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Effect of playing computer games on decision making in people with intellectual disabilities

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#### ABSTRACT

People with intellectual disabilities have difficulty making decisions and this may hinder their independence and inclusion in society. Interactive computer software may give them the opportunity to practice the underlying components of this skill. This study aimed to discover if repeated sessions playing a computer game involving aspects of decision making, such as collecting relevant information and controlling impulsivity, would improve performance in two non-computer based tests of decision making. 12 adults with intellectual disabilities were randomly assigned to either an intervention group or control group. They were all exposed to 10 twice weekly sessions, playing either the intervention game or the control game, which involved simple reaction time only. After repeated sessions, the intervention group showed a significant improvement in game score, with researcher assistance significantly decreasing. At follow up, the intervention group showed a significant decrease from baseline in the number of guesses made before guessing correctly on both of the decision making tests. The decrease observed in the control group failed to reach significance.

**Keywords:** Intellectual disabilities, computer games, cognition, decision making, control study

## INTRODUCTION

People with intellectual disabilities are one of the most vulnerable and socially excluded groups, facing daily issues of oppression and discrimination (Thomas & Woods, 2003). The majority of this group of people do not have jobs, live in their own homes or have any choice over important issues such as who cares for them or even day to day issues such as the food they eat. Due to this denial of choice and decision making, they often feel they have no control over their lives. The terms “choice” and “decision” making are used closely and interchangeably, however choice is described as “making an unforced selection of a preferred alternative from two or more options” (Stancliffe, 2001, page 92). This differs from decision making, which is acknowledged by Jenkinson and Nelms (1994) to involve more than just a simple expression of preference. They describe the process as “understanding an issue, identification and informed evaluation of options, communication of a decision and commitment to an action”. Research indicates that people with intellectual disabilities have difficulty making choices and decisions (Jenkinson & Nelms, 1994). This study suggested that people with intellectual disabilities frequently fail to use a systematic decision-making process that requires them to search for all the relevant information and evaluate alternatives before making a decision. Instead they often simply draw upon a narrow range of solutions from past experiences and apply them to new situations.

There is some evidence that this is exacerbated by a constant denial of choice (Jenkinson & Nelms, 1994; Cooper & Browder, 2001) due to poor resources, assumptions of incompetence and carers having time constraints or concerns about risks. Several studies (Kennedy and Haring, 1993; Kern et al, 1998; Parsons et al, 1998) have found that increasing choice opportunities has improved participation, engagement and behaviour during activities. Studies trying to encourage staff to offer more opportunities for choice and decision making have also been effective (Belfoire et al, 1994; Cooper and Browder, 2001). Could these opportunities be expanded through computer based practice of the component skills of decision making?

Recent research on the beneficial effects of playing action video games suggests that the skills practiced in these games transfer to other situations. Green and Bavelier (2003) found that playing action video games can give a person the ability to monitor more objects in their visual field and do so faster than a person who does not play such games. In their more recent study (Green & Bavelier, 2007) they found that the improvements observed could be explained not only by changes in strategy but also by changes in fundamental aspects of visual processing. In order to explore whether similar transfers might take place in people with intellectual disabilities, Standen et al (2006) assessed the effect of playing a switch controlled computer game with a time limit for responses on choice reaction time. They found a significant decrease in choice reaction time in the intervention group compared to the control group who, for the same amount of time, played a game with no time limit.

Choice reaction time is only one aspect of decision making and measuring decision making in people with intellectual disabilities is not straightforward. There are standardised tests

for this purpose but they pose problems. The Cambridge Gambling Task (Rogers et al, 1999) which measures quality, speed and risk-adjustments of decisions, is designed for the non-disabled population and is too complex for people with intellectual disabilities. The Information Sampling Task (IST) ([www.cantab.com](http://www.cantab.com)) measures the amount of information collected before a decision is made and impulsivity ie making a decision too early. It is simpler than the Gambling Task and does not rely on language. However, as it is computer based an improved outcome in people with intellectual disabilities could be just due to increased familiarity with computers. However, the two aspects of information collection and impulsivity drove the development of the outcome measures that were used for this study.

The current study aims to assess the effect on decision making of playing a computer game which involves making a decision based on visual information.

## METHODS

### *Design*

Baseline measures of decision making were compared with post intervention measures in an intervention group and a matched control group.

### *Participants*

12 adults with intellectual disabilities were recruited from a local day centre. Potential participants were nominated by specialist carers at the centre if they matched the following inclusion criteria:

- adequate visual ability to be able to view the screen.
- adequate motor ability to operate keys without assistance.

Participants were grouped into pairs matched on age and ability as measured by the British Picture Vocabulary Test (BPVS, Dunn et al, 1997) and the members of each pair were randomly allocated to either the intervention or control group. Their characteristics are displayed in Table 1.

Table 1

### *Interventions*

*Intervention Task* Cheese Factory, based on Tetris, is a game written in Flash specifically for people with severe intellectual disabilities. It involves sections of various sizes (eg quarters) from whole rounds of cheese falling from the top of the screen. Cheese sections could be left to form a pile immediately below or using the arrow keys on the keyboard sent to fall either left or right. When a cheese section appears at the top of the screen, the player must decide which direction to move it so that the section falls on to the pile where there is an appropriate gap for it to form a whole cheese. The game has a number of levels based on the varying speed of appearance of the stimuli or shape of the stimuli and thus levels were available to accommodate more disabled players. The level participants played at and the scores they achieved in each session were recorded.

*Control Task* Running Man was also written in Flash and designed specifically for people with intellectual disabilities and success is dependent on speed of simple reaction time.. It involves a man jogging across the screen and encountering obstacles (e.g a rock) on his way to the finishing line. The player has to make the man jump over the obstacles by a single click of the space bar on the keyboard. If they fail to do this at the right time, the man crashes into the obstacle. The game could be made more challenging by increasing the speed that the man ran and increasing the number of obstacles. The level participants played at and the number of crashes in each session were recorded.

### *Measures*

*Picture Guess Test* This test was designed on similar principles to the standardised Information Sampling Test (IST) from CANTAB. The participant has to guess which of four pictures displayed in front of them is depicted on one placed face down in front of them. This is cut into 12 pieces like a jigsaw and in order to make a decision they can turn over as many

pieces as possible before they make a guess. Outcome measures are the number of pieces turned over, number of guesses before a correct guess is made and time taken to guess correctly averaged over the four times the test was repeated.

*Picture Completion Test* This test was a simplified version of Raven's Matrices. The participant has to identify the missing segment from a display of six in order to complete a larger pattern presented in a 3×3 grid. The larger pattern has two dimensions, such as a change in number horizontally and a change in colour vertically. The number of guesses they could make was limited to four, as there were only six possible segments to choose from, therefore once the participant has made four incorrect guesses, that test item was terminated. The test comprised two introductory items and then three sections, each focused on different dimensions that increased the difficulty of the tasks (eg colour and number; shape and number; shape and orientation), with three items in each section making 11 sheets in total. Outcome measures were the number of guesses made; time taken to make a correct guess and how many items they could complete.

In both tests participants could make their guesses verbally or by pointing.

*Performance on Intervention and Control Tasks* For both tasks level of difficulty at which participants were playing was recorded as well as scores obtained for the intervention group and crashes for the control group. To ensure any change in performance was not due to an increase in supervisor assistance all the sessions with both groups were videotaped and analysed for amount of supervisor assistance given using a method established in an earlier study (Standen et al, 2002).

*Procedure*



After completing the BPVS, all participants were assessed at baseline on the two measures of decision making before being assigned to either the intervention or control group. Each participant was scheduled for 10, twice weekly sessions of 20 minutes over five weeks. The sessions were timed using a stopwatch and when 20 minutes had passed the session was terminated to ensure everyone had equal lengths of exposure to the games. One of the researchers (FR) sat alongside them to give assistance and encouragement. Five sessions were recorded on videotape, with the camera positioned to view both the participant and the researcher sitting next to them. After the tenth session all participants repeated the two outcome measures of decision making.

### *Analysis*

To minimise bias the tapes were scrambled so that the researcher (FR) was unaware of whether the session being analysed was earlier or later in the study. Repeat reliability was established on four randomly selected sessions. Video collected data were expressed as a percentage of session duration. Scores and crashes were adjusted for length of session. Statistical comparisons were made using t tests for data that met the requirements for parametric analysis and the Wilcoxon Signed Ranks Test for paired data that did not meet these requirements.

## RESULTS

### *Did both groups improve their performance on the intervention tasks?*

For the Intervention Group there was a significant increase in scores achieved between the first and the tenth sessions ( $t = 3.01$ ,  $df = 5$ ,  $p < 0.03$ ) in spite of a steady increase in the level of difficulty at which they were playing the game (see Figure 1.)

Figure 1`

This was not due to the amount of help they received from the researcher as this decreased over repeated sessions with a significant ( $t = 22.02$ ,  $df = 5$ ,  $p < 0.0001$ ) decrease in the percentage of time in which help was given between sessions one and ten (see Figure 2).

Figure 2

Similar results were found for the control group (see Figure 3).

Figure 3

The fall in the number of crashes from session one to session ten did not reach significance ( $Z = 1.16$ ,  $P < 0.25$ ) but there was a significant reduction in the percentage of session time in which help was received from sessions one to ten ( $t = 13.76$ ,  $df = 5$ ,  $p < 0.001$ ) (see Figure 4).

Figure 4

*Is there a difference between the Intervention and Control Groups in change from baseline to post-intervention on the two tests of decision making?*

For the Picture Guess Test both groups showed a reduction in the number of guesses before the correct guess from baseline to post intervention (see Table 2).

Table 2

However this reduction was only significant for the Intervention Group ( $Z = 2.21$ ,  $p < 0.03$ ). For the Intervention Group this was accompanied by an increase in the number of pieces turned over before a correct guess was made although this did not reach significance. None of the other changes in scores for either group were significant.

For the Picture Completion Test both Groups showed a reduction in the number of guesses before the correct guess from baseline to post intervention (see Table 3).

### Table 3

However this reduction was only significant for the Intervention Group ( $t = 6.74$ ,  $df = 4$ ,  $p < 0.003$ ). Although for both groups there was an increase in the number of sheets completed from baseline to post intervention, neither reached significance. None of the other changes in scores for either group were significant.

## DISCUSSION

This study was successful in setting an appropriate level of difficulty for the intervention task as all participants showed a steady increase in performance on Cheese Factory in terms of scores obtained and level of difficulty at which they were prepared to play. This was in spite of a decreasing amount of help from the researcher who sat alongside them. For the control group their increase in performance was not significant. This may have been partly due to the performance indicator chosen. In a previous study using this game, the outcome measure chosen was the number of effective switch presses (ie those presses that resulted in a successful clearance of the obstacle) as a proportion of number of switch presses made. This indicated the degree to which participants were pressing at a high rate

in the hope that by chance they would press the switch at the right time. It was hoped that this strategy would decrease as participants became more proficient at the game. A second explanation for the lack of significant improvement was that the level of difficulty of this game was too high. One participant never really seemed to grasp the principle of the game and showed no improvement over the ten sessions. This is one danger in including participants with a wide range of ability. Table 1 showed that although the two groups were matched, there was much variability in participants' BPVS scores.

However, even with the short intervention time, small sample size and non-standardised tests the intervention group showed a significant decrease in the number of guesses before guessing correctly from baseline on both tests. The control group showed no significant change. Fewer guesses implies they are being less impulsive and taking fewer risks (Rahman et al, 2001). Indeed, this explanation is supported by the fact that in the Picture Guess Test, at post-intervention, the intervention group were turning over more pieces before making a correct guess and are collecting and processing more information before making a guess. This measure decreased from baseline to post-intervention for the control group. Collecting insufficient evidence is a common feature of decision making deficits (Mavaddat et al, 2000; Rahman et al, 2001).

It is worth mentioning another of the changes that failed to reach significance. Time to guess correctly decreased for both groups in the Picture Guess Test. For the Intervention Group this occurred in spite of turning over more pieces of the picture and implies an increased ability to process information and to arrive at a conclusive decision faster. For the Picture Completion Test, it is difficult to conclude anything from this measure as both groups were completing more items at post-intervention testing. This would have involved

them completing much more difficult items and for this they may have needed more time to make a selection from the display.

With such a small sample and non-standardised outcomes it is dangerous to conclude too much from the results and to be too certain about the implications of the significant results. However, the study does provide valuable information from which future studies can be designed. Although a small sample size, all twelve participants completed all sessions indicating that the procedure was enjoyable to them and presented sufficient challenge to keep them interested (Gredler, 2003) but not too much to be discouraging. The tests used, while not standardised, were developed with the advice of several clinical psychologists who work in intellectual disability. The tests have face validity but now need repeat reliability and construct or criterion validity establishing. For the Picture Completion test, some easier levels should be introduced at the beginning as it was very challenging for some of the participants. Since the study was completed Van Leijenhorst, Westenberg and Crone (2008) have devised a simplified version of the Cambridge Gambling task: the Cake Gambling task and this may be appropriate for some of our more able users.

Although these challenges need to be overcome, this study supports the ever expanding body of research which shows that interactive computer software does have a role in benefiting people with intellectual disabilities (Standen & Brown 2004, 2006). In providing a safe environment in which to practice making their own decisions without fear of negative consequences (Cromby et al, 1996) it may help them to overcome barriers to decision making, giving them more confidence and opportunity to take charge of their lives.

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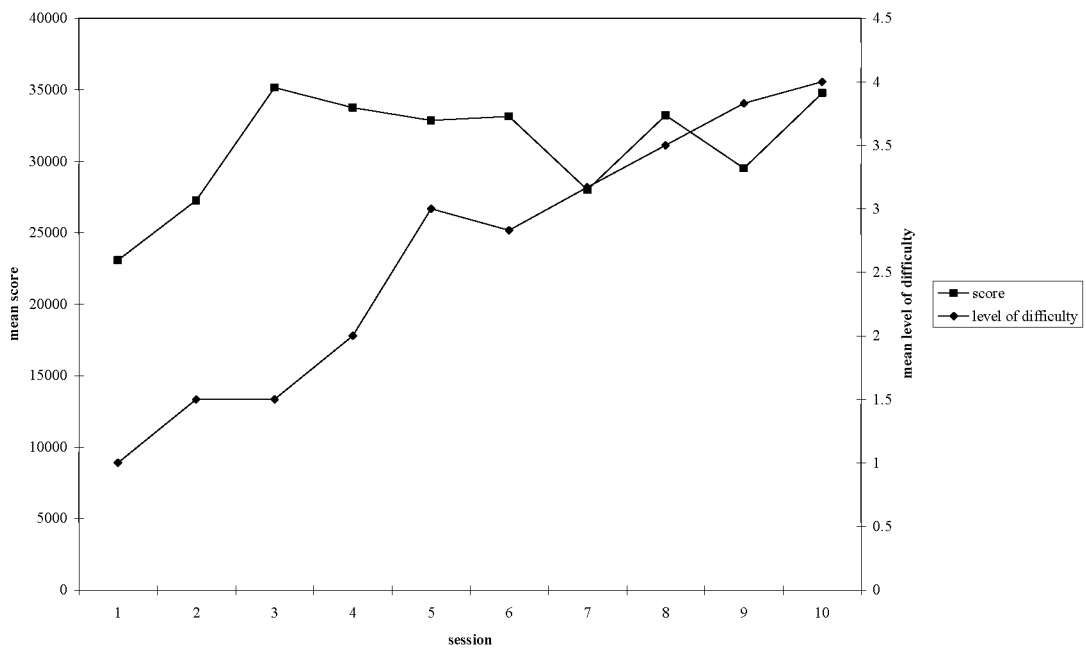
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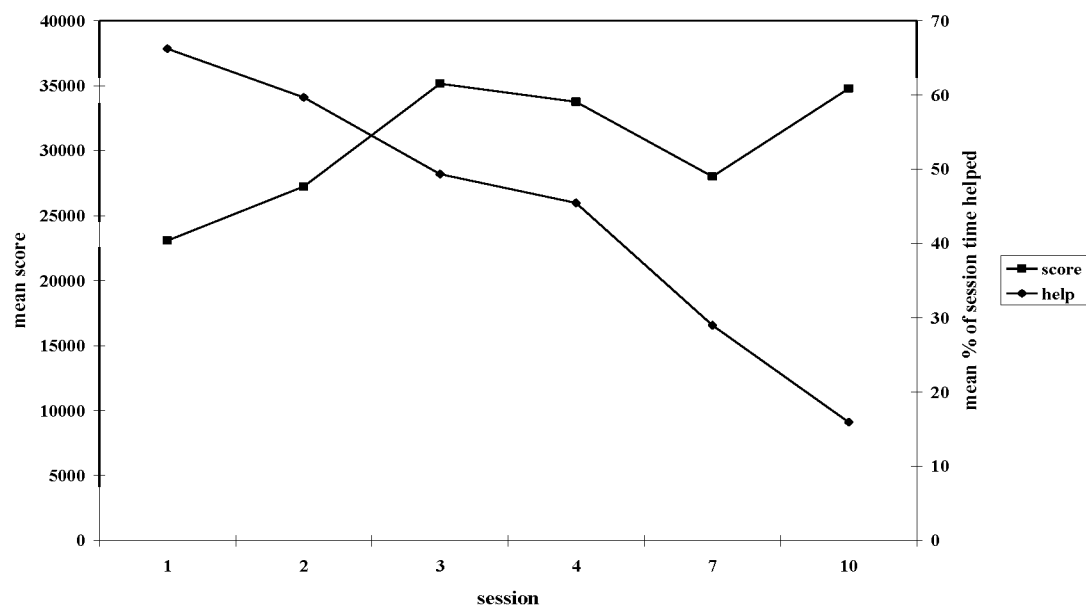
**Table 1** Characteristics of Participants

	Intervention Group N=6	Control Group N=6	All Participants N=12
Median Age in Years	33.5	42.0	41.25
Median Raw Score (BPVS)	57.0 (SD = 35.5)	59.3 (SD = 38.7)	58
Male:Female Ratio	3:3	5:1	8:4
Ethnicity	6 Caucasian	6Caucasian	12 Caucasian

**Figure 1.** Means score and level of difficulty in each session for the intervention group

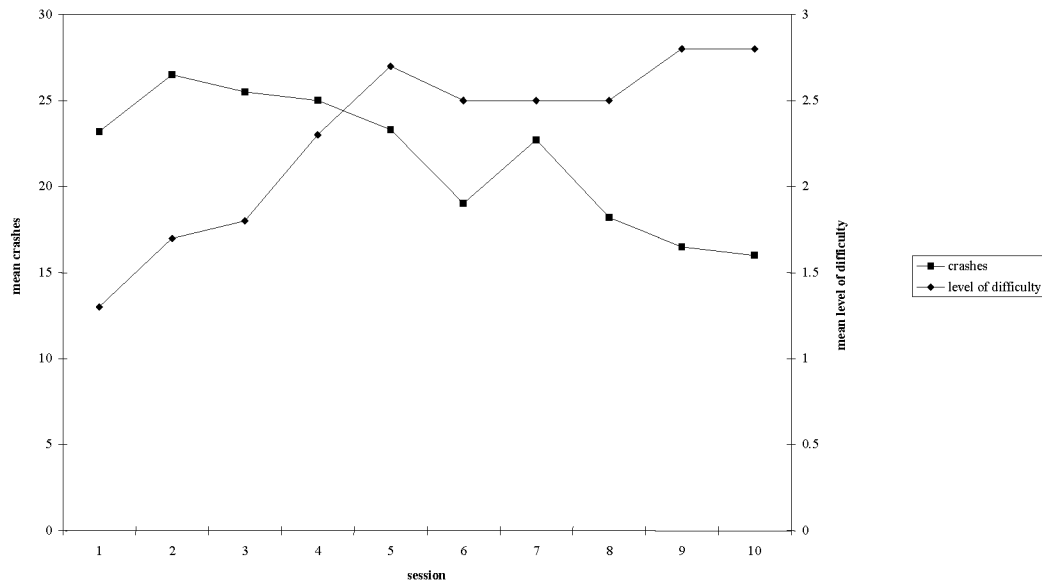


**Figure 2.** Mean percentage of time helped and score in each session for the intervention group

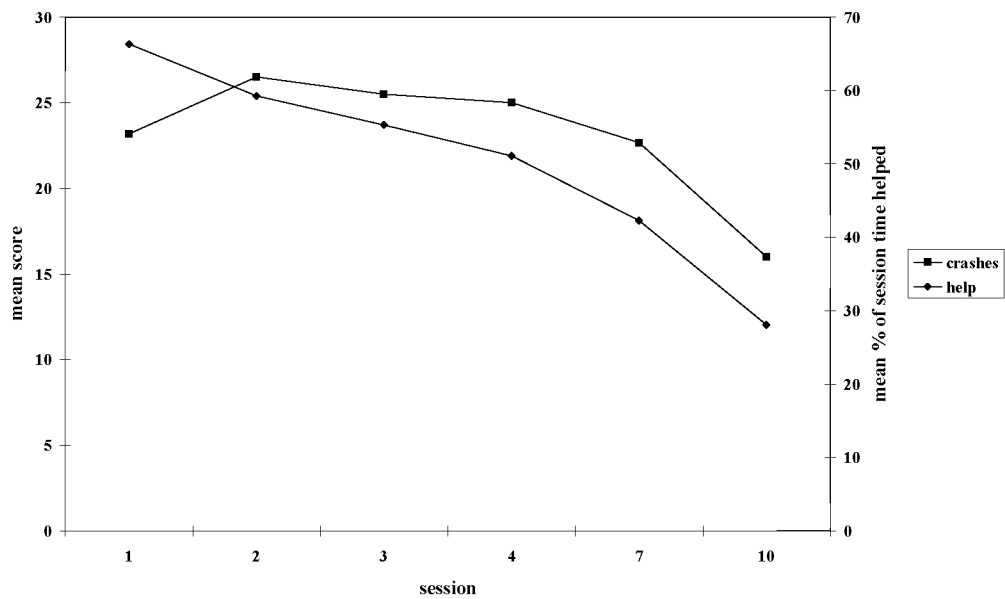




**Figure 3.** Mean number of crashes and level of difficulty in each session for the control group



**Figure 4.** Mean percentage of time helped and number of crashes by session for the Control group



**Table 2.** Picture Guess Test variables at baseline and post intervention

	Intervention Group(n=6)		Control Group (n=6)	
	Baseline	Post Intervention	Baseline	Post Intervention
<b>Median number of guesses (range)</b>	1.63 (1.25 - 2.25)	1.00 (1.0 - 1.25)	1.75 (1.5 – 4.0)	1.63 (1.0 – 3.0)
<b>Median number of pieces turned over (range)</b>	3.50 (1.75 - 3.75)	3.75 (2.75 - 5.75)	4.13 (2.0 - 8.5)	4.00 (1.25 - 6.25)
<b>Median time to guess correctly (range)</b>	25.00 (11.25 - 46.75)	23.38 (12.75 - 59.75)	32.88 (11.25 - 106.5)	27.63 (7.75 - 113.75)

**Table 3.** Picture Completion Test variables at baseline and post intervention

	Intervention Group(n=6)		Control Group (n=6)	
	Baseline	Post Intervention	Baseline	Post Intervention
<b>Median number of sheets completed (range)</b>	9.00 (0 -11.00)	10.00 (2.0 - 11.0)	4.50 (0 -11.00)	6.50 (1.0 - 10.00)
<b>Mean number of guesses (SD)</b>	2.60 (0.65)	1.87 (0.76)	2.35 (0.67)	2.00 (0.74)
<b>Median time to guess correctly (range)</b>	30.80 (13.45 - 50.33)	36.27 (23.0 - 45.91)	27.73 (17.0 - 115.00)	46.22 (23.56 - 97.75)