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Propensity for risk taking and trait impulsivity in the Iowa Gambling Task

Daniel J. Upton [a], Anthony J. Bishara [b], Woo-Young Ahn [c], Julie C. Stout [a,*]

[a] School of Psychology & Psychiatry, Monash University, Victoria, Australia
[b] Department of Psychology, College of Charleston, SC, USA
[c] Department of Psychological and Brain Sciences, Indiana University, IN, USA

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ABSTRACT

The Iowa Gambling Task (IGT) is sensitive to decision-making impairments in several clinical groups with frontal impairment. However the complexity of the IGT, particularly in terms of its learning requirements, makes it difficult to know whether disadvantageous (risky) selections in this task reflect deliberate risk taking or a failure to recognise risk. To determine whether propensity for risk taking contributes to IGT performance, we correlated IGT selections with a measure of propensity for risk taking from the Balloon Analogue Risk Task (BART), taking into account potential moderating effects of IGT learning requirements, and trait impulsivity, which is associated with learning difficulties. We found that IGT and BART performance were related, but only in the later stages of the IGT, and only in participants with low trait impulsivity. This finding suggests that IGT performance may reflect different underlying processes in individuals with low and high trait impulsivity. In individuals with low trait impulsivity, it appears that risky selections in the IGT reflect in part, propensity for risk seeking, but only after the development of explicit knowledge of IGT risks after a period of learning.

1. Introduction

The Iowa Gambling Task (IGT) is widely used to study decision-making under risk and uncertainty and is a sensitive tool for detecting frontal dysfunction in several psychiatric populations (e.g. substance dependence, ADHD, pathological gambling) (e.g. Bechara & Damasio, 2002; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2006; Malloy-Diniz, Fuentes, Leite, Correa, & Bechara, 2007; Stout, Busemeyer, Lin, Grant, & Bonson, 2004; Stout, Rock, Campbell, Busemeyer, & Finn, 2005). Although the IGT's sensitivity for detecting decision-making impairment is well established, recent studies have highlighted the complexity of this task and the challenges this poses for understanding what functions (or dysfunctions) it measures (Brand, Recknor, Grabenhorst, & Bechara, 2007; Buelow & Suhr, 2009; Dunn, Dalgleish, & Lawrence, 2006).

For example, the results of a recent study suggest that risk taking in the early and later stages of the IGT need to be considered separately (Brand et al., 2007). This study found that a person's propensity for risk taking, as measured by the Game of Dice Task (where risks are explicit) (Brand et al., 2005), was related to later IGT selections, but not earlier IGT selections. This suggests that in the earlier stages of the IGT, when players have little explicit knowledge about IGT alternatives, risk taking is not a deliberate act, but rather, reflects a failure to recognise risk. As the task progresses however, players presumably develop explicit knowledge of the risk profile across IGT alternatives. At this stage of the task, the player is able to express their propensity for risk taking, either by continued 'risky' choices (despite knowing risks), or by safer choice behaviour, which reveals their avoidance of risk.

In contrast to the IGT, where players cannot express their risk propensity until they have learned the risks, the Balloon Analogue Risk Task (BART) (Lejuez et al., 2002) is designed so that players are able to express their risk propensity from the beginning of the task. This may account for why three previous studies have found no association between the tasks (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Bishara et al., 2009; Lejuez, Aklin, Jones et al., 2003), despite the fact that each task is separately related to drug abuse and other risk taking behaviours (Lejuez, Aklin, Zvolensky, & Pedulla, 2003; Lejuez, Aklin, Jones et al., 2003; Stout et al., 2004, 2005). Perhaps if these studies had separated IGT selections into early (pre-learning) and later (post-learning) stages of the task, later IGT selections would have been associated with BART performance. For such a relationship to emerge however, a player's ability to learn IGT risks should be taken into account, especially since there is evidence of heterogeneity in the ability of some groups to learn about risk from experience (Stout et al., 2005).

Trait impulsivity, measured in its narrow form using questionnaires such as the Eysenck I_7 and Barratt Impulsiveness Scale[1], is

* Corresponding author. Address: School of Psychology & Psychiatry, Room 527, Building 17, Clayton Campus, Monash University, Victoria 3800, Australia. Tel.: +61 3 9905 3987; fax: +61 3 99053997.
E-mail address: julie.stout@monash.edu (J.C. Stout).

[1] These self-report questionnaires measure the tendency of individuals to consider negative consequences before acting (Miller, Joseph, & Tudway, 2004).

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Table 1
Demographic and substance use variables for low and high impulsivity groups.

	Impulsivity group			
	M(SD)		*Mdn (Min–Max)*	
	Low	High	Low	High
Age	20.35(2.52)	20.03(2.54)	21(16–25)	20(16–24)
IQ*	111(7.29)	105.67(8.53)	112(97–125)	105.67(87–123)
Eysenck I_7**	2.45(1.39)	13.37(2.16)	3(0–4)	13(11–18)
Alcohol*	1.59(1.73)	2.96(2.38)	1.08(0–6.62)	3.1(0–8)
Tobacco*	10.16(29.85)	30.45(43.95)	0(0–140)	3.95(0–175)
Cannabis**	0.69(2.27)	3.36(3.79)	0(0–10.5)	2(0–14)
Stimulants**	0.02(0.07)	0.25(0.46)	0(0–0.38)	0.05(0–1.9)

Note. Substance use is average weekly frequency for 12 months prior to testing.
* Significant at $p < .01$.
** Significant at $p < .001$.

associated with learning difficulties in problem solving situations (McMurran, Blair, & Egan, 2002) and increased risk taking in situations where learning is required (e.g. IGT) (Franken, van Strien, Nijs, & Muris, 2008; Sweitzer, Allen, & Kaut, 2008). This is important, because past studies that have attempted to correlate IGT and BART performance have focussed on samples with high trait impulsivity such as substance abusers, who are known to have problems learning from experience about risk (Stout et al., 2005). In an impulsive sample, inefficient learning in the IGT may mean that IGT performance, even in the later stages of the task, reflects unintentional risk taking rather than deliberate risk taking. Thus, it may be premature to conclude that IGT and BART are generally unrelated until the BART is compared to the most relevant stage of the IGT, and relevant individual differences such as impulsivity have been taken into account.

Thus, the aim of this study was to re-examine the association between IGT and BART, by correlating IGT and BART performance in early and later stages of the IGT separately. We also correlated IGT and BART performance from early and late stages of the IGT in groups with low and high trait impulsivity separately. We hypothesised that IGT and BART performance would be associated in the later stages of the IGT, but only in individuals with low trait impulsivity, reflecting their ability to learn IGT risks and therefore express their propensity for risk taking following a period of learning.

2. Method

2.1. Participants and procedure

Ninety-eight young adults participated (52 females), ranging in age from 16 to 25 years (Table 1). We recruited participants from the local area surrounding Indiana University. Minor participants (<18) brought a consent form signed by a parent/guardian in addition to signing an assent form themselves. Inclusion criteria for participation were: (1) reporting no alcohol or substance use for at least 12 h prior to the experiment, (2) reporting a regular night's sleep on the previous night (e.g. no night shift work), and (3) showing no signs of an extreme negative mood state, stress, or fatigue.

Participants completed a demographic questionnaire and a battery of personality, substance use, and computerised cognitive assessments. This study reports data from a subset of these measures described below.

2.2. Materials and participant characterisation

2.2.1. Impulsivity, IQ, and substance use

We assessed trait impulsivity using the 19 item Impulsiveness subscale from the Eysenck I_7 (Eysenck, Pearson, Easting, & Allsopp, 1985). Possible scores range from 0 to 19, with higher scores indicating higher impulsivity. The Impulsiveness subscale measures one component of a wider impulsivity construct sometimes referred to as rash impulsivity, or the tendency to act without considering negative consequences (Miller et al., 2004). From the Eysenck I_7, we created two groups; one representing low-range impulsivity (lower 1/3 of distribution), and one representing high-range impulsivity (upper 1/3) in order to make it possible to determine whether trait impulsivity moderates the association between IGT and BART performance. Given the small sample size (and our expectation of a small effect size), we aimed to maximise the contrast between low and high impulsivity groups in order to increase our power to find an effect of impulsivity if it was present (Perales, Verdejo-Garcia, Moya, Lozano, & Perez-Garcia, 2009). The results of this work were not different when more extreme cut-off scores were used to create low and high impulsivity groups (upper and lower 1/4 and 1/5). The low impulsivity group ($n = 31$, 16 females) had a mean impulsivity score of 2.5, which is lower than previous studies that have tested the association between IGT and BART behaviour (Aklin et al., 2005; Bishara et al., 2009; Lejuez, Aklin, Jones et al., 2003). The high impulsivity group ($n = 30$, 16 females) had a mean impulsivity score of 13.4, which is higher than the mean impulsivity score reported for high impulsivity groups in previous studies of decision-making (Franken et al., 2008; Sweitzer et al., 2008).

We used the Shipley Institute of Living Scale (Shipley, 1940) (total raw score stratified by age) to estimate WAIS-R full scale IQ (Zachary, Paulson, & Gorsuch, 1985). We also assessed the average weekly frequency of alcohol, tobacco, cannabis, and stimulant use (for the 12 months prior to testing) using a structured interview developed in our laboratory. Problems associated with alcohol use were assessed using the Michigan Alcohol Screening Test (MAST) (Selzer, 1971), and problems associated with illicit substance use were assessed using the Drug Abuse Screening Test (DAST) (Skinner, 1982).

The low impulsivity and high impulsivity groups were similar in age, $t(59) = 0.50$, $p = .62$ and gender, $\chi^2(1, N = 61) = 0.89$, $p = .89$, but estimated IQ was lower in the high impulsivity group, $t(59) = 2.63$, $p = .01$ (Table 1). The high impulsivity group also used alcohol more frequently, $z = 2.47$, $p = .01$, and reported significantly more alcohol related problems on the MAST, $t(53) = -3.19$, $p < .01$. The high impulsivity group also used tobacco, $z = 3.05$, $p < .01$, cannabis, $z = 3.44$, $p < .01$, and stimulants, $z = 3.94$, $p < .01$ more frequently, and reported significantly more illicit substance use related problems on the DAST, $t(41) = -2.91$, $p < .01$.

2.2.2. Iowa Gambling Task (IGT) and Balloon Analogue Risk Task (BART)

In the IGT (Bechara, Damasio, Damasio, & Anderson, 1994) participants make a series of choices from a set of four computerised 'decks of cards' (decks A, B, C and D) with the aim of earning as much money as possible. Each deck is associated with a fixed immediate reward for every selection (A and B, $1.00; C and D, $0.50), as well as an occasional penalty which differs in frequency and magnitude across the decks. Although decks A and B have a larger fixed reward for each selection compared to decks C and D, selection of decks A and B is disadvantageous because the occasional losses associated with these decks (ranging from −$1.5 to −$12.50) mean that participants lose $2.50 per 10 selections. Selection of decks C and D on the other hand is advantageous because the occasional losses associated with these decks are relatively small (−$0.25 to −$2.50), resulting in a net gain of $2.50 per 10 selections. Players are not given any information about the decks and must learn from experience to select advantageously (see Ahn, Busemeyer, Wagenmakers, & Stout, 2008). Participants performed a single block of 150 trials, divided off-line into six blocks of 25 trials. Participants received any final earnings above the starting balance, and IGT performance was measured as the proportion of advantageous selections ((C + D choices)/ total choices).