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Research in Developmental Disabilities 31 (2010) 536–544

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Symbol labelling improves advantageous decision-making on the Iowa Gambling Task in people with intellectual disabilities

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ARTICLE INFO

Article history:
Received 12 November 2009
Accepted 1 December 2009

Keywords:
Decision-making
Iowa Gambling Task
Symbol labelling
Executive functioning
Set shifting
Developmental disabilities

ABSTRACT

Individuals with intellectual and developmental disabilities often have difficulties foregoing short-term loss for long-term gain. The Iowa Gambling Task (IGT) has been extensively adopted as a laboratory measure of this ability. In the present study, we undertook the first investigation with people with intellectual disabilities using a two-choice child version of the IGT, with measures of intellectual and executive functioning. Compared to a group of matched controls, people with intellectual disabilities performed advantageously and showed high levels of subjective awareness about the relative goodness and badness of the decks. A symbol labelling intervention, in which participants were taught to label the good and bad decks at regular intervals significantly improved advantageous decision-making to levels approximating that of controls. Factor analysis of executive functioning scores identified working memory and mental flexibility (response initiation and set shifting), with a near-significant inverse correlation between the extent to which the intervention was required and mental flexibility. These findings show, for the first time, that people with intellectual disabilities are capable of performing advantageously on the IGT and add to the growing clinical literature on decision-making.

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1. Introduction

The ability to make decisions that offset some form of short-term loss for a potentially greater long-term gain is a defining feature of adaptive functioning. For instance, deciding whether to spend or invest money involves a consideration of the relative benefits of the immediate goods/services to be gained, combined with the likelihood that the sums invested will accrue interest or remain available for alternative purchases. People with intellectual disabilities often have difficulties foregoing short-term loss for long-term gain, and over the years several laboratory tasks have been developed to mimic real-world decision-making in a variety of participant groups (Suto, Clare, Holland, & Watson, 2005; Willner, Bailey, Parry, & Dymond, in press).

One such task, the Iowa Gambling Task (IGT) involves making decisions among four concurrently available decks of cards for hypothetical monetary gain and/or loss (e.g., Bechara, Damasio, Damasio, & Anderson, 1994). Two of the decks result in frequent immediate high gain per choice (e.g., £100), but produce high magnitude losses of differing frequencies depending on the deck, leading to a cumulative long-term loss (i.e., the "disadvantageous" decks). The other two decks typically result not only in lower immediate rewards (e.g., £50), but also generate lower magnitude losses at the same frequency of punishment as decks A and B, resulting in a cumulative long-term gain (i.e., the "advantageous" decks). A defining feature of

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doi:10.1016/j.ridd.2009.12.003

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healthy, normal performance on the IGT is the gradual adjustment to the reward and punishment contingencies, as participants initially sample cards from all of the decks before showing, by around the second block of trials, a choice preference for the advantageous decks (see Dunn, Dalgleish, & Lawrence, 2006).

Impaired learning on the IGT, defined as a preference for the disadvantageous decks over the course of the task, has been observed in individuals with ventromedial prefrontal cortex (VMPFC) damage (Bechara et al., 1994; Bechara, Tranel, & Damasio, 2000), as well as in several psychiatric populations, including patients with depressive disorder (Must et al., 2006), obsessive compulsive disorder (Lawrence et al., 2006) and impulse control disorders (Cavedini, Riboldi, Keller, D'Annucci, & Bellodi, 2002). While a large body of research has been conducted using the IGT with numerous clinical populations and with healthy volunteer groups of all ages, this procedure has not yet been used with individuals with intellectual or developmental disabilities. This is perhaps surprising given that the IGT was developed to mimic real-world decision-making (Bechara et al., 1994), and people with intellectual disabilities often face situations in which the choice alternatives available may both lead to some form of immediate gain yet which differ in overall net loss; for instance, a choice between junk food with its attendant health costs versus more expensive healthy foods, or between limited spending at the start of the week versus spending everything and being without money for food at the end of the week. The advantageous strategy, therefore, is to outweigh the immediate gain for longer term, cumulative gain and the IGT offers a potentially novel means of assessing this ability in people with intellectual disabilities.

Modifications to the format of the IGT may be necessary for use with people with intellectual disabilities, and decision-making research conducted with young children may be salutary in this regard. Developmental research on the IGT and its variants has been undertaken with children as young as 3 years of age (Garon & Moore, 2004, 2007; Heilman, Miu, & Benga, 2009; Kerr & Zelazo, 2004), adolescents and teenagers (e.g., Crone, Vendel, & van der Molen, 2003) and older adults (e.g., Denburg, Recknor, Bechara, & Tranel, 2005; Fein, McGillivray, & Finn, 2007). Garon and Moore (2007) employed an age-appropriate two-deck version of the IGT in a study examining the decision-making performance of children 3.5 and 4.5 years of age. Children were presented with the two deck and invited to play a card game. The disadvantageous decks has pictures of two bears on each card, and the advantageous deck had one bear on each card. Children were informed that bears indicated a win and that sometimes they would also see pictures of tigers, which indicated a loss. Selections from the advantageous deck always resulted in a gain of 1 and, where scheduled, a loss of 2. Selections from the disadvantageous deck always resulted in a gain of 2 and, where scheduled, a loss of 13. The task ended after 60 selections, and children were asked to identify which deck was better and which was worse, and why, after the 40th trial and again at the end of task. Garon and Moore (2007) found that the older children showed a preference for the advantageous deck and the younger children showed a preference for the disadvantageous deck, with both groups showing clear evidence of awareness of the reward and punishment contingencies associated with each deck.

Garon and Moore speculated that the significant age differences on the task were not attributable to the minor difference in awareness between the groups. It remains possible, however, that asking the awareness questions may have affected the younger children in different ways to the older children. Garon and Moore (2007) investigating this possibility in a second experiment. At two points in the task (after 30 trials and 60 trials, respectively), awareness was measured in which some of the children were asked to decide which deck was "good" and which was "bad", as in Experiment 1. However, children were also given symbols of a bear or tiger to place next to the respective decks which remained in place until the next scheduled awareness test: no corrective feedback followed incorrect labelling (i.e., placing the bear next to the bad deck). Garon and Moore (2007) found that 3.5- and 4.5-year-old children who correctly labelled the decks chose significantly more from the good deck during the course of the task, compared to the other conditions. These findings indicate that advantageous performance on the 2-choice IGT may be facilitated by a simple intervention that labels the decks as good or bad, allowing for future behavior to be guided by the affective consequences of the labels. Taken together, Garon and Moore's findings provide a novel, low-cost method of improving decision-making performance in children, and one that has numerous implications for extension to other groups, in particular individuals with intellectual disabilities.

There are several possible reasons for investigating the performance of people with intellectual disabilities in paradigms such as the IGT. First, there has been conflicting evidence for a relationship between intelligence and IGT performance. For instance, some studies with both healthy normal volunteers and clinical populations have shown a relationship between higher IQ and improved learning on the IGT (Barry & Petry, 2008; Monterosso, Ehrman, Napier, O'Brien, & Childress, 2001) while others have not (Lösel & Schmucker, 2004). Furthermore, other studies have found that measures of general intellectual ability, such as educational history, both do (Evans, Kemish, & Turnbull, 2004) and do not (Barry & Petry, 2008; Lawrence et al., 2006) predict IGT performance. Working memory load has also been shown to be a factor influencing advantageous decision-making (Dretsch & Tipples, 2008; Pecchinenda, Dretsch & Chapman, 2006). Taken together, these findings indicate that an assessment of the ability of people with intellectual disabilities to perform the IGT, and the identification of any possible relationships with measures of general intellectual functioning, would be both informative and timely. Second, a wide range of different variants of the IGT have been developed for use with young children, who would appear to be the population of most direct relevance for understanding the decision-making capabilities of people with intellectual disabilities. It remains to be seen whether one of these variant tasks, the two-choice IGT developed by Garon and Moore (2007), holds promise as an ecologically valid measure of decision-making in intellectual disability. Third, as people with intellectual disabilities might be anticipated to have difficulties performing advantageously on the IGT, it is imperative that interventions to improve learning should be adapted to the specific group under study. Indeed, if the IGT is truly intended to simulate real-world decision-making, then a demonstration of impaired learning in people with intellectual

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disabilities tells us very little about how this impairment might be overcome. This has obvious, immediate ramifications for designing effective interventions to promote adaptive real-world decision-making in people with intellectual disabilities, and the symbol labelling intervention developed by Garon and Moore (2007) has considerable potential in this regard. Finally, only a small number of studies have employed interventions to seek to improve decision-making performance, and most have been focussed on normal, healthy volunteers (e.g., Fernie & Tunney, 2005; Overman et al., 2006).

The objective of the present study was to investigate the decision-making ability of people with intellectual disabilities using the adapted 2-choice IGT developed by Garon and Moore (2007). We anticipated that our participants may have some difficulties on the task relative to healthy volunteers and thus we also aimed to explore the feasibility of adapting the symbol labelling intervention for use with people with intellectual disabilities to improve decision-making performance. We also sought to investigate the role of task awareness more systematically than before by recording participants' subjective experience ratings after every twenty trials (Cella, Dymond, Cooper, & Turnbull, 2007; Dymond, Cella, Cooper, & Turnbull, in press).

2. Method

2.1. Participants

The participants were 39 adults (54% males) with a mean (SD) age of 41.6 (10.9) who attended day services for people with mild to moderate learning disabilities, and a control group of 20 staff members (50% males) with a mean (SD) age of 40.2 (10.7) working within learning disability services. (The term 'learning disability' is used in the UK to refer to people with significant impairments of both intellectual and functional abilities, acquired in childhood. Participants' disabilities were of mixed aetiology, and the aetiology was typically unknown.)

Two groups of service users participated: Service User Group 1 consisted of 20 participants (55% males) with a mean age (SD) of 39.9 (9.6), and Service User Group 2 consisted of 19 participants (53% males) with a mean age (SD) of 43.4 (12.1). There were no significant differences between any of the groups with regard to age or gender. The local NHS Research Ethics Committee approved all aspects of the study. Participants provided informed consent prior to commencement of the study.

Service users were assessed for intellectual ability using the Wechsler Abbreviated Scale of Intelligence (WASI), and with the Cambridge Executive Functioning Assessment for people with Intellectual Disability (CEFA-ID), which consists of 6 tests of executive functioning (EF) and 6 memory tests, two of which reflect 'executive memory' (Ball, Holland, Treppner, Watson, & Huppert, 2008); factor analysis of EF scores identified two groups of subtests, which assess, respectively, working memory and mental flexibility (response initiation and set shifting; Willner, Bailey, Parry, & Dymond, submitted for publication). All participants were assessed for receptive language ability using the 2nd Edition of the British Picture Vocabulary Scale (BPVS).

2.2. Procedure

2.2.1. Iowa Gambling Task

A modified, fully automated Iowa Gambling Task, similar to one adopted by Garon and Moore (2007), was employed. All participants were read aloud the following instructions (adapted from Dymond et al., in press):

> In front of you on the screen, you are going to see 2 decks of cards. When we begin the game, I want you to pick one card at a time by clicking on a card from either deck. Each time you pick a card, the computer will tell you that you won some money. I don't know how much money you will win. You will find out as we go along. Every time you win, the green bar gets bigger.
>
> Every so often, when you click on a card, the computer will tell you that you won some money as usual, but then it will say that you lost some money as well. I don't know when you will lose or how much. You will find out as we go along. Every time you lose, the green bar gets smaller. You are absolutely free to switch from one deck to the other at any time, and as often as you like. It is totally up to you which card you pick each time. The goal of the game is to win as much money as possible and avoid losing as much money as possible.
>
> You won't know when the game will end. Simply keep on playing until the computer stops. I am going to give you £10 of credit, this green bar, to start the game and the more money you win the bigger the green bar will get. If you lose a lot of money the bar will turn red. The computer does not change the order of the cards once the game begins. The computer decides on the order of the cards before you begin the game and this doesn't change. The computer does not make you lose at random, or make you lose money based on the last card you picked. The only hint I can give you, and the most important thing to remember is this: Out of these two decks of cards, one is worse than the other, and to win you should try to stay away from the bad deck. No matter how much you find yourself losing, you can still win the game if you avoid the worst deck. Do you have any questions?

Service User Group 1 and the control participants were then given the opportunity to complete a 10-trial practice session in which they chose cards by clicking on them using the computer mouse or, if they preferred, by pointing to the card while the researcher positioned the mouse. The aim of the practice session was to provide familiarisation with the task and response requirements. In the practice session, participants always won £2 and incurred no losses. During the practice session, the researcher also explained details of the subjective rating scale. After the practice session, participants were told that the game would now begin.

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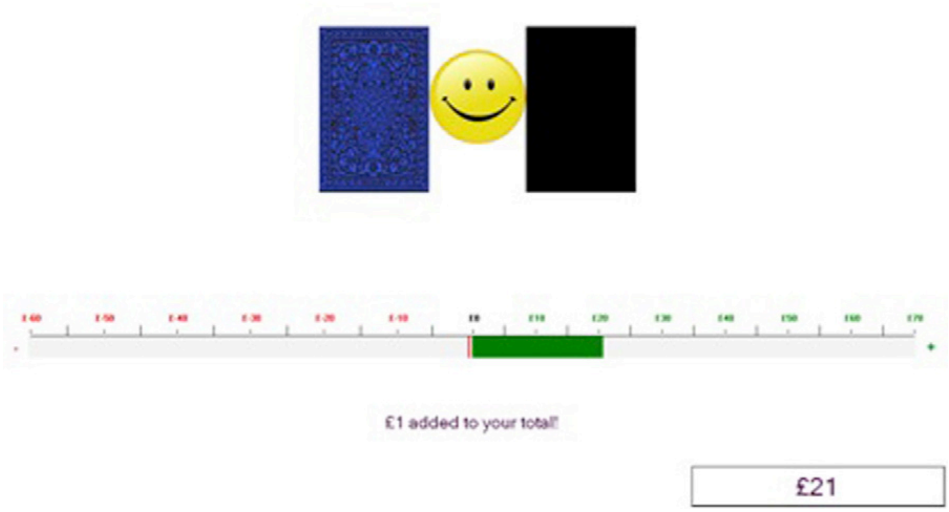

Fig. 1. A screenshot of the 2-choice IGT. Following selection of one of the decks, the card colour changed from blue to black. If a reward was scheduled on that trial, a smiley face was displayed and the horizontal counter incremented by the specified amount (in this case, £1). See text for further details. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

Participants were instructed to select cards from two blue-coloured decks presented on a laptop screen. The computer programme randomly determined which of the two decks was to be 'advantageous' and which was to be 'disadvantageous' for each participant. Once decks were allocated to one or the other condition, the positions of the decks remained unchanged for the remainder of the task. A loan of £10 of pretend money was displayed at the bottom right of the screen and was updated immediately following each choice (see Fig. 1). Displayed beneath the decks of cards was a green horizontal bar that increased or decreased in size according to the amount of money the participant won or lost with each card selection. This bar remained green as long as participants' total earned sum remained in positive numbers; if it entered negative numbers (i.e., lost more money than they currently had) the bar became red in colour.

Selecting a card from either deck caused that card to change to black in colour (see Fig. 1). Participants always won £2 if they selected a card from the 'disadvantageous' deck and always won £1 if they selected a card from the 'advantageous' deck. The losses on the 'disadvantageous' deck were always £13 while the losses on the 'advantageous' deck were always £2. The schedule of gains and losses was the same as that used by Garon and Moore (2007) and the frequency of losses was the same for both the advantageous and disadvantageous decks, with 4 choices out of every 20 leading to a loss. In the case of a gain, a sentence stating "X added to your total!" appeared on the screen while a voiceover included in the computer programme also said "Well done, you won X" (Fig. 1). The amount of money won was added to the total at the bottom of the screen and to the green bar. In the case of a gain and a loss, the message presented on the screen was "X added to your total! You lose Y! Y has been deducted from your total" while the voiceover stated, "Well done, you won X. Oh dear, you lost Y." In this case, the total after the win and loss was immediately displayed as the total at the bottom of the screen, while the green bar showed the money being added and then the money being taken away, in time with the voiceover.

The IGT consisted of 5 blocks of 20 trials, with subjective experience ratings presented after each block. Ratings were made on a 5-point scale: *Like it a lot* (=*5*), *Like it a bit*, *Don't mind it*, *Don't like it*, and *Hate it* (=*1*) (see Fig. 2 for a screen shot).

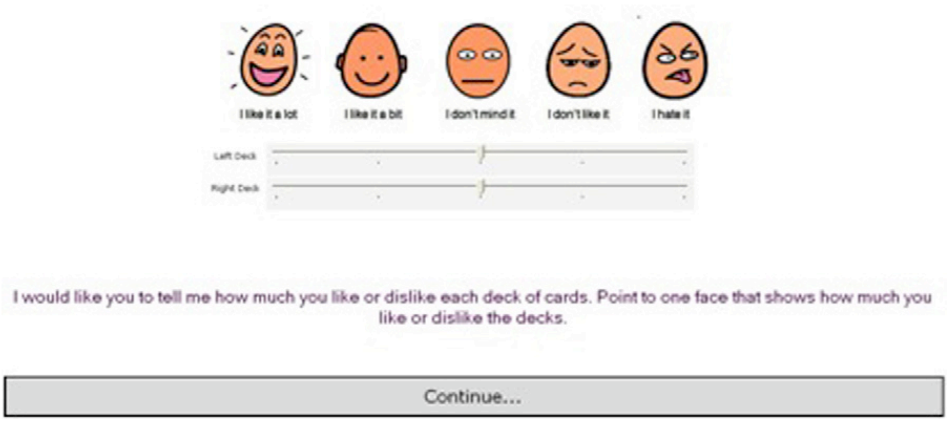

Fig. 2. Screenshot of the subjective experience rating scale presented after every 20 trials. Participants selected one of the 5 statements (ranging from "I like it a lot" to "I hate it") corresponding to the left and right deck by dragging or clicking on the slider scale with the computer mouse.

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2.2.2. Symbol labelling intervention

A training intervention based on that devised by Garon and Moore (2007) was implemented as follows with Service Users Group 2 only. First, after receiving the verbal instructions, participants were given the opportunity to practice using the mouse (or if they preferred, by pointing to the screen) during the first 10 trials of the actual game. Practice on the actual game was given to ensure participants had experience of the different gain and loss contingencies associated with each deck and to prevent any potential confounding influence from the fixed exposure to the £2 gain that may have occurred during the original practice task.

Second, after the 10th trial, service user participants were shown two cartoon faces, one a happy face and one an unhappy face (taken from the subjective rating scale; see Fig. 2), and asked to say which emotion was shown with the prompt, "How do you think this person feels?" It was explained that these faces would be used later in the game.

Third, service users provided subjective ratings after each block of twenty trials and were presented with the happy and unhappy faces and asked to place the happy face on the computer screen next to the "better deck" (the advantageous deck) and the unhappy face next to the "worse deck" (the disadvantageous deck). The order in which the faces were presented was randomised. A correction procedure was used following incorrect labelling responses. That is, if participants placed the happy face next to the disadvantageous deck or the unhappy face next to the advantageous deck, the faces were removed and they were asked to re-label the decks. The correction procedure was enforced a maximum of five times per trial; if participants continued to incorrectly label the decks, then the researcher first modelled the correct responses before re-presenting the faces. The number of error correction trials was recorded. Fourth, once the decks were correctly labelled, participants resumed selecting cards and the face-labels remained in place during the remaining trials in that block before being removed at the onset of the rating-scale screen. The same procedure was used to rate the decks and place the labels back onto the screen after each block of 20 trials.

2.3. Statistical analysis

For each block of 20 trials, a net score performance measure was calculated by subtracting disadvantageous selections from advantageous selections. A net score above zero is indicative of advantageous selections, while a net score below zero implies disadvantageous selections. Similarly, a net subjective rating was calculated for each block of trials by subtracting the ratings of the disadvantageous deck from the subjective ratings of the advantageous deck.

Data were analysed using 2-way ANOVA with repeated measures (groups $\times$ trial blocks), followed by 1-way repeated-measures ANOVA of each group (linear trend), and 1-way between-groups ANOVA for each block of trials with post hoc Student–Newman–Keuls (SNK) test. The main statistic of interest for the repeated measures analyses was linear trend.

For Service User Group 2, regression lines were fitted to each participant's scores for the five blocks of performance and ratings measures, and Pearson's product-moment correlation coefficient was used to examine the relationships between the slope of the regression line and each of the four cognitive measures.

3. Results

3.1. IQ, EF and BPVS scores

Service users' mean (SD) *WASI* Full-Scale IQ scores were 58.8 (3.6) for Group 1 and 59.7 (6.2) for Group 2. The two groups of service users' mean (SD) *CEFA-ID* executive functioning scores were 30.6 (9.1) and 31.6 (11.2), and their memory scores were 69.2 (15.4) and 69.3 (20.9). Participants mean (SD) raw *BPVS* scores were 81.6 (20.5) and 78.7 (34.1) for the two groups of service users (age equivalents: 7:11 and 7:09), and 152.1 (5.4) for the control group. No significant differences were found between the two groups of service users in relation to *WASI*, *BPVS*, EF or memory scores.

3.2. Mean net score

Fig. 3 shows that performance of both the controls and Service Users Group 1 was initially indistinguishable as participants sampled cards from each of the decks. By the second block of trials, both groups were performing advantageously with the control group learning at a level more than twice that of the Service Users Group 1. The learning profile of the control group increased steadily throughout the remainder of the task, while the Service Users Group 1 showed only a marginal improvement by the final block of trials. Fig. 3 also shows that the performance of Service Users Group 2, who received the symbol labelling intervention, was immediately advantageous and continued to increase and achieved near-identical levels to that of the controls by the end of the task. These data clearly demonstrate a facilitative effect of the symbol labelling intervention in people with intellectual disabilities.

Analysis of mean net scores confirmed a significant main effect of Groups [$F(2,56) = 3.24$, $p < 0.05$] and a marginally significant linear trend to the Groups $\times$ Trial blocks interaction [$F(2,56) = 3.14$, $p = 0.051$]. Further analysis confirmed significant linear trends for the Control group [$F(1,18) = 13.74$, $p < 0.001$] and Service User Group 2 [$F(1,18) = 13.20$, $p < 0.001$], but not for the Service User Group 1 [$F(1,19) = 1.83$, NS]. The groups differed significantly in the fifth trial-block [$F(2,56) = 4.78$, $p < 0.02$], where scores in the Controls and Service User Group 2 were significantly higher than in Service User Group 1 (SNK test).

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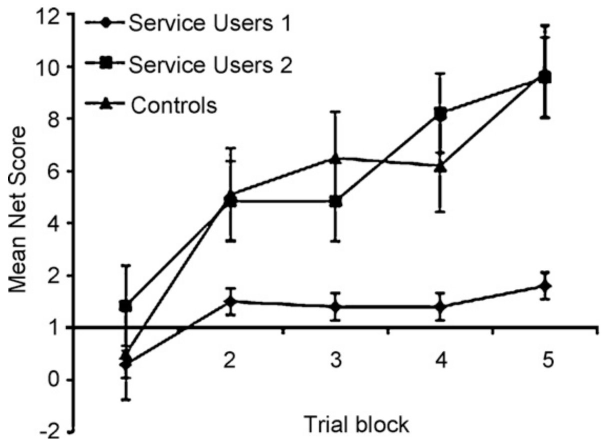

Fig. 3. Mean net score performance for each group across the 5 blocks of 20 trials. Advantageous performance is indicated by mean net score >0.

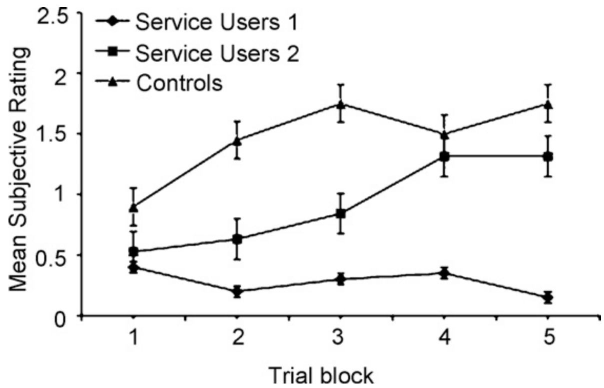

Fig. 4. Mean subjective experience ratings for each group across the 5 blocks of 20 trials.

3.3. Mean net subjective rating

Fig. 4 shows that the mean subjective rating of all groups was initially high and continued to increase for the controls and Service Users Group 2, while the ratings performance of Service Users Group 1 was maintained during the task in much the same way as their behavioural performance. The subjective experience data show that all groups had little difficulty in discriminating the good deck from the bad deck, and that the symbol labelling intervention boosted awareness levels of each of the decks' contingencies.

Analysis of ratings confirmed a significant main effect of Groups ([$F(2,56) = 11.14$, $p < 0.001$] and a significant linear trend to the Groups × Trials interaction [$F(2,56) = 3.22$, $p < 0.05$]. Further analysis confirmed significant linear trends for the Control group [$F(1,18) = 4.49$, $p < 0.05$] and Service Users Group 2 [$F(1,18) = 6.05$, $p < 0.025$], but not for Service Users Group 1 [$F(1,19) = 0.34$, NS]. The groups differed significantly in the second to fifth trial blocks [$F(2,56) = 5.09$, 7.11, 6.68, 13.10, respectively, $p < 0.01$]. Ratings were higher in the Control group than Service Users Group 1 in all trial blocks, and Service Users Group 2 rated higher than Service Users Group 1 in trial blocks 4 and 5 (SNK tests).

3.3.1. Error correction trials

During the symbol labelling intervention, the mean (range: SD) number of error corrections required in each block of 20 trials was 1.4 (0–6: 2.5), 0.3 (0–2: 0.7), 0.3 (0–2: 0.6), 0.1 (0–2: 0.5) and 0. These data show that the error correction procedure was required most often at the outset of the task and in a decreasing fashion throughout the remainder of the task such that it was not required at all in the final block of trials.

Correlations between the four cognitive variables and the regression coefficients for the two IGT measures were all nonsignificant (max $r = 0.21$, NS). However, there was a near-significant inverse correlation between the number of error correction trials and the EF measure of mental flexibility [$r = -0.37$, $p < 0.06$]. Further examination of this relationship showed that it became highly significant when partial correlation was used to control for variations in IQ and BPVS scores ($r = -0.61$, $p < 0.005$).

4. Discussion

The present findings show that people with intellectual disabilities perform advantageously on an adapted two-choice IGT, relative to controls, with both groups showing high levels of subjective awareness about the nature of the task. Both

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groups of service users with intellectual disabilities and controls showed a clear selection preference for the advantageous deck from an early stage in the task, and the learning level of control participants increased steadily throughout the remainder of the task. The learning profile of service users, on the other hand, remained constant, yet clearly advantageous. These findings show, for the first time, that people with intellectual disabilities are capable of performing advantageously on the IGT and add to the growing literature on decision-making in various clinical and non-clinical populations (e.g., Bechara, 2007; Dunn et al., 2006; Garon & Moore, 2007; Kerr & Zelazo, 2004).

Our findings from the Service Users Group 2 show that a symbol labelling intervention significantly improved advantageous decision-making to levels approximating that of controls. By asking individuals with intellectual disabilities to place either a happy or sad face next to each of the decks, and providing feedback following incorrect responses, these labels served to cue the cumulative long-term consequences associated with each deck. In so doing, this relatively simple intervention adopted from developmental neuropsychology (Garon & Moore, 2007) significantly boosted decision-making performance in the second service user group such that their learning profile was almost indistinguishable from that of the controls.

The symbol labelling intervention may have considerable potential for overcoming many of the decision-making deficits often observed in clinical research with the IGT (Bechara, 2007). There has, surprisingly, been a dearth of research aimed at developing facilitative decision-making interventions. Notwithstanding Garon and Moore's (2007) study with young children, the only prior intervention studies that we have been aware of were conducted with college students. Fernie and Tunney (2005) compared the effects of instruction-type on IGT performance and found that performance was improved when the instructions contained a hint about which decks were better than others (see also Balodis, MacDonald, & Olmstead, 2006). These authors also demonstrated that performance improved during re-exposure to the task in a second IGT session. Overman et al. (2006) found that contemplation of moral dilemmas, which has been shown to activate similar cortical regions involved in IGT performance, abolished sex differences on the task. As far as we know, these previous studies, along with the present study, are the only direct investigations of facilitative interventions for the IGT.

How, then, might we explain the facilitative effect of the present symbol labelling intervention? One possibility is that it may have exerted a form of conditional discriminative control over decision-making by signalling which of the decks was good and which was bad. The happy face, for example, may have exerted conditional control over selections of the good deck (S^D), and non-selections of the bad deck (S^Δ). According to this interpretation, participants who received the symbol labelling intervention were likely engaging in a form of conditional discrimination learning that accounts for the improved advantageous performance. There are, however, several factors that make this an unlikely explanation of the enhanced learning effects we observed. First, participants could still choose cards from the bad deck, while the labels were in place, as there were no differential consequences for doing so (other than those provided by the underlying IGT reward/punishment schedule). Our data show that during the symbol labelling intervention, the mean number of disadvantageous deck selections decreased from 9.3 (3.8) in block 1 to 5.2 (4.4) in block 5, indicating that participants did not have an exclusive preference for the conditionally labelled advantageous deck. This suggests that, rather than engaging in conditional discrimination of the advantageous deck, participants instead chose optimally from both decks—a pattern of selection observed in Garon and Moore's (2007) original study and elsewhere in the wider IGT literature (e.g., Cella et al., 2007). Second, as the task progressed, participants may have relied less on the response cueing or discriminative properties of the labelling intervention and the schedule of gain and loss, and more on the affective consequences of their card selections. The somatic marker hypothesis predicts that advantageous decision-making, is guided by affective states, or somatic markers, that drive the IGT behavioural performance (Dunn et al., 2006; Maia & McClelland, 2005). However, within this account, it is unclear precisely what role the cognitive schedule and discriminative labelling intervention might play, and thus it is reasonable to conclude that the pattern of deck selection suggests an interaction between cognitive and affective components of the task. Third, further research is necessary to directly test the prediction that symbol labelling may have functioned as a conditional discriminative cue by, for instance, comparing IGT performance in which inconsistent symbol labels are used by arranging a happy face next to the bad deck and an unhappy face next to the good deck. If inconsistent labelling of the decks has a negative impact on decision-making, then it suggests that the labels did in fact exert strong conditional control over participants' deck selections. This empirical issue warrants further attention.

A potential factor that may be relevant to the effectiveness of the symbol labelling intervention is mental flexibility (response initiation and set shifting). We found that mental flexibility was inversely correlated with the number of error correction trials required, indicating that those participants who scored high on this EF factor actually relied less on the symbol labelling intervention than those who scored lower. This suggests that the effect of the symbol labelling intervention may be to compensate for a lack of mental flexibility. This interpretation is consistent with findings showing that the degree of reversal learning impairment, which may be considered as an instance of the broader EF category of mental flexibility, is often correlated with the extent to which IGT performance is impaired (Fellows & Farah, 2003, 2005). Other support comes from findings that performance on the Wisconsin Card Sorting Task (WCST), a widely used EF task involving reversal learning, is correlated with performance on the latter blocks of IGT trials (Brand, Recknor, Grabenhorst, & Bechara, 2007). The precise role of mental flexibility in IGT performance is an issue that requires further investigation and has lead to the development of several variant tasks designed to assess this aggregate learning ability (e.g., Dymond et al., in press). Therefore, the present findings that mental flexibility predicted the extent to which the symbol labelling intervention was recruited by people with intellectual disabilities on the 2-choice IGT are in keeping with the evidence showing that the greater mental flexibility, the better the advantageous performance.

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Our findings demonstrate, for the first time, advantageous decision-making performance in individuals with low IQ scores. The participants in Service Users Group 1 had a mean Full-Scale *WASI* score of 58.8 (SD: 3.6) and performed advantageously on the IGT, although at much lower levels than that of the controls. The participants in Service Users Group 2 who received the symbol labelling intervention had a mean Full-Scale *WASI* score of 59.7 (SD: 6.2) and also performed advantageously on the IGT, but at near-identical levels to those of the controls. Further analysis revealed that the two groups' *WASI* and *BPVS* scores were not significantly different. These findings are consistent with previous research with young adults showing that IQ level does not influence task performance (Lösel & Schmucker, 2004) and stand in contrast to those of other studies showing a relationship between higher IQ and improved learning on the IGT (Barry & Petry, 2008; Monteresso et al., 2001). Clearly, further research is needed to elucidate the relationship, if any, between IQ and performance on all of the different versions of the IGT (2-choice and 4-choice) with both healthy young adults and individuals with intellectual disabilities.

The findings have implications for understanding the role of awareness in IGT performance (Cella et al., 2007; Maia & McClelland, 2005). All groups showed elevated levels of subjective experience ratings from the outset, with the control group and Service Users Group 2 showing an increasing trend throughout the remainder of the task. These data demonstrate that participants can readily discriminate between the good and bad decks at an early stage in the task. Explicit knowledge of the contingencies of the game emerged at the same time as advantageous behavioural performance, suggesting that awareness may in fact be necessary in order to show learning on the IGT. The relationship between awareness and IGT performance is a controversial issue that has often been addressed using indirect measures like open-ended questions or post-experimental interviews, which may not be sufficiently sensitive to detect the ongoing changes in subjective awareness during the task. Our method of concurrently measuring awareness at regular intervals overcomes this limitation, and thus the present study contributes to previous findings of preserved subjective experience on the IGT in healthy young adults (e.g., Cella et al., 2007), psychosis-prone individuals (Cella, Dymond, & Cooper, 2009) and people with schizophrenia (Evans, Bowman, & Turnbull, 2005).

5. Conclusions

In conclusion, we have shown, for the first time, that people with intellectual disabilities perform advantageously on the IGT, and that a simple symbol labelling intervention improves performance further to levels approximating that of a control group. Subjective experience ratings indicated that all participants had little difficulty discriminating the good deck from the bad deck, and that this possibly contributed to the effectiveness of the symbol labelling intervention. No relationship was found between EF ability and IGT performance, but participants with higher scores on the EF mental flexibility factor needed fewer prompts to use the symbol labelling intervention appropriately. Future research should investigate the role played of working memory, and the effects of inconsistent symbol labelling, in deciding advantageously.

Acknowledgements

This research was supported by a grant from the Welsh Office for Research and Development in Health and Social Care. The authors wish to thank the participants for their cooperation with the study. Address correspondence to Simon Dymond PhD, BCBA-D, Department of Psychology, Swansea University, Singleton Park, Swansea SA2 8PP, United Kingdom (s.o.dymond@swansea.ac.uk).

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