

# Impairment on a Simulated Gambling Task in Long-Term Abstinent Alcoholics

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**Background:** Recent research indicates that currently active or recently detoxified substance abusers make more disadvantageous decisions on a simulated gambling task (SGT). This study expands on the current literature by using the SGT to examine decision making in long-term abstinent alcoholics (mean of 6.6 years' abstinence) who do not have antisocial personality disorder or a history of conduct disorder.

**Methods:** A total of 102 subjects (58 controls and 44 abstinent alcoholics) were tested on the SGT, in which subjects choose cards from 4 different decks that vary in terms of the magnitude of the immediate win (large or small) and the magnitude of long-term loss (large or small). The association of SGT performance with alcohol use variables, with the number of externalizing symptoms, and with personality measures of social deviance was examined.

**Results:** Compared with controls, long-term abstinent alcohol-dependent subjects had more externalizing symptoms, had personality profiles associated with a proneness to social deviance, and made more disadvantageous decisions on the SGT. The magnitude of disadvantageous decision making was associated with the duration of peak alcohol use but was associated with only one measure (low socialization) of socially deviant personality traits.

**Conclusions:** The results suggest that alcoholics can achieve long-term abstinence despite persistent deficits in decision making and abnormal personality profiles. The decision-making deficits either may be the result of long-term alcoholism or may reflect a factor predisposing to alcoholism that persists with abstinence. The possibility is raised that alcoholics who cannot achieve long-term abstinence are even more impaired on their decision making and have more abnormal personality profiles than the abstinent alcoholics studied here.

**Key Words:** Simulated Gambling Task, Alcohol Abuse, Long-Term Abstinence, Risk Taking, Decision Making.

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**A**LCOHOLISM AND DRUG abuse are disorders in which people continue their use of harmful substances despite major long-term negative consequences (e.g., in the areas of employment, family, education, and health). A number of studies (Bechara, 2001; Bechara et al., 2001; Grant et al., 2000) have examined the mechanisms underlying this aspect of substance dependence by using the simulated gambling task (SGT) developed by Bechara et al. (1994). The SGT simulates real-life decision making that requires an individual to weigh reward and punishment in an atmosphere of uncertain outcomes. Subjects are asked to choose between decks of cards that have small positive gains associated with relatively smaller negative consequences (the good decks) and decks of cards with large positive gains with even larger negative consequences (the

bad decks). If subjects choose from the good decks, over the long run they will gain money, and if they choose from the bad decks, they will lose money. These choices are similar to those made by substance abusers. They too continually weigh the short-term rewards against the long-term consequences of their behavior. A hallmark of drug and alcohol abuse is that users persist in behaviors that have short-term benefits (e.g., intoxication) despite long-term major negative consequences.

The gambling task was initially developed to study patients with acquired sociopathy due to damage to the ventromedial prefrontal cortex (Bechara et al., 1994, 1997). Such patients often take part in risky behaviors that are immediately gratifying while ignoring negative future outcomes. It is thought that they cannot see beyond short-term rewards to potential long-term consequences (Bechara et al., 1994). Compared with controls, when playing the SGT, patients with ventromedial prefrontal lesions consistently choose to draw more cards from decks with larger immediate rewards and long-term net losses than from decks with a smaller immediate reward, smaller delayed punishments, and long-term net gains (Bechara et al., 1994, 1997). Although they performed poorly on the SGT, patients with ventromedial prefrontal lesions performed normally in

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other cognitive domains (Bechara et al., 1998). Ventromedial prefrontal dysfunction may predispose an individual to make disadvantageous personal choices that can lead to socially inappropriate or socially deviant behavior (Bechara et al., 1994, 1997) or to drink excessively, even when it leads to significant problems.

Studies show that currently active or recently detoxified alcoholics (Bechara, 2001; Bechara and Damasio, 2002; Mazas et al., 2000) and drug abusers (Grant, 2000; Petry et al., 1998) exhibit SGT performance similar to that of ventromedial prefrontal lesion patients. Their performance is characterized by favoring larger immediate rewards while disregarding long-term negative consequences. This pattern of impaired decision making resembles the typical decisions made by an alcoholic to drink excessively to experience the immediate pleasure of intoxication despite the many longer-term consequences of intoxication (Clark and Robbins, 2002). Studies that have compared alcoholics with versus without antisocial personality (ASP) indicate that disadvantageous decision making is more strongly associated with ASP and conduct disorder (CD) than with alcoholism (Mazas, 2002; Mazas et al., 2000; Petry, 2002). In a review, Finn et al. (2002) suggested that disadvantageous decision making reflects a stable disposition to behavioral undercontrol or social deviance, which are also a major risk factors for alcoholism (Finn et al., 2000; Sher et al., 1991).

It is not clear whether impaired decision making that overemphasizes immediate rewards while discounting or even disregarding long-term negative consequences is a symptom of active alcoholism that might resolve with long-term abstinence, a consequence of chronic alcohol abuse on brain structure and function that may or may not resolve with long-term abstinence, or a stable characteristic of an underlying disinhibitory disposition in alcoholics that would predate active alcohol abuse and persist into long-term abstinence. Moreover, looking at alcoholism from the perspective that abusive drinking is a symptom of the underlying alcoholic disorder, it is a tenable hypothesis that gambling task impairment supports abusive drinking and lessens the likelihood of achieving long-term abstinence. If such were the case, one would expect that alcoholics who are able to achieve long-term abstinence would also evidence relatively normal performance on the SGT (i.e., those with SGT impairments would not have achieved long-term abstinence). There have been no studies of SGT performance in long-term abstinent alcoholics.

This study was designed to examine disadvantageous decision making in long-term abstinent alcoholics. It examined SGT performance in a sample of alcoholics who had been abstinent for an average of 6.6 years and for a minimum of at least 6 months. Rather than include alcoholics with diagnosable ASP or past CD, we decided to exclude individuals with such diagnoses and to assess the association of disadvantageous decision making with the number of symptoms of ASP and CD and with personality measures of social-deviance proneness. Social-deviance proneness,

**Table 1.** Exclusion of Abstinent Alcoholics (ages 35–55)

Reason for exclusion	No. Excluded
Current drug abuse or lifetime drug dependence	25
Failed alcohol dependence, use, or abstinence criteria	47
Met medical exclusion criteria	28
Met psychiatric exclusion criteria	29
Total	121

assessed with the Socialization scale of the California Personality Inventory (Gough, 1969) and the Minnesota Multiphasic Personality Inventory (MMPI) Psychopathic Deviance scale (Hathaway, 1989), is thought to reflect the basic personality dispositions that lead to ASP (Finn et al., 2000; Gough, 1969; Hathaway, 1989). This study tested the hypothesis that long-term abstinent alcoholics will demonstrate disadvantageous decision making on Bechara's SGT. It also tests the hypothesis that disadvantageous decision making is associated with behaviors and personality traits that reflect a proneness to social deviance.

## METHODS

### Participants

A total of 102 participants were recruited from the community at large by canvassing Alcoholics Anonymous meetings and by café postings, newspaper advertisements, and a local Internet site. Two groups were recruited: controls ( $n = 58$ ; 21 men and 37 women) and abstinent alcoholics ( $n = 44$ ; 26 men and 18 women). The inclusion criterion for the control group was a lifetime drinking average of fewer than 30 drinks per month with no periods of more than 60 drinks per month. Abstinent alcoholics needed to meet the lifetime criteria for alcohol dependence, have a lifetime drinking average of at least 100 drinks per month for men and 80 drinks per month for women, and be abstinent for at least 6 months.

Exclusion criteria for both groups were (1) history or presence of an axis I diagnosis (including ASP and CD) on the Diagnostic Interview Scale (DIS; Robins et al., 1998); (2) history of drug dependence other than nicotine or caffeine; (3) significant history of head trauma or cranial surgery; (4) history of diabetes, stroke, or hypertension that required medical intervention or of another significant neurological disease; (5) clinical evidence of Wernicke-Korsakoff syndrome; and (6) current substance abuse other than caffeine or nicotine. The number of potential abstinent alcoholic subjects rejected for various reasons is presented in Table 1.

All participants were informed of the study's procedures and aims and signed a consent form before participation. Subjects participated in four sessions that lasted between 1.5 and 3 hr: this included clinical, neuropsychological, electrophysiological, and neuroimaging assessments. Control subjects were asked to abstain from drinking alcohol for at least 24 hr before any laboratory visits, and a Breathalyzer (Draeger, Durango, CO) test was administered to all subjects before each session. We had one positive Breathalyzer test result for one "abstinent alcoholic" subject assessed before an electroencephalogram; that subject was excluded from the study. Subjects who completed testing were paid for their time and travel expenses, and those who completed the entire study were also given a completion bonus.

### Assessment

All subjects were assessed for psychiatric diagnoses by using the DIS (Robins et al., 1998). Subjects were interviewed on their drug and alcohol use by using the lifetime drinking history method (Skinner and Sheu, 1982; Sobell and Sobell, 1990; Sobell et al., 1988), medical histories were re-

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viewed, and liver functions were tested. Personality traits reflecting social deviance were assessed with the Psychopathic Deviance scale of the MMPI-2 (Hathaway, 1989) and the Socialization scale of the California Psychological Inventory (Gough, 1969). The extent of externalizing symptoms was indicated by the sum of positive Antisocial Personality Disorder and Conduct Disorder items from the DIS.

#### Gambling Task Administration

The game begins with \$2000 of fake money. The subjects' task is to try to win as much money as possible. They are asked to select one card at a time from one of the four decks. Some cards will add money and some cards will subtract money from their running total. Subjects are told that they can switch from one deck to another at any time and as often as they wish. Each deck has a total of 60 cards, and the game ends after a total of 100 cards are selected. They are told that they will not know when the game will end, that they should continue to choose from whichever decks they like until the game ends, that some decks are better than others, and that the computer does not change the order of cards after the game starts, make one lose at random, or make one lose money on the basis of the last card chosen. The dependent variable reflects advantageous decision making and is indexed by the number of cards chosen from the good decks minus the number of cards chosen from the bad decks.

#### Alcohol Use Variables

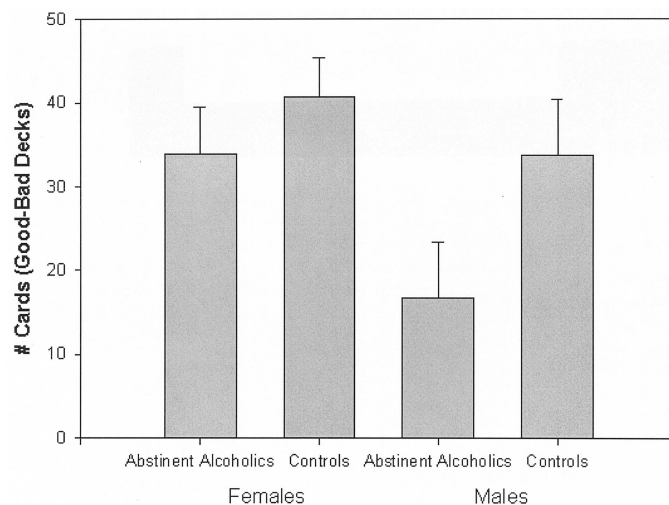
Alcohol use variables were defined on the basis of subjects' responses on the lifetime drinking history. *Alcohol lifetime duration* refers to the number of months of alcohol consumption in the individual's lifetime, and *peak duration* refers to the number of months of peak alcohol use. *Alcohol lifetime dose* is the average number of drinks per month of alcohol consumption over the subject's lifetime, and *peak dose* is the number of drinks per month during the period of peak alcohol consumption. *Duration of abstinence* was also included as an alcohol use variable.

#### Statistical Analysis

The data were analyzed with SAS (SAS Institute, Cary, NC). ANOVA for unbalanced designs was performed with the general linear models procedure. The robustness of main effects to outliers was assessed with the nonparametric Wilcoxon test. Spearman correlations were examined because they are robust and resistant to outliers (Fig. 1).

## RESULTS

Table 2 presents the demographic, alcohol use, externalizing symptom, and deviance-proneness measures for men and women in the abstinent alcoholic and control groups. There were no group or gender differences in subject age or years of education. Abstinent alcoholics and men had many more externalizing symptoms on the DIS than did controls or women. The group difference accounted for 31.3% of the variance of the measure, whereas the gender difference accounted for 5.3% of the variance. There was an enormous group difference in socialization scores (accounting for 44.2% of the California Psychological Inventory socialization score variance); no gender difference was present. Finally, there were much higher MMPI Psychopathic Deviance scale scores in the abstinent alcoholics (group accounted for 18% of the measures variance), with no gender differences.



**Fig. 1.** Gambling task performance (number of cards chosen from the good decks minus number of cards chosen from the bad decks) for abstinent alcoholics and controls separately for men and women. Gambling task performance was worse for abstinent alcoholics versus controls ( $p < 0.05$ ) and for men versus women ( $p < 0.05$ ). No sex  $\times$  group interaction was observed.

#### Gambling Task Performance

We examined gambling task performance as a function of group (abstinent alcoholic versus control) and gender. Because the sampling design was not balanced, group and gender needed to be evaluated with the other effect partialled out to indicate the effect of each variable independently of the other. In this analysis, there was a significant main effect of group [ $F(1,98) = 4.03$ ;  $p < 0.05$ ] and a significant main effect of gender [ $F(1,98) = 4.08$ ;  $p < 0.05$ ], with a nonsignificant group  $\times$  gender interaction [ $F(1,98) = 0.36$ ;  $p > 0.54$ ]. When the data were analyzed for main effects by using the Wilcoxon test, the effects of group and gender remained significant, thus indicating that those effects were not due to a few extreme values.

#### Association of Gambling Task Performance With Subject Variables

Across the entire sample there were significant correlations of gambling task performance with socialization scores ( $r = 0.31$ ;  $p < 0.002$ ) and the number of externalizing symptoms ( $r = -0.19$ ;  $p = 0.05$ ), but there was no association with the MMPI Psychopathic Deviance scale ( $r = -0.07$ ;  $p > 0.50$ ). None of these measures was associated with gambling task performance in either the abstinent alcoholic group or the control group when these groups were examined separately. The only within-group correlation that even had a trend toward statistical significance was the correlation of SGT score with the socialization score in the control group ( $r = 0.19$ ;  $p > 0.14$ ); all other correlations had  $|r|$  values less than 0.11 ( $p > 0.40$ ).

**Table 2.** Demographic, Alcohol Use, Externalizing Symptom, and Social-Deviance Proneness Measures for the Abstinent Alcoholic and Control Samples

Variable	Abstinent alcoholics		Controls	
	Men (n = 26)	Women (n = 18)	Men (n = 21)	Women (n = 37)
Demographic variables				
Age (years)	45 ± 1.34	47.4 ± 1.34	43.1 ± 1.36	44.8 ± 1.11
Years of education	15.5 ± .43	15.6 ± .5	16 ± .4	16.4 ± .28
Alcohol use variables				
Duration of alcohol use (months)	251 ± 17.4	246 ± 21.2	291 ± 31.4	306 ± 22.4
Average alcohol dose (drinks/mo)	167 ± 26.3	134 ± 19.8	6.63 ± 1.75	6.07 ± .89
Duration of peak alcohol use (months)	52.3 ± 6.29	82.8 ± 19.2	106 ± 30	112 ± 19.1
Peak alcohol dose (drinks/mo)	353 ± 51.5	311 ± 66.8	14.7 ± 3.12	16.8 ± 3.25
Abstinence duration (years)	6.79 ± 1.19	7.13 ± 1.36	N/A	N/A
Externalizing symptoms <sup>a</sup>				
	16 ± 1.52	11.74 ± 1.61	7.19 ± 1.37	3.51 ± .43
Social-deviance proneness measures				
CPI Socialization scale	27 ± 1.13	28.9 ± 1.33	36.6 ± .94	37.5 ± .56
MMPI-Pd	23.1 ± 1.36	25.3 ± 1.73	17.9 ± .72	19.1 ± .78

Data are mean ± SE.

CPI, California Personality Inventory; Pd, Psychopathic Deviance scale; N/A, not applicable.

<sup>a</sup> Sum of Antisocial Personality Disorder and Conduct Disorder symptoms from the DIS.

### Association of Gambling Task Performance With Alcohol Use Variables

Gambling task performance was negatively correlated in the abstinent alcoholic group with the duration of alcohol use ( $r = -0.30$ ;  $p < 0.05$ ) and duration of peak alcohol use ( $r = -0.35$ ;  $p < 0.03$ ). After partialling out the contribution of age (older subjects have a longer life in which to use or use at a high dose), duration of alcohol use remained a weak trend ( $r = -0.23$ ;  $p = 0.14$ ), whereas duration of peak use remained significant ( $r = -0.30$ ;  $p < 0.05$ ). There were no associations with duration of abstinence.

## DISCUSSION

The major result of this investigation was the finding of gambling task impairment in alcoholics who had been abstinent for a minimum of 6 months and an average of 6.6 years. This result demonstrates that individuals with persistent decision-making impairment on the SGT are able to achieve long-term abstinence.

It is important to note that the long-term abstinent alcoholics studied here had personality profiles with regard to externalizing symptoms and social deviance that were grossly different from those of controls. Compared with controls, the abstinent alcoholics had dramatically lower socialization scores on the California Personality Inventory, had highly increased psychopathic deviance scores on the MMPI, and had more than twice the number of ASP and CD symptoms on the DIS. Our data demonstrate that alcoholics who have twice the number of externalizing symptoms as controls and who have personality profiles that reflect a proneness to social deviance (short of actual ASP or CD) can achieve long-term abstinence. Advantageous decision making was associated with higher scores on the socialization scale but was only modestly associated with low externalizing symptoms and was not associated with psychopathic deviance. This suggests that poor decision making in this sample did not reflect variations in social deviance or antisocial tendencies.

Only 45% of the potential volunteer subjects for the abstinent alcoholic sample were excluded for drug or psychiatric comorbidity. In addition, none of our potential volunteer subjects with a minimum of 6 months of abstinence was excluded for a DIS lifetime diagnosis of ASP or CD. We do not know whether these low comorbidities in the volunteer sample are because individuals with such comorbidities are less likely to achieve long-term abstinence (and, thus, be potential volunteers for our study) or whether they are simply less likely to volunteer for research studies in response to flyers at Alcoholics Anonymous meeting places and advertisements in newspapers. In either case, the data suggest that our recruitment efforts selected for alcoholics with relatively low drug and psychiatric comorbidities (including zero comorbidity for ASP and CD). Our data also suggest that such low comorbidities are characteristics of alcoholics who are able to achieve long-term abstinence; however, careful community-based studies are needed to establish whether such is the case. Finally, our study illustrates the difficult decisions in study design (e.g., whether to exclude individuals with comorbid drug or psychiatric conditions) and the complexity of analysis and interpretation inherent in studying alcoholic versus control samples. These arise from the confounding in clinical samples of the effects of factors predisposing to alcoholism, the effects of comorbid conditions, the effects associated with preclinical signs and symptoms of such comorbid conditions when individuals meeting actual diagnostic criteria for such conditions are excluded from study, and the effects of alcoholism per se.

Impairment on the SGT may result from impairments in the cognitive or motivational realm or in both. One limitation of this study is that in our implementation of the SGT, we did not save individuals' choices on successive cards (we saved only the total number of cards chosen from each deck). Therefore, we were unable to examine changes in performance with task progression; this would have provided hints as to whether individuals were able to learn the task contingencies over time. Such data would have helped

differentiate between a motivational versus cognitive disturbance underlying impaired SGT performance. We now routinely save such trial-by-trial data.

Nonetheless, our data indicate that individuals with impairments on the SGT can maintain long-term abstinence. Our results suggest that although these abstinent alcoholics remain susceptible to making poor decisions and have personality profiles associated with deviance proneness, they somehow manage to compensate for their deficits by recruiting other mechanisms of behavioral control that enable them to resist drinking. Our results raise the question of whether alcoholics who are unable to maintain long-term abstinence have even more abnormal psychological profiles and more impaired decision making on the SGT. Another potential implication of this research is that the achievement of long-term abstinence may involve different processes in different subgroups of alcoholics—these results provide some hints as to how those subgroups may be constituted. Different mechanisms of behavioral control may be used to maintain abstinence by alcoholics who evidence impairment on the SGT compared with alcoholics who exhibit normal performance on the SGT. These issues deserve further research and may illuminate important processes involved in the attainment of long-term abstinence.

We also found that, in our sample of abstinent alcoholics, the magnitude of the SGT impairment was unaffected by the duration of abstinence and was positively associated with the duration of peak alcohol use. This suggests two alternatives. The first is that gambling task impairment in part reflects the consequence of chronic alcohol abuse on the brain, and this effect does not resolve with abstinence, even very long-term abstinence. The other is that the findings reflect some preexisting factor in alcoholics that accounts for both the impaired decision making and the severity of alcoholism. The current data cannot differentiate between these alternatives.

Finally, the results raise the possibility that the abstinent alcoholic subjects studied here had abnormalities in their ventromedial prefrontal cortex. We are in the process of examining structural imaging data from these subjects to test this hypothesis.

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