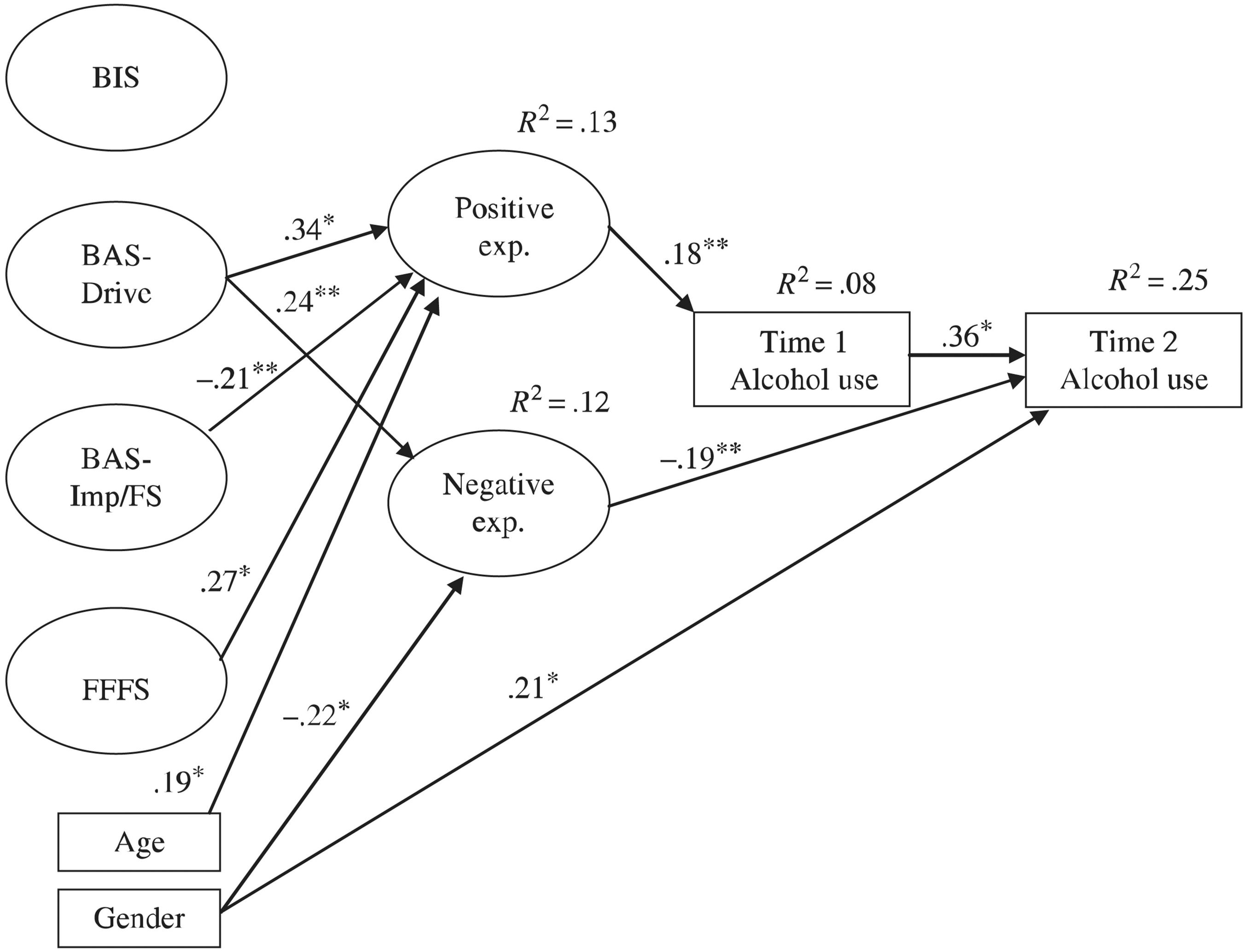

Figure 1.

Standardized path coefficients from final structural equation model. Covariance between exogenous variables and between expectancies factors were estimated but omitted from the figure. Gender coded 0 = male, 1 = female. BIS, behavioral inhibition system; BAS, behavioral activation system; Imp/FS, impulsivity/fun seeking; FFFS, fight-flight or freeze system; Exp, expectancies **p*<.05, ***p*<.01. Only statistically reliable paths are shown.

Table 1

Indirect effects and confidence intervals

		95% Asymmetric confidence interval	
Mediational path	**Indirect Effect**	**Lower**	**Upper**
Drive→Positive expectancy→Time 1 alcohol use	.061	.003	.138
Impulsivity/fun seeking→Positive expectancy→Time 1 alcohol use	−.038	−.094	−.001
Fear/shyness→Positive expectancy→Time 1 alcohol use	.048	−002	.115
Positive expectancy→Time 1 Alcohol use→Time 2 alcohol use	.064	.003	.151
Drive→Negative expectancy→Time 2 alcohol use	−.044	−.104	−.004