Brief communication

Some decks are better than others: The effect of reinforcer type and task instructions on learning in the Iowa Gambling Task

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Abstract

The Iowa Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994) has become widely used as a laboratory test of “real-life” decision-making. However, aspects of its administration that have been varied by researchers may differentially affect performance and the conclusions researchers can draw. Some researchers have used facsimile money reinforcers while others have used real money reinforcers. More importantly, the instructions participants receive have also been varied. While no differences have been reported in performance dependent on reinforcer type, no previous comparison of participants’ instructions has been conducted. This is despite one set of instructions giving participants a clear hint about the nature of the task. Additionally, in previous research one set of instructions have not been used exclusively with one reinforcer type making any differential or cumulative effects of these factors difficult to interpret. The present study compared the effects of instruction and reinforcer type on IGT performance. When participants received instructions without a hint performance was affected by reinforcer type. This was not the case when the instructions included a hint. In a second IGT session performance was improved in participants who had received the hint instructions compared with those who had not.

Keywords: Iowa Gambling Task; Learning; Reinforcer; Instructions

1. Introduction

The Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994) was developed to assess decision-making impairments acquired following damage to the ventromedial area of the prefrontal cortex. In the IGT participants make multiple selections from four decks of cards which have different schedules of reward and loss. The expected values of the decks vary such that two decks give an immediate high reward but long-term overall loss with repeated selections (the disadvantageous decks, A and B), whereas two decks give lower immediate rewards but with repeated selections result in long-term overall gain (the advantageous decks, C and D). The decks also vary in their schedule of losses such that decks A and C have frequent smaller losses (5 losses per 10 card selections) while decks B and D have infrequent high losses (1 loss per 10 card selections). The standard performance measure on the IGT has become a measure of net score obtained from subtracting the number of cards selected from the disadvantageous decks from the number selected from the advantageous decks. In general, normal controls develop a preference for the advantageous decks over the course of the task. People with ventromedial damage select preferentially from the disadvantageous decks (Bechara et al., 1994; Bechara, Tranel, & Damasio, 2000). Consequently, the IGT has been investigated as a test of ventromedial prefrontal cortex functioning.

Despite remaining superficially similar the IGT has been varied in several ways that could influence participants’ performance. It began as a manual card task using facsimile money as a reinforcer but has since been computerised (Bechara, Damasio, Damasio, & Lee, 1999) and real money reinforcers have been used instead of facsimile ones (Schmitt, Brinkley, & Newman, 1999). No differences in
participants’ performance on the task due to computerisation have been reported (Bechara et al., 1999, 2000; Bowman, Evans, & Turnbull, 2005).

Bechara et al.’s (1994) method using large values of facsimile money as reinforcers has been followed by others (Grant, Contoreggi, & London, 2000; Petry, Bickel, & Arnett, 1998; Turnbull, Evans, Bunce, Carzolino, & O’Connor, 2005). However, given that the task is a gambling task it might be argued that real money would be a more realistic reinforcer and result in improved performance (cf. Hertwig & Ortmann, 2001). Bowman and Turnbull (2003) maintained the schedules of gains and losses but altered the values in a real money condition (values were one-thousandth those of the facsimile money condition) and directly compared reinforcer types. They found no significant differences in IGT performance between reinforcer types. However, Bowman and Turnbull (2003), in extrapolating the learning curves produced by each group, did suggest that real money reinforcers may improve performance relative to facsimile reinforcers given more exposure to the task. Carter and Pasqualini (2004) reported no significant difference in money made between real and facsimile money conditions, although the amount won by participants who received real money reinforcers was substantially more.

These results contrast with the evidence from other decision-making paradigms where real monetary gain has been found to influence performance. Hertwig and Ortmann (2001) found that in the majority of behavioural decision-making papers they reviewed, when payments were used participants’ performance improved. Camerer and Hogarth (1999), in a similar review, concluded that financial incentives do affect performance on judgement and decision tasks. But where the task involves risky choices incentives have little effect on performance though variation in responses is decreased. Shanks, Tunney, and McCarthy (2002) showed that in a repeated two-choice probability learning task large financial incentives increased maximising behaviour (in the case of the IGT this would be increasing advantageous card selections). Vulkan (2000) noted in his review of repeated, binary choice experiments that introducing monetary rewards increases maximising behaviour. Despite the evidence suggesting that participants’ behaviour should be affected by the type of reward on offer, to our knowledge no such effect has been reported on the IGT.

Mazas, Finn, and Steinmetz (2000) have also reported normal selection behaviour when real money reinforcers were used. In contrast, Schmitt et al. (1999) used real money reinforcers but found no difference between the performance of psychopaths and incarcerated controls. Neither group exhibited behaviour consistent with normal performance as both showed no clear preference for either advantageous or disadvantageous decks by the end of the session. Of the possibilities Schmitt et al. (1999) suggested to explain the contrast between their results and those of Bechara et al. (1994) the most intriguing was that although their instructions were the same as those published by Bechara et al. (1994) they were not those given in the more detailed procedure published by Bechara et al. (1999, 2000). In the more detailed instructions participants are given more information about the nature of the decks and informed explicitly that the decks are not the same, that some are worse than others and that by staying away from the worst decks they can win. Including this “hint” in the instructions gives participants much more information about, and arguably changes, the nature of the task from one without the hint where the only information received about the nature of the decks comes from the results of one’s own behaviour. Buehner and May (2004) found that less subtle changes in instructions affect human causal learning and Kudadjie-Gyamfi and Rachlin (2002) found that including a hint about how to maximise long-term reinforcement in the instructions of a choice task improves performance above the contingency-governed behaviour seen otherwise. Such a difference in instructions for the IGT could similarly affect behaviour.

The work of James Blair’s group supports this possibility. Blair and Cipolotti (2000) used the no hint instructions and found no difference between psychopathic prisoners and incarcerated controls. But Blair, Colledge, and Mitchell (2001) and Mitchell, Colledge, Leonard, and Blair (2002) used the hint instructions and found, respectively, differences in performance between boys with psychopathic tendencies and age-matched controls, and between psychopathic adults and incarcerated controls.

In contrast, several studies have replicated Bechara et al.’s (1994) results using the no hint instructions but reinforcer type has varied between studies. Mazas et al. (2000) used real money reinforcers and their normal control participants developed a preference for the advantageous decks. Grant et al. (2000) and Petry et al. (1998) found controls performed better than substance abusers, though the overall net score was not as high as that of normal controls in Bechara et al.’s (1994, 1999, 2000) experiments. Like Mazas et al. (2000), both these studies paid participants for taking part (this is implied in Grant et al. as participants were recruited through newspaper advertisements) though unlike Mazas et al. facsimile reinforcers were used. Similarly in Blair and Cipolotti (2000), Blair et al. (2001), and Mitchell et al. (2002) participants received facsimile reinforcers. Petry et al. (1998) added an incentive payment of $10 contingent upon participants finishing the task in profit.

These results paint a somewhat confusing picture. There is a strong suggestion that reinforcer type does not influence performance and normal selection behaviour has been found with both sets of instructions. However, the methodology has not been consistent and so it has not been established that the same learning processes are taking place in each case or that normal performance is not enhanced with one combination of methods. This study aims to directly compare the influences of each reinforcer and instruction type on IGT performance.

Given the different methodologies used in the administration of the IGT it is not clear which factors are important in influencing IGT performance. We compared instruction and reinforcer types to assess their influence on learning using a computerised version of the IGT. It was predicted that par-
Participants who were given the hint instructions would perform better than those who did not receive these instructions. Manipulating reinforcer type allowed a test of Bowman and Turnbull’s (2003) finding that reinforcer type did not affect performance. To investigate participants, learning behaviour on the task in more detail a second session of 100 trials was introduced. We used a second session 48h after the first to give participants some time to reflect on their behaviour (Dempster, 1988; Tunney & Shanks, 2002). A second session also allows a test of Bowman and Turnbull’s (2003) prediction that reinforcer type did not affect performance.

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2. Method

Two factors (instruction type and reinforcer type) were investigated at different times using participants from slightly different populations. As the methodology was the same for each factor, except where indicated, it has been collapsed into one. One condition (No Hint—Facsimile Money) was an attempt to replicate the results of normal participants of Bechara et al. (1994, 1999, 2000) using the less informative instructions provided in that paper and facsimile money reinforcers. A second condition (Hint—Facsimile Money) used the more detailed instructions from Bechara et al. (1999, 2000) that included the hint. A third (No Hint—Real Money) and fourth (Hint—Real Money) condition used real money rather than facsimile money as a reinforcer.

2.1. Participants

In total, 88 participants were recruited from the Keele University community. Six participants were excluded as they failed to turn up for a second session and two were excluded due to administration errors. Each one of four conditions had 20 participants. Participants in the Facsimile Money levels were exclusively psychology undergraduates who participated in return for course credit. The Real Money levels included undergraduates from other disciplines who were recruited through poster advertisements that offered the opportunity to “Earn up to £6” by participating in a cognitive psychology experiment.

2.2. Apparatus

Participants were tested individually in a soundproofed testing laboratory. A PC controlled the experiment. A program based on published descriptions of the Iowa Gambling Task was run on the PC. Fig. 1 displays a representative screenshot from the computerised task. Briefly, four decks of cards were displayed horizontally on screen labelled A, B, C and D. Above the decks a written message (green font) informed the participant how much they had won after every card selection. A second written message (red font) was displayed below the first message and informed the participant when a loss was made. These messages changed depending on participants’ card choices and in line with the reinforcement schedules for each deck (as Bechara et al., 1994; all monetary figures were divided by 1000 in the Real Money reinforcer conditions). In addition, a gain was signalled by the sound of a man shouting “Yippee!” and the appearance of a smiley face. A loss was signalled by the sound of a man shouting “Doh!” and the appearance of a frowning face. Two bars were also displayed at the top of the screen. A green bar labelled “Cash” displayed how much the participant had earned on the task so far. In the Real Money reinforcer conditions earnings or losses (not collected) of up to £3 (US$5.5) per session were possible. A red bar labelled “Borrowed” displayed the amount of money ‘loaned’ to the participant to play the game. This was £2000 for Facsimile Money reinforcers and £2.00 for Real Money reinforcers. Participants used the mouse to select their choice of deck.

![Fig. 1. Screenshot from the computerised gambling task using facsimile reinforcers. All monetary values were divided by 1000 when Real reinforcers were used.](attachment:image.png)
A mixed design was used to compare participants’ performance between each of the Factors (reinforcer type and instruction type) and within-subjects within sessions. The number of selections from each deck was recorded allowing a net score to be calculated by subtracting the number of disadvantageous choices (number of cards selected from decks A and B) from the number of advantageous choices (number of cards selected from decks C and D). Each session was divided into 20 trial blocks (Bechara et al., 1999) in order to estimate participants’ learning rates.

2.4. Procedure

All participants were told that participation was required for two 15-min sessions separated by 2 days, and that the aim of the task was to earn as much money as possible. Participants were then instructed to read the on-screen instructions (Appendix A) which described the task. Briefly, the instructions told participants to make a series of card selections until instructed to stop, that all of the cards would give money but some would lose money, that their goal was to earn as much money as possible and that they were free to switch from any deck to any other. In addition, participants in the Hint conditions were given the following instructions: “All I can say is that some decks are worse than others. You may find all of them bad, but some are worse than others. No matter how much you find yourself losing you can still win if you stay away from the worst decks” (Bechara et al., 1999, 2000). If after reading the instructions participants required clarification the experimenter referred to the written instructions and quoted from them, i.e., no information beyond that given in the instructions was provided.

Each session ended after 100 trials and a screen informed participants of their earnings. The implications of this figure (either a profit or a loss made on the monetary loan) were communicated to the participant by the experimenter. When Real Money reinforcers were used participants were paid the money they had earned, reminded that they could have earned up to £3 (the maximum amount possible) and that they would have a further opportunity to earn any earnings (in the Real Money conditions) were paid. Participants in the Real Money conditions were reimbursed £2 for any expenses incurred in travelling to the university campus (the cost of a return bus fare), but were unaware of this payment prior to the beginning of the experiment.

3. Results and discussion

Net score was calculated in blocks of 20 trials for each participant in each condition. It ranges from a minimum of −20 to a maximum of 20; positive net scores indicate a preference for the advantageous decks. Fig. 2 displays the mean net scores across trial blocks for each condition and in each session. We discuss performance in each session separately bearing in mind that the standard design features only one session.

3.1. Session 1

A 2 × 2 × 5 (reinforcer type by instruction type by block) mixed-design ANOVA was performed to investigate differences in net score due to the experimental factors. Alpha was set at .05 for all tests unless otherwise stated. Due to a violation of the assumption of sphericity in the calculation of the repeated measures components of the ANOVA the Greenhouse Geisser correction is used where appropriate.

The ANOVA revealed a main effect of block, $F(3.25, 246.66) = 9.35, MSE = 43.16, p < .05$, indicating that net score differed between some blocks and reflecting the trend for net score to increase with exposure to the task. A main effect of reinforcer type was also found, $F(1, 76) = 3.84, MSE = 77.08, p = .05$; mean net score across block was higher when participants were earning Real Money ($1.02, SE = 0.62$) rather than Facsimile Money ($−0.7, SE = 0.62$). No other main effects or interactions were significant: instruction type, $F(1, 76) < 1$; reinforcer by instruction type, $F(1, 76) < 1$; block by reinforcer type, $F(3.25, 246.66) = 2.20, MSE = 43.16, p < .05$; block by instruction type, $F(3.25, 246.66) = 1.28, MSE = 43.16, p < .05$; block by reinforcer type by instruction type, $F(3.25, 246.66) < 1$.

In accordance with experimental predictions an effect of reinforcer type was found in Session 1. Net score is greater...
when the reinforcer used is Real rather than Facsimile Money. This finding that monetary payoffs improve performance is in agreement with the behavioural decision-making literature (Camerer & Hogarth, 1999; Hertwig & Ortmann, 2001) but it does not replicate Bowman and Turnbull’s (2003) result. They found no effect of reinforcer type when comparing the performance of a similar population. Bowman and Turnbull (2003) used Bechara et al.’s (1999) Hint instructions and the manual version of the gambling task. In contrast, we used a computerised version from data collapsed across groups who received different sets of instructions. There was no reinforcer type by instruction type interaction in the mixed-design ANOVA implying that Hint instructions did not differentially affect performance in either of the reinforcer type groups. However, to more clearly compare Bowman and Turnbull’s (2003) results with our own, simple effects analyses were conducted on the net scores for Session 1, which is the standard dependent variable. Comparing between the two levels of reinforcer type for the participants who received the Hint instructions is equivalent to Bowman and Turnbull’s analysis. No effect of reinforcer type was found, $F(1,38) = 1.36$, $MSE = 545.16, p > .05$, replicating Bowman and Turnbull’s (2003) findings. However, analysis of the simple effects of reinforcer type for participants who received the No Hint instructions revealed an effect of reinforcer type, $F(1,38) = 6.73, MSE = 224.92, p < .05$. Net score was significantly higher (mean net score = 6.1, $SE = 3.37$) when the reinforcer was Real Money than when it was Facsimile Money (mean net score = $-6.2$, $SE = 3.33$).

These findings go some way to supporting Bowman and Turnbull’s (2003) result, but also provide support for our experimental hypotheses that receiving the Hint instructions changes behaviour on the IGT. The results of the further analyses indicate that reinforcer type does have an effect on IGT performance, but that this effect is only apparent when task instructions do not contain a Hint. These results suggest that behaviour on the IGT is influenced in at least two ways. When the only information about the contingencies of the decks is available from the results of one’s own card selections (No Hint instructions) mean net score is affected by the level of incentive on offer. Real Money incentives result in more selections from the advantageous decks, consistent with the behavioural decision-making literature. However, when information on the deck contingencies is available (Hint instructions: “some decks are worse than others”) the effect of Real Money reinforcers is cancelled out (Real Money—Hint) and participants who have no financial incentive to do well but information about the nature of the task (Facsimile Money—Hint) are able to succeed. It may be that the level of incentive was not high enough within the Hint condition, although it was sufficient to facilitate a division in performance when participants had less information. This interpretation suggests influences on learning in the IGT that are not additive and which may have some neuropsychological basis.

### 3.1.1. Learning rates

While a main effect of block is indicative of improved performance and therefore learning, more specific information is available from examination of learning rates. Learning rate can be estimated by looking at the change in participants’ net scores across block, i.e., the slope $b$, and analysed separately using ANOVA. An advantage of using this estimate of learning rates is it can be compared both within and across groups as well as allowing predictions of future performance to be made. Table 1 displays mean learning rates and shows that in each condition they are positive indicating that the number of selections from the advantageous decks increased with exposure to the task.

In order to determine if these learning rates were different, a $2 \times 2$ (instruction type by reinforcer type) independent-measures ANOVA was performed. No significant differences in learning rate were found between reinforcer types, $F(1,76) < .01$, $MSE = 5.43, p < .05$; instruction types, $F(1,76) = 2.02, MSE = 5.43, p < .05$; nor was any interaction, $F(1,76) = .61, MSE = 5.43, p < .05$. The effect of reinforcer type does not emerge when learning rate is examined implying that despite a difference in net scores between some of the experimental groups learning rate does not vary between them.

However, the highest learning rates in Session 1 followed receipt of the Hint instructions. This would suggest that with increased trials the difference between participants who had received the Hint instructions and those who had not should increase. As a result participants who received the Hint instructions should reach asymptotic performance sooner. Bowman and Turnbull (2003) suggested that with more trials a similar difference would be seen between reinforcer types. We find no replication of this trend when the conditions are the same as in Bowman and Turnbull (2003). Extrapolating from session 1 data such an effect would only be expected when No Hint instructions are used. However,

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Summary of mean learning rates by session in each condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reinforcer</strong></td>
<td>Facsimile</td>
</tr>
<tr>
<td><strong>Session 1</strong></td>
<td></td>
</tr>
<tr>
<td>Instruction</td>
<td></td>
</tr>
<tr>
<td>No Hint</td>
<td>0.68 (.42)</td>
</tr>
<tr>
<td>Hint</td>
<td>1.82 (.62)</td>
</tr>
<tr>
<td><strong>Session 2</strong></td>
<td></td>
</tr>
<tr>
<td>Instruction</td>
<td></td>
</tr>
<tr>
<td>No Hint</td>
<td>0.6 (.34)</td>
</tr>
<tr>
<td>Hint</td>
<td>1.09 (.49)</td>
</tr>
</tbody>
</table>

*Note. $n = 20$ in all cases. Figures in parentheses are the standard error of the mean.*

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1. Keppel (1991, p. 384) recommends against pooling the error variance in mixed factor designs so separate error terms were used for the simple effects analyses.
by looking at participant performance in a second session on the IGT these predictions can be investigated.

3.2. Session 2

A second session on the IGT was conducted to allow an examination of when, and in what conditions, asymptotic performance is reached. A second session also allows a test of Bowman and Turnbull's (2003) hypothesis that increased trials on the IGT would lead to differential performance between reinforcer types.

As in Session 1 a 2 x 2 x 5 (reinforcer type by instruction type by block) mixed-design ANOVA was performed to investigate differences in net score due to the experimental factors. ANOVA revealed a main effect of block, $F(3.33, 253.36) = 6.45, \text{MSE} = 33.01, p < .05$, indicating that net score differed between some blocks. Contrary to the Session 1 analysis a main effect of instruction type was also found, $F(1.76) = 9.05, \text{MSE} = 267.60, p < .05$; net score was higher when participants received Hint instructions ($6.52, SE = 1.16$) rather than No Hint instructions ($1.6, SE = 1.16$). Also in contrast to Session 1 no effect of reinforcer type was found, $F(1.76) < 1$. No other main effects or interactions were significant: reinforcer type by instruction type, $F(3.33, 253.36) < 1$; block by reinforcer type, $F(3.33, 253.36) < 1$; block by instruction type, $F(3.33, 253.36) = 1.66, p > .05$; block by reinforcer type by instruction type, $F(3.25, 246.66) < 1$.

In Session 1 participants who received the Hint instructions had the highest learning rates. These were not significantly different to those of participants who had received the No Hint instructions but did suggest that differential performance would be found with more trials on the IGT. An alternative explanation suggested by one reviewer is that in adding a second session after a 48-h delay a further change was made to the standard IGT procedure. It is plausible that in re-reading the instructions after some experience on the IGT participants who received the hint were better able to utilise the help afforded by the Hint instructions and this subsequently affected their performance. However, given that the learning rates following Hint instructions were higher, while not significantly different to those following No Hint instructions, a distinction in performance did exist between instruction groups and it seems plausible this would have occurred whether the second session followed immediately or after a delay. However, this possibility will need to be empirically tested.

It is puzzling that no effect of reinforcer type is found, even at one level of the instruction type factor. In Session 1 learning rate was higher in the No Hint—Real Money condition than in the No Hint—Facsimile Money, and a significant difference in net score was found between these conditions. However, this effect disappears in the second session. Examination of Fig. 2 suggests that there is little learning in the No Hint conditions, despite the difference in reinforcer type. Two explanations for this result spring to mind. Participants in the No Hint—Real Money condition may not have acquired an understanding of the task in the same way or to the same extent as those who received the Hint instructions; or the introduction of the break between sessions has affected behaviour in some way. If this were the case then a continuation of the Session 1 trend may have been found had the second session immediately followed the first.

3.2.1. Learning rates in Session 2

Learning rates were estimated as in Session 1 by calculating the slope $b$ from the change in net score across block. A 2 x 2 (instruction type by reinforcer type) independent-measures ANOVA found a main effect of instruction type, $F(1.76) = 10.36, \text{MSE} = 1.37, p < .01$; no effect of reinforcer type, $F(1.76) = 1.26, p > .05$; and no interaction, $F(1.76) = 0.29, p > .05$. These results reflect the rapid rise in net score between blocks 6 and 7 in the Hint instruction conditions despite net score reaching asymptote in the subsequent blocks. No such rise occurs following No Hint instructions and the learning rate remains flat (Fig. 2), suggesting that with increased exposure to the IGT it is the instructions one receives that influence learning. This is apparent in Fig. 2. In both No Hint conditions mean net score is no different to chance in block 10 of the IGT despite the preceding 180 trials worth of experience and a gap between sessions in which to reflect on behaviour (No Hint—Facsimile Money, $t(19) < 1, SD = 8.17, p > .05$; No Hint—Real Money, $t(19) < 1, SD = 10.61, p > .05$).

Receiving the Hint instructions does improve performance on the IGT over and above what would occur should participants be unaware prior to beginning the task that two of the decks are better than the others. This finding supports our hypothesis and the suggestion by Schmitt et al. (1999) and Blair et al. (2001) that difficulties in replicating Bechara et al.'s (1994) results in normal controls can be attributed to differences between the instructions used. It may also be the case that, given the increased information Hint instructions impart, participants who receive them should be better able to describe what is going on in the IGT and indeed may reach the 'conceptual' period (Bechara, Damasio, Tranel, & Damasio, 1997) sooner than if No Hint instructions were received. This remains to be empirically tested.

Our results are consistent with Bowman and Turnbull (2003). No effect of reinforcer type was found when participants received the Hint instructions. However, when the No Hint instructions were used an effect of reinforcer type was found with net score higher when Real Money was used as a reinforcer. Instruction type affects IGT performance. Higher learning rates are found following Hint instructions and with longer exposure advantageous asymptotic performance is reached.

4. General discussion

This study varied the administration of the Iowa Gambling Task in several ways that had the potential to
influence performance. Participants were either given instructions that included a hint or did not, and received either real or facsimile money reinforcers. Performance was assessed by comparing net score across experimental blocks and between conditions. An effect of reinforcer type was found in the first experimental session. However, this effect was only apparent when participants received No Hint instructions, suggesting that instruction type influenced behaviour on the IGT despite no main effect emerging over the first 100 trials. An effect of instruction type did emerge in the second experimental session as indicated in the first session by larger learning rates following receipt of the hint instructions. In fact, there was little evidence of learning in the participants who had received the instructions without the hint: after 180 trials mean net score in these groups was not significantly different to chance. In addition, the effect of reinforcer type was not sustained into a second session in contrast to Bowman and Turnbull’s (2003) prediction.

The analysis of IGT performance using the net score measure assumes that the advantageous and disadvantageous decks are similar enough to allow the number of cards selected from them to be collapsed together. While this is true of the long-term gains, the decks differ in the immediate gain and, crucially, the schedule of losses. Each deck is different from the others on at least one of these three dimensions. Wilder, Weinberger, and Goldberg (1998) and MacPherson, Phillips, and Della Sala (2002) have reported that participants’ card selection is not uniform within the advantageous and disadvantageous decks. Both studies report that their normal and clinical samples selected more cards from the decks where they received frequent gains without loss (decks B and D). This selection behaviour is consistent with what is observed in the animal operant conditioning literature and suggests that the ratio of wins to losses is important in card selection (Greenberg & Weiner, 1966).

From their published reports (Wilder et al., 1998) or personal correspondence (MacPherson et al., 2002) it is clear that both studies used Facsimile Money reinforcers and No Hint instructions. In the equivalent condition of the present study (Session 1: No Hint—Facsimile Money) a preference for decks B and D is also found. This pattern is found in all factorial conditions (see Table 2). More information about the effect of reinforcer type reported in the results can be found by comparing in Table 2 selection from decks B and D between reinforcer types in the No Hint conditions. When Real Money was the reinforcer selection was lower from deck B and higher from deck D than when Facsimile Money was the reinforcer. Comparing between instruction types, the mean total number of cards selected within each deck are much the same, which was reflected in the earlier analyses of net score.

Fig. 3 displays the number of cards selected from each deck across block and within each experimental factor. This more detailed examination of deck selection reveals the changes over time that are not found when only total cards selected are looked at. It is apparent from Fig. 3 that selection from deck A remains consistent and below chance in all conditions, while selection from deck D changes little despite remaining above chance. These observations do not tell us much more than what is available from looking at total card selections. However, what this more local examination reveals is that selection from deck B decreases while selection from deck C increases. This implies that the learning rate calculated from net score is driven by differential selection within the advantageous and disadvantageous decks. Indeed in Session 2, where the effect of instruction type is found, this trend is even more apparent and shows that participants who received the Hint are correctly identifying the worst decks.

The observation that there are differences in preference for decks with the same long-term expected value but different short-term contingencies implies that learning in the IGT is not only governed by expected value. This is of interest because it may shed light on basic learning processes’ sensitivity to the magnitude versus the frequency of reinforcement. This in turn has implications for researchers in all fields using the IGT. If clinical participants show differential deck selection within decks with the same expected values, then the contingencies offer a greater insight into what is influencing their behaviour on the IGT.

While these observations are interesting they must be interpreted cautiously. As the number of cards selected from one deck is dependent on the number selected from the others analysis using parametric statistics would violate the assumption of independence, making any analysis of differences between decks difficult to investigate, and this is the reason why only observations of the data have been reported here.

The main finding from this study is that the instructions participants receive affect their subsequent performance on the IGT. This should not come as a surprise. Being told that “some of the decks are worse than others and that if you stay away from the worst decks you will win” should affect participants’ ability to distinguish between decks and

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### Table 2

<table>
<thead>
<tr>
<th>Reinforcer</th>
<th>Session 1 Instruction</th>
<th>Session 2 Instruction</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No Hint</td>
<td>Hint</td>
</tr>
<tr>
<td>A</td>
<td>Facsimile</td>
<td>20.45 (1.31)</td>
</tr>
<tr>
<td></td>
<td>Real Money</td>
<td>20.65 (1.03)</td>
</tr>
<tr>
<td>B</td>
<td>Facsimile</td>
<td>32.65 (2.02)</td>
</tr>
<tr>
<td></td>
<td>Real Money</td>
<td>26.3 (1.59)</td>
</tr>
<tr>
<td>C</td>
<td>Facsimile</td>
<td>21.65 (1.44)</td>
</tr>
<tr>
<td></td>
<td>Real Money</td>
<td>21.95 (1.56)</td>
</tr>
<tr>
<td>D</td>
<td>Facsimile</td>
<td>25.25 (1.65)</td>
</tr>
<tr>
<td></td>
<td>Real Money</td>
<td>31.1 (2.03)</td>
</tr>
</tbody>
</table>

*Note.* Figures in parentheses are the standard error of the mean.
thereby improve on the IGT. It is perhaps the strength of the gambling task paradigm that differences in performance between sub-populations and control groups are found without using the Hint instructions (Grant et al., 2000; Mazas et al., 2000; Petry et al., 1998). However, in altering the instructions participants are given, the nature of the task is less one of learning from behaviour as in a traditional decision-making task (or operant conditioning task), but one of monitoring behaviour to distinguish between opposing (good and bad) options (cf. Kudadjie-Gyamfi & Rachlin, 2002). This should certainly have an impact on participants’ ability to describe what is going on as the task progresses (Bechara et al., 1997; Maia & McLelland, 2004).

Appendix A. Participants’ instructions

You are going to see four decks of cards on the computer screen. You must make a series of card selections, one card at a time, from any of the four decks of cards until you are told to stop. After selecting each card you will receive some money. After selecting some cards you will be given money but will also lose money. The amount you have earned will be displayed on screen as a value and in a green bar at the top of the screen.

To start you off you have been given a loan of £2000 (£2.00 in Hint instruction conditions). A red bar will display this value to remind you how much money you were loaned to play the game.

The goal of the game is to maximise profit on the loan of money (to earn as much money as possible) [Authors’ note: In the experiments where facsimile reinforcers were used the word “play” was inserted before money in this sentence].

You are free to switch from any deck to another, at any time, and as often as you wish until you are instructed to stop.

It is important to know that just like in a real card game, the computer does not change the order of the cards after the game starts. You may not be able to figure out exactly when you will lose money, but the game is fair and the computer does not make you lose money at random. [The following Hint instructions only appeared in the Hint instruction conditions: All I can say is that some decks are worse than others. You may find all of them bad, but some are worse than others. No matter how much you find yourself losing you can still win if you stay away from the worst decks].

Any questions? No? Then click on “Start.”

References


