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# Impulsivity in Social Drinkers*

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Impulsivity in groups of light- and heavy-drinking students was assessed in a simple choice task. This discrete-trial choice task used a titration procedure where the higher probability of winning a hypothetical $100 was fixed over trials, and the lower probability of winning $150 or $450 was adjusted. Choices between $100 and $150, and between $100 and $450 were presented in different within-session conditions. Heavy drinkers were more impulsive than were light drinkers, for both $100–$150 and $100–$450 choices, in that they preferred the smaller high-probability outcome to a greater extent than did the light drinkers. An impulsivity score based on preference on the last trial was significantly correlated with quantity and frequency measures of drinking history. Nonsignificant correlations of impulsivity with abstraction, vocabulary, and conceptual quotient scores of the Shipley Institute of Living Scales and with the Trail-Making Test suggested that the relation between impulsivity and extent of social drinking was not mediated by cognitive impairment. The clear relation between impulsivity and social drinking supports the treatment of social drinking in terms of behavioural theories of choice.

Behavioural theories of choice place individual behaviour in a reinforcement context. The tendency to opt for a particular choice is influenced by the outcomes of the choice relative to the outcomes of competing alternatives. The reinforcement context is thus provided by the tapestry of previous and potential consequences of past and current behaviours, woven to form a background for the outcomes of the target behaviour. In a range of experimental situations with humans and nonhumans, Herrnstein's (1970) matching law successfully predicts the choice for a given behaviour relative to competing alternatives as a function of the relative outcomes of that behaviour (Pierce & Epling, 1983). According to the matching law, the proportion of choices in a given situation matches the proportion of outcomes or reinforcers produced by those choices. This view of behaviour as choice in a reinforcement context has been applied to therapeutic situations (Szabadi, Bradshaw, & Ruddle, 1981; McDowell, 1982, 1988, 1989), criminal behaviour (Wilson & Herrnstein, 1985) and self-control problems (Rachlin, 1980, 1989), as well as to a wide range of other applied (Myerson & Hale, 1984) and basic (Williams, 1988) research questions. A clear introduction to the precise formulation of the matching law and its applications is provided by McDowell (1988, 1989).

The behavioural treatment of impulsivity (and its converse, self control) emphasises the choice between "impulsive" versus "self controlled" courses of action and their

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corresponding outcomes (Logue, 1988; Rachlin, 1974, 1980, 1989). Typically, the outcomes of impulsivity are immediate but of low value, whereas the outcomes of self control are delayed and of greater value. Impulsive behaviour is strongly influenced by the immediacy of its consequences and is seen as the tendency to choose small immediate outcomes in preference to alternatives involving larger but delayed outcomes. That is, the reinforcement context for impulsivity includes outcomes that differ in delay.

Vuchinich and Tucker (1983, 1988) and Vuchinich, Tucker, and Rudd (1987) recently provided a useful account of alcohol consumption in terms of behavioural theories of choice and impulsivity. They used a straightforward laboratory procedure in which subjects could choose points exchangeable for alcoholic drinks at the end of the experimental session versus points exchangeable for money received at a later time. They found an increasing preference for alcohol consumption with increasing delay in the receipt of money (up to several weeks). Plausibly, they suggest that their laboratory preparation characterises the choice in normal environments between alcohol consumption versus other activities associated with outcomes occurring at different delays (Vuchinich et al., 1987). Vuchinich and Tucker's (1983, 1988) analysis is of interest because of its implications for understanding the choice to drink as a problem of impulsivity (White & Moesbergen, 1989). In Vuchinich's studies, the choice offered was between immediate alcohol consumption versus delayed monetary gain. The increase in preference for alcohol consumption with increasing delay in receipt of money is thus construed as increasing impulsivity.

Rachlin, Logue, Gibbon, and Frankel (1986) have convincingly argued that probability acts in the same way as the inverse of delay. In terms of average delay from choice, high-probability outcomes are fairly immediate whereas low-probability outcomes involve longer waiting times. That is, the average interval between consecutive occurrences of a probabilistic event is inversely related to the probability of the event (it is a simple matter to calculate this time given the duration of the event and the duration between successive occurrences of the event). Impulsivity and self control can therefore be applied to cases where the consequences of behaviour are probabilistic as well as delayed. In other words, impulsivity is not only seen in the preference for immediate outcomes, it is also evident in the preference for high-probability outcomes (Rachlin, 1989). For example, instances of "risk-taking" behaviour, often thought to be associated with impulsivity, are instances where behaviour leads to risks or undesirable consequences as a result of an over-riding preference for short-term or high-probability gain.

The present study examined impulsivity in light and heavy social drinkers in the context of probabilistic choice. The task offered a choice between two spinners, following the procedure described by Rachlin et al. (1986). In Rachlin et al.'s study, one spinner consisted of 17 white sectors and 1 black sector. If the spinner landed on white, the subject won $100 (hypothetical money). The other spinner began with 7 white and 11 black sectors. If the spinner landed on white the subject won $250. Thus a choice was offered between a small high-probability outcome versus a large low-probability outcome. This is analogous to the traditional impulsive versus self-controlled choice between small immediate versus large delayed outcomes.

The procedure involved a titration of odds over trials: if the smaller outcome was chosen on the prior trial, a black sector was replaced by white on the low-probability spinner, making it slightly higher probability, and if the larger outcome was chosen on the prior trial, a white sector was replaced by black on the low-probability spinner, making it even lower probability. An increasing probability of winning over trials on the low-probability spinner shows increasing impulsivity in that it results from consistent choice of the higher-probability small amount. It is arguable whether the procedure allows an assessment of *absolute* levels of impulsivity. But it is clearly useful in affording a measure of impulsivity under one condition (or in one population) *relative* to that in another. In the previous studies conducted to date, a greater tendency towards impulsivity is seen with longer intervals between trials (Rachlin et al., 1986; Silberberg, Murray, Christensen, & Asano, 1988) and with a smaller "starting amount" of hypothetical money at the beginning of the trials (Silberberg et al., 1988).

In the present study, we used the choice task

to assess impulsivity in groups of light and heavy social drinkers. Following Vuchinich's analysis (Vuchinich & Tucker, 1983, 1988; Vuchinich, Tucker, & Rudd, 1987) alcohol consumption involves an impulsive preference for immediate (or high probability) gain. Greater impulsivity in the choice task might therefore be expected in individuals with histories of heavier alcohol consumption. Additionally, each group was tested with two sets of choices, differing in amount won. One choice was between \$100 won with a high probability and \$150 won with a low probability; the other between \$100 (high probability) and \$450 (low probability). Overall greater impulsivity was expected when the low-probability spinner offered the smaller amount, owing to the effect of the reinforcement context on the "impulsive" choice for the high-probability spinner.

## Method

*Subjects*

Forty undergraduate university students were recruited through an advertisement in laboratory classes and hostels asking "light or heavy drinkers" to volunteer for an experiment concerning alcohol consumption and personality. Ten males and 10 females in the "light drinkers" group had identified themselves as light drinkers. Their mean age was 21.9 years (standard deviation 4.0). Ten males and 10 females in the "heavy drinkers" group had identified themselves as heavy drinkers. Their mean age was 19.9 years (standard deviation 2.3). The groups were differentiated on the basis of quantity and frequency measures of consumption (see below). Each volunteer gave written consent to participate in the experiment.

*Procedure*

The choice task followed the procedure employed by Rachlin et al. (1986). The apparatus consisted of a pair of spinners, under each of which was a circular array of 18 pie-shaped sectors, white on one side and black on the other. Throughout the experiment, the left spinner displayed 17 black sectors and one white sector (the high-probability spinner). (For arbitrary reasons, the role of black and white was the reverse of that in Rachlin et al., 1986.) Sectors of one colour were grouped together. Initially, the right spinner displayed 13 black sectors and five white sectors (the low-probability spinner). A card in front of the high-probability spinner showed \$100. In front of the low-probability spinner, a card showed \$150 or \$450, depending on the condition. For 15 trials the larger amount was \$150 and for 15 trials it was \$450. A win occurred if the spinner stopped on black. The money was hypothetical.

Each subject sat at a table opposite the experimenter. The following instructions were read to the subject.

"The purpose of the following task is to see how you judge various imaginary gambles. A gamble takes place when I spin one of the two spinners in front of you. Your job is to choose which one of the two spinners you prefer. If the pointer of the spinner lands on black, you win. On your left, the hypothetical amount would be \$100. On your right the hypothetical amount would be \$150 (or \$450, depending on the condition). If the pointer lands on white you win nothing. After each gamble I may change the odds by turning over one or more chips from black to white or white to black. Please do not try to calculate odds or plan ahead. Just judge the gamble that most appeals to you in each case. You must make your choice within 5 seconds after I ask you".

The subject was then asked to choose a spinner, and the chosen spinner was spun by the experimenter. The choice and spin took about 8 s. If the pointer landed on black, the experimenter said "you won". If the pointer landed on white, the experimenter said "you lost". After each trial, the experimenter placed a sheet of cardboard at the bottom of the apparatus to block it from the subject's view, and turned a sector on the low-probability spinner. If the subject had chosen the high probability spinner on the previous trial, a white sector was turned over to black on the low-probability spinner (making it higher probability). If the subject had chosen the low-probability spinner on the previous trial, a black sector on this spinner was turned to white (making it even lower probability). Although it was possible for all sectors on the low-probability spinner to be black, the maximum number of black sectors at any stage never exceeded 17.

Following 15 trials the experimenter said:

"Now the amount of the right spinner is going to change to \$450 (or \$150, depending on the condition). The rules remain the same as before".

Half the subjects in each group completed 15 trials with the \$100–\$150 choice first, followed by 15 trials with the \$100–\$450 choice. The other half of subjects completed 15 trials with the \$100–\$450 choice first, followed by 15 trials with the \$100–\$150 choice. At no stage were subjects informed about the number of trials to be completed (cf. Silberberg et al., 1988).

*Alcohol-related and neuropsychological measures*

Following completion of the choice task, each subject was administered the Michigan Alcoholism Screening Test (MAST), the Trail Making Test (TMT), the Khavari Alcohol Test (KAT), and the Shipley Institute of Living Scales (SILS). In

addition, subjects were asked to estimate how much alcohol they had drunk over the previous year and over the previous week. The different alcohol-related measures were used to verify that the self-described light and heavy drinkers could be differentiated on the basis of their reported alcohol use, and to examine the relation between alcohol use and individual differences in impulsivity on the choice task. The MAST is a 25-item questionnaire measuring the subject's own appraisal of drinking habits and the social, vocational, and familial problems associated with drinking. The majority of items discriminate problem from adjusted drinkers (Zung & Charalampous, 1975) and appropriately measure alcohol problems in New Zealand samples (McLean, 1988). The KAT has 12 items relating to frequency and amount of alcohol consumption and differentiates alcoholics from nonalcoholics (Khavari & Farber, 1978).

The neuropsychological measures were included because cognitive impairment may be associated with heavy social drinking (Parker & Noble, 1977; Parsons, 1986) and possibly also with impulsivity or disinhibition (Stuss & Benson, 1985). The TMT involves having to connect a sequence of numbers and a sequence of letters, scattered over a page (in Part A) and also sequences of numbers and letters in alternating consecutive order (Part B). The TMT is sensitive to alcohol abuse (Parsons & Farr, 1981). The SILS involves vocabulary and abstraction tests and provides a "conceptual quotient" (CQ) which normalises the abstraction measure. The vocabulary test includes 40 multiple-choice questions about word meanings and the abstraction test requires completion of sequential patterns. It has been used to measure cognitive dysfunction in heavy social drinkers (Parker, Birnbaum, Boyd, & Noble, 1980; Parker & Noble, 1977; Parker, Parker, Brody, & Schoenberg, 1982).

## Results

Preference for the higher-probability small outcome in the choice task was regarded as an indication of impulsivity. Our general prediction was that heavy drinkers would exhibit greater impulsivity in the choice task. Because "impulsive" choices of the high-probability spinner resulted in an increase in the probability of the low-probability spinner, the latter was used as the dependent variable, following Rachlin et al. (1986) and Silberberg et al. (1988). Figure 1 shows that the probability of winning on the low-probability spinner over trials (measured in terms of the number of black sectors out of 18) was overall higher for heavy drinkers than for light drinkers, for both the \$100–\$150 and \$100–\$450 choices. This difference was significant,

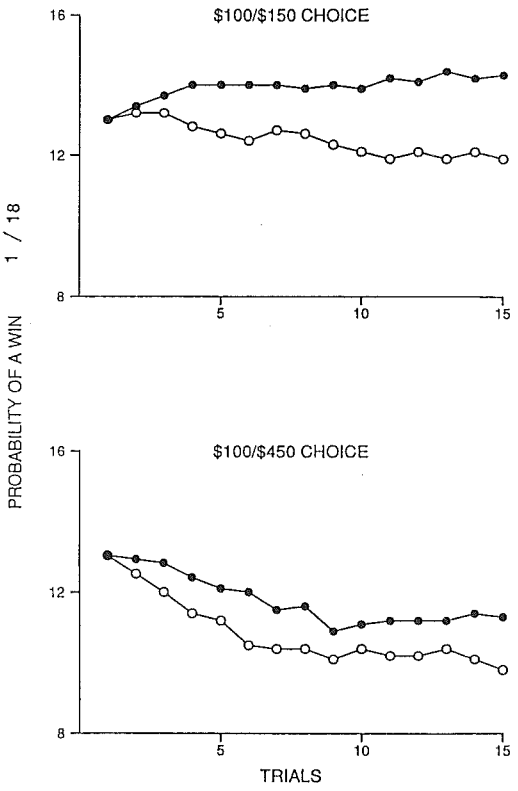


Fig. 1. Mean probability of a win (number of black sectors) on the low-probability spinner (18ths) as a function of trials for \$100–\$150 and \$100–\$450 choices for light drinkers (unfilled points) and heavy drinkers (filled points).

$F(1,38) = 6.53$, $p < .01$, as shown by a repeated measures analysis of variance on the factors of groups (light versus heavy), amount (\$150 versus \$450) and trials (Trial 1 did not contribute to the analyses because the probability on this trial was fixed at 13/18). The difference is consistent with overall greater impulsivity of heavy drinkers compared to light drinkers; in the choice procedure, higher probabilities of winning on the low-probability spinner are associated with continued or increasing preference for the high-probability small outcome.

The greater impulsivity of heavy drinkers is confirmed by their consistent preference over trials for the high-probability small outcome, compared to the more rapidly increasing preference for the low-probability spinner over trials in light drinkers (associated with the reduction over trials in probability of winning on the low-probability spinner). This differen-

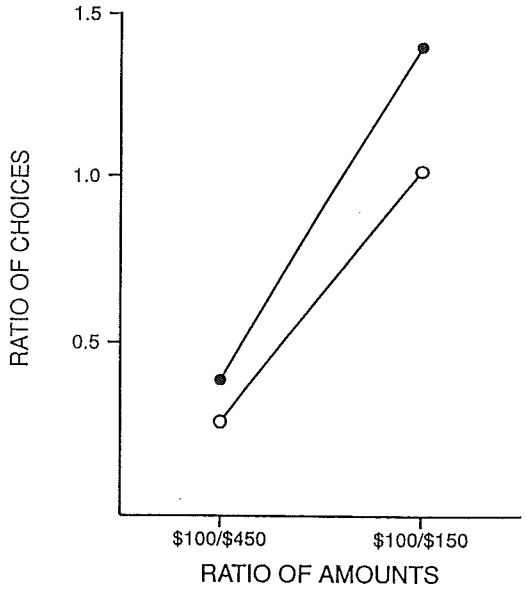


Fig. 2. Mean preference for the high-probability spinner (ratio of choices between the two spinners) as a function of the ratio of amounts offered by the two spinners, for light drinkers (unfilled points) and heavy drinkers (filled points).

tial change in impulsivity over trials for light and heavy drinkers was confirmed by a significant groups by trials interaction, $F(13,494) = 2.31$, $p < .01$.

Subjects' preference for the high-probability smaller outcome versus the low-probability larger outcome depended on the value of the larger outcome. Preference for the high-probability spinner was greater when the larger outcome was \$150 than when it was \$450, $F(1,38) = 37.31$, $p < .001$. In addition, preference for the high-probability outcome decreased over trials more rapidly when the low-probability outcome was \$450 compared to when it was \$150, as shown by the significant amount by trials interaction, $F(13,494) = 6.96$, $p < .001$. However, this pattern of change in preference over trials as a function of the size of the low-probability outcome did not differ between light and heavy drinkers, $F(13,494) = 1.67$, $p > .05$.

A second analysis confirmed the greater impulsivity of heavy compared to light drinkers. For each subject, the number of trials on which the high-probability spinner was chosen was expressed as a ratio of the number of trials on which the low-probability spinner was chosen. This ratio provides a measure of preference for the high-probability small outcome, following an analysis in terms of the matching law (Logue, 1988; Rachlin, 1989; White & Pipe, 1987). Figure 2 shows that, consistent with the above conclusion, heavy drinkers exhibited a significantly stronger preference for the high-probability small outcome than did the light drinkers, $F(1,38) = 10.64$, $p < .01$. Preference for the high-probability spinner was greater when the low-probability spinner offered \$150 compared to \$450, $F(1,38) = 53.69$, $p < .001$, and to a slightly greater extent for the heavy drinkers than for the light drinkers, $F(1,38) = 4.85$, $p < .05$.

Table 1 gives the means and standard deviations for the groups of heavy and light drinkers on the various alcohol-related measures. The two groups differed significantly on each measure (*t*-tests), with greater quantity and frequency of drinking being recorded for the heavy drinkers. These measures were significantly correlated with an impulsivity score when the data were combined across all 40 subjects in both groups. The product moment correlations are given in Table 1. The impulsivity score was the sum of the probability

Table 1: *Means (and standard deviations) of alcohol-related measures and product moment correlations between the alcohol-related measures and the impulsivity score. All correlations were significant ($p < .05$). KAT = Khavari Alcohol Test, MAST = Michigan Alcoholism Screening Test. ℓ = litres.*

| Measure | Light drinkers (N=20) | Heavy drinkers (N=20) | Correlation with Impulsivity (N=40) |
|---|---|---|---|
| Annual consumption (ℓ) | 2.80 (2.47) | 24.99 (16.38) | 0.36 |
| Past week consumption (ℓ) | 0.05 (0.06) | 0.40 (0.27) | 0.32 |
| Annual frequency, KAT | 11.85 (6.85) | 19.90 (4.04) | 0.34 |
| MAST | 0.85 (1.04) | 4.20 (1.88) | 0.37 |

Table 2: *Product-moment correlations (N=40) between neuropsychological measures (vocabulary, abstraction and conceptual quotient or CQ, scales of the SILS), and the Trail Making Test (TMT) and impulsivity and alcohol-related measures.*

| Measure | SILS | | | TMT |
|---|---|---|---|---|
| | Vocabulary | Abstraction | CQ | |
| Impulsivity | 0.19 | 0.22 | 0.18 | 0.12 |
| Annual consumption | 0.30* | 0.02 | -0.11 | 0.00 |
| Past week consumption | 0.24 | 0.09 | -0.25 | -0.02 |
| Annual frequency, KAT | 0.27* | -0.01 | -0.03 | -0.19 |
| MAST | 0.24 | 0.08 | -0.11 | -0.06 |

*$p < .05$

of a win on the $150 gamble and the probability of a win on the $450 gamble on the last trial.

Table 2 shows that the impulsivity scores were not significantly related to scores on the SILS and TMT. Nor were there significant correlations between the alcohol-related measures and the TMT and SILS scales (Table 2). Exceptions were correlations between the Vocabulary Scale of SILS and two alcohol-related measures (annual consumption and KAT frequency).

## Discussion

The present data indicate a very clear relation between the extent of social drinking and impulsivity. That is, we identified an association between reported level of drinking and the tendency to prefer lower valued but more certain outcomes over high valued but uncertain outcomes.

A tendency towards impulsivity may be treated as a general characteristic of behaviour that has its origins in prior experience in a variety of situations. For example, Wilson and Herrnstein (1985) have argued that individual differences in impulsivity may be explained in terms of prior learning histories. That is, owing to their prior learning histories, individuals who characteristically discount delayed consequences and overvalue more immediate or more certain gains, may be more likely to exhibit impulsivity than individuals who take account of delayed or uncertain consequences. Wilson and Herrnstein suggest that parent–child interactions may be important in shaping the child's ability to take account of the future consequences of present action. Children for whom parents have not effectively arranged consistent behavioural consequences are more likely to be impulsive in their choices. Social drinking is one of many choices faced by individuals from their mid-teenage years. The reason that social drinking is a prime candidate for an association with impulsivity is that it has fairly immediate or certain consequences and competes with alternatives that may have less immediate but more useful consequences (Vuchinich et al., 1987; White & Moesbergen, 1989). In that the more impulsive individuals are more likely to make impulsive choices in social drinking settings, we might expect a relation between impulsivity and extent of social drinking.

More circumstantial evidence for a relation between impulsivity and alcohol drinking can be deduced from the association between drinking, criminality, and youth. Wilson and Herrnstein (1985) reviewed the evidence for a higher incidence of criminal behaviour among younger males, and a positive association between criminal behaviour and alcohol consumption. The common factor is impulsivity. Criminals and young males are said to be impulsive individuals (Riddle & Roberts, 1977) and alcohol use is prevalent among both groups (Wilson & Herrnstein, 1985). In technical terms, the correlations between youth, alcohol consumption and criminality are spurious, and the common determinant that is suggested is impulsivity.

Our assessment of impulsivity was based on actual choices in a choice task (Rachlin et al., 1986). At a later stage, the choice approach could perhaps be validated against other measures of impulsivity, such as the Porteus Maze test (Porteus, 1945) or the impulsivity

scale of the EPQ (Eysenck, Pearson, Easting, & Allsopp, 1985), although such measures may not involve explicitly impulsive choices of small high probability outcomes. Theoretical support for the use of the choice task to measure impulsivity is provided by the consistency between the result in Figure 2 and matching-law based predictions from behavioural theories of choice (Rachlin, 1989). Specifically, both an increase in the ratio of certain to uncertain outcomes and an increase in the ratio of the amounts of the outcomes should result in an increase in the ratio of choices for the larger more certain outcome, as shown in Figure 2.

There was little support for previous findings that increased alcohol consumption in social drinkers is associated with poor performance on TMT and on abstraction and conceptual quotient scales of the SILS (Parker & Noble, 1977; Parker et al., 1980, 1982). Indeed, MacVane, Butters, Montgomery, and Farber (1982) could not replicate Parker's earlier findings. The correlation between consumption and vocabulary measures in the present data is consistent with the similar earlier finding (Parker et al., 1980, 1982), although the rationale for including the vocabulary measure was that "in mild states of cognitive deterioration, acquired knowledge such as vocabulary is subject to little deterioration, but the capacity for discerning new abstract relationships is particularly sensitive to disruption" (Parker et al., 1982, pp. 47–48). Nevertheless, the general absence of a clear relation in the present study between cognitive impairment and alcohol consumption is consistent with the conclusions of Grant (1987) and Parsons (1986) from reviews of studies of social drinking and brain function, that there is no evidence for a relation between drinking history and neuropsychological measures. The general absence of relations in the present study between cognitive impairment and alcohol consumption, and between cognitive impairment and impulsivity, is useful in that we can rule out cognitive impairment as a possible factor mediating the relation between alcohol consumption and impulsivity.

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