Examining Personality and Alcohol Expectancies Using Functional Magnetic Resonance Imaging (fMRI) with Adolescents*

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ABSTRACT. Objective: Personality and alcohol expectancies have been examined as risk factors for the initiation and maintenance of alcohol use in adolescents and young adults. Differences in processing appetitive stimuli are seen as a mechanism for personality's influence on behavior, and that mechanism predisposes individuals to form more positive expectancies for alcohol. The go/no-go task has been used to show how personality differences influence responding to appetitive stimuli in adolescents and adults, and functional magnetic resonance imaging (fMRI) has been used to examine the relation of go/no-go responding to personality in adult males. However, no study to date has examined the relation between fMRI responding, personality and alcohol expectancies in adolescents. **Method:** Forty-six adolescents (ages 12-14 years; 61% male) with minimal substance use histories completed measures of neuroticism, extraversion, and alcohol expectancies, and performed a go/no-go task during fMRI acquisition. **Results:** Greater blood oxygen level-dependent (BOLD) response to inhibition predicted fewer expectancies of cognitive and motor improvements but more expectancies of cognitive and motor impairment from alcohol. In addition, extraverted youths reported more positive alcohol expectancies. However, BOLD response did not predict neuroticism or extraversion. **Conclusions:** These preliminary results suggest that decreased inhibitory neural processing may contribute to more positive and less negative expectancies, which can eventually lead to problem drinking. Further, extraversion may also yield more positive expectancies and could underlie a vulnerability to disordered alcohol use. (*J. Stud. Alcohol* **66:** 323-331, 2005)

ETIOLOGICAL MODELS for alcohol-use disorders have traditionally proposed trait and cognitive explanations for initiation, maintenance and abuse/dependence. Within that framework, temperament and personality models have often focused on trait disinhibition (McGue et al., 2001), including behavioral undercontrol (Sher et al., 1991), impulsivity and sensation seeking (Grau and Ortet, 1999), suggesting that deficits in interrupting ongoing behavior may be central to hazardous drinking. These models view alcohol use as self-reinforcing through further experience with the substance.

Cognitive theories of alcohol use consider drinking an outgrowth of indirect and direct experience with alcohol. Alcohol expectancies play a major role in shaping how alcohol-related learning experiences influence drinking initiation and maintenance (Brown et al., 1985; Leigh and Stacey, 1993). Alcohol expectancies—probabilistic beliefs regarding the outcomes associated with alcohol use (e.g., "If I drink, then …")—can represent an individual's learning history as it relates to outcomes associated with alcohol use (Goldman et al., 1991). Integrated models of risk for alcohol use have incorporated both personality and learning to examine the additive and multiplicative influences of these constructs on the risk processes for maladaptive alcohol use (McCarthy et al., 2001a; Sher et al., 1999; Smith and Anderson, 2001).

Theorists have argued that temperament, which is at the core of personality, is in place at birth and has stable, long-lasting effects on behavior (Kagan, 1991; Rothbart, 1991). Although experience can modify personality, it also reflects individual neural processing strategies. Gray's (1991) work on personality hypothesizes three brain mechanisms: the behavioral activation system (extraversion), behavioral inhibition system (introversion) and fight-or-flight system, which are believed to underlie individual differences in response to reward and punishment. Patterson and Newman (1993), expanding on Gray's work, suggest that individuals high on behavioral disinhibition and nonspecific arousal (neurotic extraverts) are impaired in their ability to learn from punishment in situations where a reward-based response set is present and that these differences are associated with the septohippocampal region of the brain. For example, after a reward-based response set is established (e.g., modeling of positive reactions to alcohol), a neurotic extravert would be seen as more likely to seek reward (e.g.,

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feeling euphoric from drinking), despite the presence of punishment (e.g., vomiting).

Much of the early empirical support for this work was done using laboratory tasks, such as go/no-go and inhibition-tracing tasks (Nichols and Newman, 1986; Wallace and Newman, 1990). However, recent work has examined how personality and appetitive responding (i.e., goal-directed behavior) relate to brain activation using functional magnetic resonance imaging (fMRI). Horn et al. (2003) examined neural activation during a go/no-go task and measures of impulsivity in healthy adult males. Go/no-go activation in the presence of response inhibition was most pronounced in the right lateral orbitofrontal cortex. In their investigation, impulsive individuals had greater activation in paralimbic areas, including the right inferior frontal gyrus and right insula. They also found that lower scores on impulsivity measures were associated with greater activation in the anterior medial superior frontal gyrus and temporoparietal association areas. Using the dot-probe task to examine potential processing biases to emotional stimuli, Amin et al. (2004) found that extraverted college students had greater activation in the fusiform gyrus to the task. Recently, Reuter et al. (2004) examined the relations between Gray's personality dimensions and activation to emotionally valenced stimuli. They found that behavioral inhibition was related to fear, disgust and erotic visual images, suggesting a relation between stress proneness and activation in response to arousing stimuli. These studies represent some of the early work examining how personality may relate to differences in neural activation patterns.

The Acquired Preparedness Model (APM) for alcohol (McCarthy et al., 2001a; Smith and Anderson, 2001) suggests that trait disinhibition is a distal risk factor for alcohol use that operates through the proximal risks of alcohol expectancies, such that positive alcohol expectancies mediate the relation between disinhibition and drinking. Using Patterson and Newman's (1993) conceptualization of how disinhibition influences appetitive responding, neurotic extraverts are seen as having a reward-based learning style leading to the acquisition of more positive expectancies for alcohol than their nondisinhibited peers. Support for this model has been found in samples of college students (McCarthy et al., 2001a), racially diverse samples (McCarthy et al., 2001b) and college women (Anderson et al., 2003). However, other investigations have not found support for these indirect effects in college students (Katz et al., 2000) or middle school students (Anderson et al., 2005).

The purpose of this investigation is to examine the relationships between personality, alcohol expectancies and neural activation during inhibition (a go/no-go task) in adolescents. To our knowledge, this is the first investigation to integrate fMRI methodologies with traditional measures of personality and alcohol expectancies in youth. Adolescents with little or no alcohol experience were chosen for this investigation because of the neurocognitive deficits found in youths with histories of extensive substance use (Brown et al., 2000; Tapert and Brown, 2000; Tapert et al., 2002, 2004). Based on past theoretical work on personality, learning and APM, we would expect the following: (1) trait disinhibition assessed by personality questionnaires should positively relate to favorable expectancies for alcohol and inversely relate to negative expectancies for alcohol and (2) trait disinhibition should significantly relate to neural activation during a task requiring response inhibition (i.e., go/no-go). In addition, exploratory analyses were planned to examine the relations between neural response to the go/no-go task and alcohol expectancies. Based on past work (Deckel et al., 1995), we might expect alcohol expectancies to relate to frontal lobe functioning.

Method

Participants

The current study examined 50 12- to 14-year olds with minimal substance use histories (85% had never consumed alcohol; six maximum lifetime drinks). Participants were recruited from local middle and high schools for a larger study on neurocognition in youths at risk for substance-use disorders. The participants were selected on the basis of family history of alcohol dependence. Forty-six percent of the participants had no first- or second-degree relative with any history of substance use disorder. Approximately 35% had at least one first-degree relative as well as at least one second-degree relative from the same side of the family who had a history of alcohol dependence. The remaining 20% had second-degree relatives with substance-use disorders but no first-degree relatives.

Exclusion criteria included the following: history of head injury with loss of consciousness >2 min; neurological or medical problems; learning disabilities; Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, psychiatric disorder other than conduct disorder (determined by Computerized Diagnostic Interview Schedule for Children 4.0 [Shaffer et al., 2000] with parents and youths); current psychotropic medication use; significant maternal drinking during pregnancy; family history of bipolar I or psychotic disorder (determined by Family History Assessment Module [Rice et al., 1995] with parents and youths); left-handedness; and MRI contraindications (e.g., braces). Left-handed participants are excluded from this functional MRI study because the lateralization of left-handers is heterogeneous and different from that of right-handed individuals (e.g., right-hand motor response and language functions aren't necessarily controlled by the left hemisphere). Thus, including left-handed individuals in group-level analyses of fMRI data adds substantial heterogeneity to the analysis.

Ten participants met criteria for conduct disorder using the Conduct Disorder Questionnaire (Brown et al., 1996), albeit mild forms of the disorder (Child Behavior Checklist [Achenbach, 1991] delinquency *t* score [entire sample]: mean [SD] = 45.75 [3.74]). Given relations in Patterson and Newman's (1993) work between psychopathy and disinhibited responding, the presence of conduct disorder was examined within these analyses.

Confidentiality was ensured during private review of the consent and the assent forms with the parent and the teen, respectively. Prior to the interviews, parents and teens were reminded that responses are confidential (with the exceptions of learning about suicidality, homocidality or child/elder abuse) and that other family members would not learn what is reported in the interview, as is stated in the consent and assent forms. Parents and teens were each interviewed privately by separate interviewers. In accordance with the University of California San Diego Institutional Review Board, written informed assent and consent (from youths and legal guardians) were obtained prior to study initiation. Participant characteristics are provided in Table 1.

Table 1. Sample characteristics of the participants ($N = 46$)

	Mean or %	SD
Age (range: 12-14)	13.63	0.88
Gender		
Female	39.1%	–
Male	60.9%	–
Ethnicity		
White	80.4%	–
Hispanic American	6.5%	–
Asian American	4.3%	–
African American	2.2%	–
Other	6.5%	–
Hollingshead Index	23.80	13.96
Lifetime no. of drinks	0.52	1.39
Family history of alcohol-use disorder	54.3%	–
Extraversion *t* score	50.00	8.61
Neuroticism *t* score	40.50	11.64
WASI vocabulary *t* score	57.37	7.60
AEQ-A		
Global positive	39.13	10.33
Social behavior	39.94	9.02
Sexual enhancement	20.50	5.09
Cognitve and motor impairment	96.70	9.78
Improved performance	16.85	4.60
Relaxation and tension reduction	43.19	9.74
Increased arousal	23.57	5.13
Total expectancy score	86.47	35.60

Notes: WASI = Wechsler Abbreviated Scales of Intelligence; AEQ-A = Alcohol Expectancy Questionnaire-Adolescent.

Measures

Within 7 days of scanning, a neuropsychological battery assessed multiple cognitive domains, including attention; working memory; learning and memory; and executive, visuospatial and language functioning, including the Wechsler Abbreviated Scales of Intelligence (WASI; Wechsler, 1999) vocabulary subtest to estimate intellectual functioning level. Current alcohol consumption was assessed with the Customary Drinking and Drug Use Record (Brown et al., 1998) and the Timeline Followback (Sobell and Sobell, 1992). During the testing session, the personality and expectancy measures were also administered. Parents were administered the Child Behavior Checklist (Achenbach, 1991) and family background interview.

Alcohol Expectancy Questionnaire-Adolescent (AEQ-A) form. The AEQ-A (Brown et al., 1987) is a 100-item Likert scale, self-report instrument that measures alcohol expectancies in older children and adolescents. It is comprised of seven scales. Reliability estimates in this sample were as follows: global positive changes (alpha = .89), changes in social behavior (alpha = .80), sexual enhancement (alpha = .85), cognitive and motor impairment (alpha = .80), improved cognitive and motor abilities (alpha = .74), relaxation and tension reduction (alpha = .91) and increased arousal (alpha = .77), as well as a total expectancy score (alpha = .94). The AEQ-A has been shown to predict subsequent drinking among adolescents (Christiansen et al., 1989; Smith et al., 1995).

Junior Eysenck Personality Inventory (JEPI). The JEPI (Eysenck, 1963) was created to assess personality dimensions in children ages 7-16 years. This self-report measure has 60 items, including 24 extraversion (alpha = .64) and 24 neuroticism (alpha = .91) statements (alphas derived from this sample). Using the JEPI, extraversion has been associated with increased risk for early alcohol involvement (Hill et al., 2000). Disinhibition was operationalized as the interaction of neuroticism and extraversion.

Procedures

The vast majority of participants (98%) reported no substance use in the 30 days prior to scanning and testing. The most recent alcohol use reported was 4 days before, and drug use (marijuana) was 5 days before scanning. Alcohol breath tests ensured no intoxication during imaging. During the scan, task stimuli were back-projected onto a screen at the foot of the MRI bed and viewed from a mirror attached to the head coil. A magnet-safe response box measured task performance during the scan.

During fMRI acquisition, youth performed a standard go/no-go task (Schweinsburg et al., 2004). One of four different solid blue shapes (i.e., small/large squares/circles) was presented for 200 ms every 1,500 ms. Participants were instructed to press a button as quickly as possible each time they saw the large square, large circle or small circle (go stimuli) but not to press the button when they saw the small square (no-go stimulus). The task lasted 6 min and 25 s, and participants completed the entire task both before and during fMRI scanning.

Images were acquired on a 1.5 Tesla General Electric Signa LX scanner. A high-resolution structural image was collected in the sagittal plane using an inversion recovery prepared T_1-weighted three-dimensional spiral fast-spin echo sequence (Repetition Time [TR] = 2,000 ms; Echo Time [TE] = 16 ms; Field of View [FOV] = 240 mm; resolution = 0.9375 mm × 0.9375 mm × 1.328 mm) (Wong et al., 2000). Functional imaging was collected in the axial plane using T_2*-weighted spiral gradient recall echo imaging (TR = 3,000 ms; TE = 40 ms; flip angle = 90°; FOV = 240 mm; 20 continuous slices; slice thickness = 7 mm; in-plane resolution = 1.875 mm × 1.875 mm; 128 repetitions).

fMRI analyses

Data were processed and analyzed using Analysis of Functional NeuroImages (AFNI; Cox, 1996) and involved several steps. A motion-correction algorithm was applied to the time-series data, then two raters visually reviewed time-series data for motion, and repetitions with visually discernible motion were removed. If more than 15% of repetitions were thus discarded, the participant was excluded (n = 4 of the original 50 adolescents). Time-series data were deconvolved with a reference vector that contrasted no-go trials with go trials and accounted for delays in hemodynamic response (Bandettini et al., 1993) while covarying for motion correction and linear trends. This resulted in a fit coefficient representing the response contrast between no-go and go trials in each voxel for each participant. Imaging data were transformed to standard coordinates (Lancaster et al., 2000; Talairach and Tournoux, 1988), and the functional data were resampled into 3.5 mm^3 voxels. Finally, we applied a spatially smoothing Gaussian filter (full-width, half-maximum = 3.5 mm) to account for interindividual anatomic variability.

After processing individual functional data, we determined regions that showed significant blood oxygen level-dependent (BOLD) response contrast between no-go and go trials in a single sample t test (N = 46). To control for Type I error, significant voxels (alpha < .05) were required to form clusters exceeding 943 microliters (22 contiguous 3.5 mm^3 voxels; Forman et al., 1995; Ward, 1997). Twenty-two such clusters were found (see Table 2). Talairach Daemon (Lancaster et al., 2000; Ward, 1997) and AFNI (Ward, 1997) confirmed cluster labels. Subsequent analyses utilized the fit coefficient representing each participant's BOLD response to no-go trials relative to go trials averaged across the cluster.

Results

Participants were very accurate on go trials (i.e., very few omission errors; 99% mean accuracy ± 2%), but commission errors during no-go trials were more common (80%

TABLE 2. Regions showing significant BOLD response contrast during the go/no-go task (N = 46)

Anatomic region	Brodmann Area	Volume (microliters)	Talairach coordinates x	y	z
Go > no-go					
Right middle frontal gyrus	46	1,243	44R	38A	17S
Right middle and superior frontal gyri	8, 9	3,473	26R	38A	31S
Right lateral inferior frontal gyrus	9	2,873	44R	17A	31S
Right inferior frontal gyrus	47	2,101	26R	24A	8I
Right precentral gyrus	4	986	54R	8P	35S
Left inferior frontal gyrus/Broca's Area	44	1,115	51L	10A	21S
Left inferior temporal and middle occipital gyri	37, 19	1,029	47L	64P	15I
Left inferior frontal and middle frontal gyri	46	986	47L	38A	10S
Bilateral cingulate and medial frontal gyri	24, 6	9,990	5R	5P	35S
Bilateral medial frontal gyrus, precuneus, posterior cingulate and right cuneus	6, 7, 30, 18	62,426	2R	15P	66S
Right transverse temporal gyrus and insula	41, 13	2,487	51R	26P	10S
Right superior and middle temporal gyri	39	1,715	51R	47P	10S
Left superior temporal gyrus and insula	41, 13	1,115	37L	33P	14S
Left lateral superior temporal gyrus	42	3,902	58L	33P	17S
Right inferior parietal lobule	40	2,401	58R	29P	31S
Left superior parietal lobule	7	943	26L	61P	56S
Right lentiform nucleus	–	2,530	19R	13A	1I
Left lentiform nucleus	–	5,274	23L	1P	4I
Left thalamus	–	943	2L	12P	17S
No-go > go					
Bilateral anterior cingulate and subcallosal cortex, left inferior frontal and middle frontal gyri	25, 32, 47	9,218	2L	13A	4I
Left postcentral gyrus	3	1,243	37L	29P	59S

Notes: Talairach coordinates refer to maximum signal contrast intensity within the cluster, BOLD = blood oxygen level-dependent, R = right; L = left; A = anterior; P = posterior; S = superior; I = inferior.

mean accuracy ± 9%). As can be seen in Table 2, on average, many areas showed greater activation during go trials relative to no-go trials. A large area of the anterior cingulate—including the subcallosal cortex and the left postcentral gyrus—showed, on average, significantly more BOLD response during inhibition trials relative to go trials. No significant relations were found between accuracy in responding to go or no-go trials examined with response time, personality or expectancy measures.

Personality and expectancies

At the bivariate level, extraversion positively related to global positive changes ($r = 0.30$, $p < .05$), changes in social behavior ($r = 0.33$, $p < .05$), sexual enhancement ($r = 0.55$, $p < .001$), relaxation and tension reduction ($r = 0.36$, $p < .05$) and the total expectancy score ($r = 0.38$, $p < .01$). To test the effectiveness of the interaction term representing disinhibition, a series of hierarchical regressions were performed in which neuroticism and extraversion were entered in Step 1 and disinhibition (Neuroticism × Extraversion) in Step 2. Neuroticism and disinhibition were not significantly related to expectancy scores in any of these analyses.

Hierarchical regressions examined whether extraversion predicted alcohol expectancies above and beyond background variables (gender, age at time of scanning, family history of alcoholism and presence of conduct disorder) in this sample of youth. In the first step, gender and age significantly predicted expectancies in all regressions except for social behavior change (only age was significant). Background variables contributed between 24% and 30% of the variance in expectancy scores in Step 1. Extraversion significantly predicted alcohol expectancies above and beyond demographics in the cases of global positive changes ($\beta = .32$, $\Delta R^2 = 10\%$, $F_\Delta = 6.34$, 1/39 df, $p < .05$), changes in social behavior ($\beta = .35$, $\Delta R^2 = 12\%$, $F_\Delta = 7.20$, 1/39 df, $p < .05$), sexual enhancement ($\beta = .56$, $\Delta R^2 = 31\%$, $F_\Delta = 29.91$, 1/39 df, $p < .001$), relaxation and tension reduction ($\beta = .34$, $\Delta R^2 = 11\%$, $F_\Delta = 6.79$, 1/39 df, $p < .05$) and Total Expectancy Score ($\beta = .40$, $\Delta R^2 = 15\%$, $F_\Delta = 9.89$, 1/39 df, $p < .01$). Expectancies of cognitive and motor impairment, improved cognitive and motor abilities, and increased arousal from alcohol were not predicted by extraversion above and beyond background variables.

Personality and BOLD response

There were no significant correlations between BOLD response and extraversion, neuroticism or disinhibition at a liberal significance level of $p < .05$. To test the effectiveness of the interaction term representing disinhibition in predicting BOLD response, a series of hierarchical regressions were also performed in which neuroticism and extraversion were entered in Step 1 and disinhibition (Neuroticism × Extraversion) in Step 2. Neuroticism, extraversion and disinhibition were not significantly related to BOLD response in targeted areas.

In addition, the relations between accuracy in responding to go/no-go trials and response time were not significantly related to personality. Interestingly, a diagnosis of conduct disorder was not significantly correlated with personality measures.

BOLD response and alcohol expectancies

Using a stringent criterion for significance (Bonferroni $p < .0003$; $.05/132 = .0003$), no correlations between BOLD response to the go/no-go task and alcohol expectancies were significant. However, using a more liberal p value of .05, 17 significant correlations were found between BOLD response in several clusters and the six AEQ-A scale scores (132 total correlations). These correlational trends were used as the basis of hierarchical regression analyses similar to those described previously. Gender, age, family history and presence of conduct disorder were entered in Step 1, and average cluster fit coefficients were entered in Step 2.

The addition of BOLD response to no-go trials relative to go trials in Step 2 significantly improved prediction of expectancies for improved cognitive and motor abilities and cognitive and motor impairment above and beyond age, gender, family history and conduct disorder (see Table 3) but not for expectancies of global positive changes, sexual

TABLE 3. Hierarchical regression analyses for go/no-go BOLD response clusters predicting AEQ-A Scales ($N = 46$)

Variable	β	ΔR^2
DV: Improved cognitive and motor abilities		
Step 1		.12
Gender	-0.05	
Family history	-0.24	
Age	0.08	
Conduct disorder diagnosis	0.26	
Step 2		.27†
Right inferior parietal lobule (Brodmann Area 40)	-0.59†	
Right middle frontal gyrus (Brodmann Area 46)	-0.20	
Left lateral superior temporal gyrus (Brodmann Area 42)	0.18	
DV: Cognitive and motor impairment		
Step 1		.23*
Gender	-0.34*	
Family history	0.20	
Age	0.15	
Conduct disorder diagnosis	-0.27	
Step 2		.13†
Left superior temporal gyrus/insula (Brodmann Areas 41,13)	0.37†	

Notes: Hierarchical regressions are not presented for global positive changes, sexual enhancement, increased arousal, and relaxation and tension reduction expectancies due to lack of significant ΔR^2 in Step 2. BOLD = blood oxygen level-dependent; AEQ-A = Alcohol Expectancy Questionnaire-Adolescent; DV = dependent variable.
*$p < .05$; $^\dagger p < .01$.

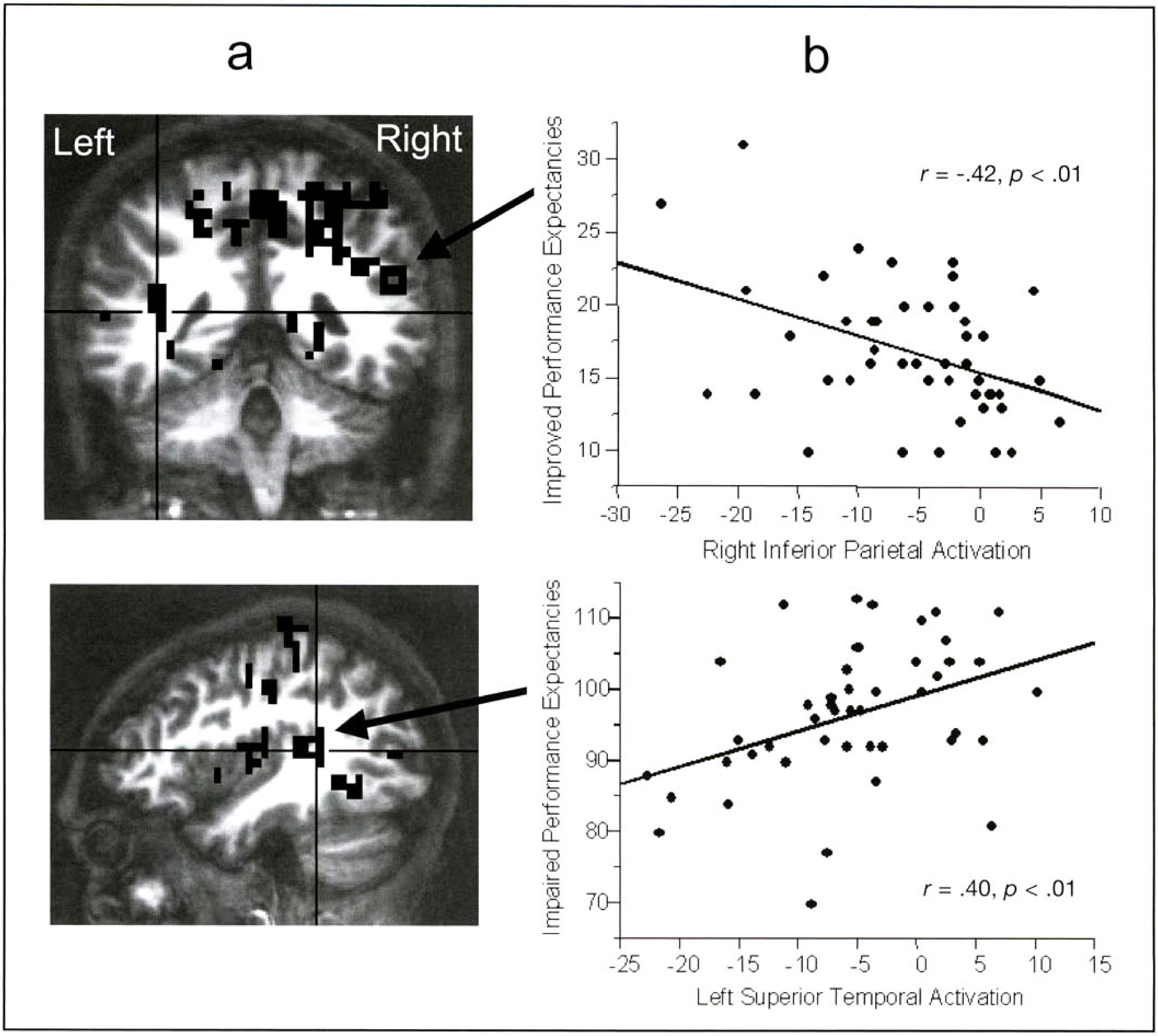

FIGURE 1. Brain regions (highlighted in black) showing (a) significant blood oxygen level-dependent (BOLD) response to the go/no-go task and (b) relationships with alcohol expectancies. Crosshairs on brain images indicate the same location in coronal (top) and sagittal (bottom) planes.

enhancement, increased arousal, or relaxation and tension reduction outcomes from drinking. Response in the cluster extending from the left lateral superior temporal gyrus to the inferior parietal lobule (Brodmann Area 42), the right inferior parietal lobule cluster (Brodmann Area 40) and the right middle frontal gyrus cluster (Brodmann Area 46) in combination predicted 27% of the variance in improved cognitive and motor abilities ($p < .01$) expectancies for alcohol. Specifically, response in the right inferior parietal lobule was negatively associated with expectancies for improved cognitive and motor abilities ($p < .01$). Response in the left superior temporal gyrus extending into the posterior insula (Brodmann Areas 13 and 41) accounted for 13% of the variance above and beyond background variables, and activation here positively predicted expectancies for cognitive and motor impairment ($p < .01$; see Figure 1).

Discussion

This investigation was the first examination of relations between personality, alcohol expectancies and BOLD response to go/no-go performance in adolescents. Adolescents with more brain response in bilateral inferior parietal lobules and right middle frontal and left superior temporal gyri during inhibition expected that alcohol produces few cognitive and motor improvements; in fact, brain response in these regions predicted 27% of the variance in this expectancy. Moreover, youths with stronger activation in the left superior temporal gyrus and insular cortex during no-go trials reported that they expected greater impairment after alcohol ingestion. Thus, greater relative inhibitory activation to this task was associated with more negative expectancies and fewer positive expectancies for alcohol's effects in the right inferior parietal lobule and left superior temporal/posterior insula regions.

The relationships detected between BOLD response to inhibition and alcohol expectancies have not previously been reported and could help us understand more about the formation of these cognitions. Adolescents with little alcohol experience who showed greater BOLD response during inhibition in right inferior parietal, right middle frontal and left superior temporal regions tended to disagree that alcohol would produce improved performance (e.g., disagree that "People understand things better when they drink alcohol"). In concert with this finding, low-drinking adolescents who demonstrated increased inhibition response in left superior temporal and insular regions were likely to anticipate that alcohol would impair performance (e.g., "After drinking alcohol, a person may lose control and bump into things"). It is possible that these differences in brain response to an inhibition task might relate to their pattern of attending to, encoding or retrieving experiences that form the basis of expectations, such as those for the effects of alcohol.

The right inferior parietal lobule, which is directly connected to the right prefrontal cortex, is implicated in many cognitive processes, including those involving sustained, and possibly selective, attention (Coull et al., 1996); voluntary attentional control (Hopfinger et al., 2000); and inhibitory control (Steel et al., 2001) (i.e., the allocation of resources to a response that has to compete with a highly overlearned and potentially habitual behavior). Decision-making paradigms have implicated the right inferior parietal lobule in autonomic arousal (Critchley et al., 2000) and risk-taking decision-making (Ernst et al., 2002). In sum, the right inferior parietal lobule may be critical for integrating attentional resources to select actions and inhibit previous prediction strategies as they relate to success or failure. Individuals at risk for alcoholism based on family history appear to have less inferior parietal response to the inhibition task used in this study (Schweinsburg et al., 2004) and to a visual oddball task (Rangaswamy et al., 2004). Insula activation is frequently associated with the assessment of aversive states. Studies have shown insula activation during the processing of fearful (Morris et al., 1998) or disgusted (Phillips et al., 1998) faces and anticipation of electric shocks (Chua et al., 1999). Moreover, insula activity is modulated by perceptual awareness of threat (Critchley et al., 2002), penalty (Elliott et al., 2000) and error-related processes (Menon et al., 2001). In combination, insula activation may function to alert the individual of expected aversive outcomes.

Our results regarding the relation between personality variables and alcohol expectancies replicate past work in this area (Brown and Munson, 1987; Katz et al., 2000; McCarthy et al., 2001a,b; Sher et al., 1991). We found that extraversion significantly predicted alcohol expectancies above and beyond demographics for expectancies for global positive change, changes in social behavior, sexual enhancement, relaxation and tension reduction, and AEQ-A total scale score. This suggests that extraverted teens in this study had more positive expectancies for drinking, despite having not yet initiated regular alcohol use. However, we did not find support for disinhibition's relation to expectancies as operationalized by the interaction of neuroticism and extraversion. This finding is consistent with Anderson et al.'s (2005) finding in fifth grade students that disinhibition directly related to drinking behavior but not to expectancies for alcohol. Although disinhibition's relation with alcohol expectancies has been reported in high school (Anderson, unpublished manuscript) and college samples (Anderson et al., 2003; McCarthy et al., 2001a,b), validation of this relation in younger samples has not been found. It is possible that development plays a role in these disparate findings. Further longitudinal research is necessary to characterize the relation between personality and expectancies across child and adolescent development.

Contrary to Horn et al.'s (2003) findings, we did not find support for the association between disinhibition and go/no-go brain response nor for the relation between go/no-go accuracy and BOLD response to the inhibition task. We selected an operationalization of disinhibition (Neuroticism × Extraversion) consistent with those used in Patterson and Newman's (1993) work on disinhibition and the go/no-go task. However, it is not known how well this operationalization maps onto the measurement of impulsivity used by Horn et al. (2003) in their study of adults or with other operationalizations of disinhibition (e.g., impulsivity, novelty seeking). It is possible that differences in how disinhibition was identified and developmental differences between adolescents in this study and adults in Horn's sample led to divergent findings. Given the variable and emerging specificity in neural development in this age range, further studies on developmental differences in the measurement of disinhibition and brain response to inhibition are necessary to answer these questions.

Our investigation does not provide support for the theoretical assumptions of Patterson and Newman's (1993) work that disinhibited responding functions through activation in the septohippocampal area. However, it must be noted that we used the go/no-go task without providing additional incentives for correct responding. Although success on the task might provide adequate incentives for some individuals, this might not have been sufficient to elicit impulsive responding among participants. In addition, priming individuals for reward has been found to elicit disinhibited responding in mixed incentive situations for some individuals (Patterson and Newman, 1993). Further, fMRI signal tends to be attenuated in hippocampal regions relative to other brain areas. Thus, it is possible that these factors masked potentially supportive findings. However, general support for APM assertions of a relation between personality, as measured by extraversion, and positive alcohol expectancies in the domains of global positive changes, social facilitation, sexual enhancement, and relaxation and tension reduction expectancies were found.

The preliminary nature of this investigation must be considered. Although we discuss these results in terms of statistical prediction via regression, the cross-sectional nature of these results precludes statements of causality. To test causality and mediational models, longitudinal investigations are necessary to examine the temporal sequence of these factors. In addition, the small sample of youth examined limits the generalizability of these findings. However, our preliminary findings suggest that differential neural activation on inhibition tasks relates to learning differences regarding alcohol effects in this sample of adolescents with limited alcohol use. Further investigations in youth and adults with greater substance involvement levels could extend these relationships.

Clinically, our findings suggest that extraverted youth might have a tendency for higher positive expectancies for alcohol, which in turn predicts initiation of drinking and maintenance of maladaptive drinking patterns (Brown et al., 1985; Goldman et al., 1991). In addition, a pattern of underutilizing brain structures central to attention, encoding and recall during an inhibition task may be associated with early formation of more positive expectations of alcohol effects. By identifying individuals more likely to have greater needs for sociability and challenging emerging positive expectancies for alcohol, targeted prevention programs might have better results in changing adolescent drinking trajectories (Anderson et al., 2005).

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