



Impulsivity and reversal learning in hazardous alcohol use

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ABSTRACT

Research into the neuropsychological basis of impulsivity indicates that it may convey risk for substance misuse through an increased motivation to obtain rewards (“reward drive”) and a propensity to act without forethought (“rash impulsiveness”). A recent model of disinhibition has also specified a role for Neuroticism in those with left hemispheric preference, due to the association of this hemisphere with action goal tendencies. This study investigated the mediating role of reversal learning, a key component of adaptive decision-making, in the prediction of hazardous alcohol use from impulsivity traits. A sample of 165 college students were administered a probabilistic reversal learning task, the Alcohol Use Disorders Identification Test (AUDIT), Sensitivity to Reward scale to measure reward drive, I₇ (Impulsiveness) to measure rash impulsiveness, Eysenck Personality Questionnaire – Revised, and a self-report measure of ear preference to determine hemispheric preference. Results support the role of reward drive and rash impulsiveness in alcohol misuse, as well as rash impulsiveness, Neuroticism and lateral preference in poor reversal learning. However, there was no support for mediation, or an interaction between Neuroticism and lateral preference.

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1. Introduction

Individuals high in impulsivity are at greater risk of developing substance use problems in the future (Tarter et al., 2003). However, impulsivity is not a unitary construct, and may comprise at least two distinct but overlapping constructs (Dawe & Loxton, 2004; Whiteside & Lynam, 2001). The first reflects Sensitivity to Reward and approach motivation emerging from the mesolimbic dopamine system. Conceptually, it is closely related to Gray's (1987) Behavioral Approach System (BAS) and the agency component of Extraversion (Depue & Collins, 1999). The second relates to difficulty inhibiting approach behavior in light of potential negative consequences, and is more related to orbitofrontal and cingulate serotonergic functioning (Gullo & Dawe, 2008). Conceptually, it resembles impulsiveness as defined by Eysenck and Eysenck (1991). Dawe and Loxton (2004) named these reward drive (RD) and rash impulsiveness (RI), respectively.

Converging evidence suggests RD and RI are related to different aspects of substance misuse. Loxton et al. (2008) found that while club drug users were higher in RD and RI, only the latter was associated with polydrug use. Brunelle et al. (2004) reported scores on the Sensitivity to Reward scale (SR), a measure of RD, predicted reward-related physiological responses to alcohol intoxication, whereas RI did not. Consistent with this, Kambouropoulos and

Staiger (2004) found cue-elicited urge to drink was related to SR scores, but not Sensation Seeking (RI-like trait) in social drinkers. In sum, there is empirical support for the utility of a two-factor approach to impulsivity and substance misuse.

However, such a two-factor conceptualization may be limited by the focus on approach-related traits. Other models of impulsivity emphasize the contributing role of avoidance-based traits, and impulsivity that arises from a desire to reduce negative affect (Jackson, 2008; Whiteside & Lynam, 2001). Jackson (2008) proposed that Neuroticism, a trait associated with increased arousal and negative affect (Eysenck, 1967), may interact with hemispheric asymmetry to produce disinhibited behavior. Notably, left prefrontal cortex activity has been associated with action goal formation and approach-related traits (Sutton & Davidson, 1997). Jackson (2008) provided evidence that individuals with right ear preference (a biomarker for left prefrontal asymmetry) were approach-oriented. Jackson then argued that people with left prefrontal asymmetry and high Neuroticism would be prone to heightened negative affect and would engage in impulsive behavior to reduce it. In four studies, Jackson demonstrated that the interaction between Neuroticism and right ear preference predicted various disinhibitory behaviors, including heavier alcohol use. Jackson's proposition that Neuroticism interacts with approach motivation to predict disinhibition is also consistent with the work of Newman and colleagues (Patterson & Newman, 1993). Patterson and Newman (1993) proposed a mechanism in which individuals high in both Extraversion and Neuroticism were

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at greater risk of poor decision-making because of difficulty learning from errors. In summary, Jackson (2008) argues that ear preference may predict approach behavior directly and may interact with Neuroticism to predict disinhibited approach behavior.

Others have argued that the “impulsivity” observed in addiction is primarily the result of disrupted decision-making (Bechara, 2005). Much of the research investigating decision-making in addiction has employed the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994; Bechara et al., 2001), which assesses adaptive, long-term decision-making. Briefly, the IGT requires participants to continuously draw from four decks of cards with different reward and punishment schedules. Two decks deliver high immediate gains but also higher delayed losses (disadvantageous decks), while the other two deliver low immediate gains but also lower delayed losses (advantageous decks). Most participants form an initial preference for the disadvantageous decks due to the high immediate rewards, but learn to shift to advantageous decks once losses begin to accrue (Fellows & Farah, 2005). However, substance dependent individuals and those with lesions to the orbitofrontal cortex (OFC) are less able to make this “preference shift” (Bechara et al., 2001).

Non-substance dependent individuals high in RI-like traits also display difficulties on the IGT (Franken, Strien, Nijs, & Muris, 2008; Zermatten et al., 2005). The role of the OFC in adaptive decision-making has led some to propose that poor decision-making is a key mechanism through which RI conveys risk for substance misuse (Dawe, Gullo, & Loxton, 2004). Indeed, several studies link RI with OFC functioning (Franken et al., 2008; Horn, Dolan, Elliott, Deakin, & Woodruff, 2003). However, a recent prospective study on college students by Goudriaan, Grekin, and Sher (2007) found that while heavy binge drinkers performed worse on the IGT, this deficit was unrelated to RI. Indeed, other studies have also failed to find an association between RI-like traits and IGT performance (Franken & Muris, 2005). Such inconsistent findings may be due to the complexity of the IGT.

The IGT engages several interdependent cognitive processes, but some argue that a deficit in reversal learning lies at the core of poor IGT performance (Fellows & Farah, 2005). Reversal learning is the updating of stimulus-reinforcement associations when contingencies change. Consistent with this view, Hildebrandt, Brokate, Fink, Muller, and Eling (2008) reported a selective deficit in reversal learning among young polysubstance abusers undergoing treatment. Similar findings were reported by Fellows and Farah (2005) in patients with OFC lesions, but not patients with lesions to other areas of the prefrontal cortex. Poor reversal learning may therefore be what mediates the risk conveyed by RI for problematic substance use. Consistent with this, Franken et al. (2008) found college students high in RI demonstrated poorer reversal learning.

The aim of the present study was to examine the possible mediating role of reversal learning in the association between impulsivity and hazardous alcohol use. Poor reversal learning was hypothesized to mediate the effect of RI and the Neuroticism–ear preference interaction on hazardous drinking. Reward drive was hypothesized to directly predict more hazardous drinking. Moreover, RI, ear preference (as a main effect) and the Neuroticism–ear preference interaction were hypothesized to predict poorer reversal and more hazardous drinking.

2. Method

2.1. Participants

The sample comprised 165 undergraduate students, 121 women ($M_{\text{age}} = 20.10$, $SD_{\text{age}} = 3.85$) and 44 men ($M_{\text{age}} = 21.07$,

$SD_{\text{age}} = 4.17$). In addition to research credit, all participants were offered the chance to win one of three portable audio players.

2.2. Materials

2.2.1. Reward drive

The 24-item Sensitivity to Reward scale (SR) of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001) was used as a measure of trait RD. Factor analytic studies have found SR to load on a latent factor with other measures of RD, supporting its construct validity (Dawe & Loxton, 2004). An item pertaining to drug use was removed to avoid possible criterion contamination. Cronbach's alpha for the 23-item SR scale was .70.

2.2.2. Rash impulsiveness

The 19-item impulsiveness scale of the I₇ questionnaire (Eysenck, Pearson, Easting, & Allsopp, 1985) was utilised as a measure of RI. This scale has been shown to load on a latent factor with other RI measures, supporting its construct validity (Dawe & Loxton, 2004). Cronbach's alpha for the scale in this study was .82.

2.2.3. Neuroticism

The Eysenck Personality Questionnaire – Revised (EPQ-R; Eysenck & Eysenck, 1991) was administered but only the Neuroticism scale was used. Cronbach's alpha in this study was .88.

2.2.4. Ear preference

The 7-item ear preference scale of the revised hand, eye and ear preference questionnaire (Jackson, 2005) was used as a measure of ear preference. Each item is rated 1 (*Always Left*) to 5 (*Always Right*). An example item includes, “If you wanted to hear someone's heart beat, which ear would you place against their chest?” Scores on the original measure have a high concordance with behavioral observation (92%; Coren, Porac, & Duncan, 1979).

2.2.5. Hazardous alcohol use

The Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, De La Fuente, & Grant, 1993) was used to measure hazardous drinking. It has been found to be more sensitive to non-dependent problem drinking than other screening instruments, and several studies support the validity of the AUDIT as a measure of hazardous drinking in college students (Dawe, Loxton, Hides, Kavanagh, & Mattick, 2002; Kokotailo et al., 2004; Roche & Watt, 1999). In the present study, the AUDIT had a Cronbach's alpha of .86.

Participants were also asked to rate on a 0 (*Not at all important*) – 10 (*Very important*) scale the degree to which the prize motivated them to participate in the study.

2.2.6. Reversal learning

Participants were asked to complete a probabilistic reversal learning task similar to that used by Cools, Clark, Owen, and Robbins (2002). Reversal learning on this task is associated with greater OFC activation, consistent with studies on lesion patients that implicate the OFC as critical to reversal learning (Cools et al., 2002; Fellows & Farah, 2005). Each trial of the task involved the presentation of two abstract coloured patterns presented simultaneously on the left and right of the computer screen. Participants were informed prior to commencing the task that one of the patterns had been chosen according to “some rule” and that they had to choose which stimulus was correct. The images remained on-screen until a response was made. Correct responses were followed by the presentation of a green smiley face, and incorrect responses by a red frown face. The location of the two patterns on-

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