

An evaluation of the use of a switch controlled computer game in improving the choice reaction time of adults with intellectual disabilities

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ABSTRACT

The inability of people with intellectual disabilities to make choices may result from their lack of opportunities to practice this skill. Interactive software may provide these opportunities and software that requires a timed response may reduce choice reaction time. To test this, 16 people with severe intellectual disabilities were randomly allocated to either an intervention or a control group. The intervention group spent eight sessions playing a switch controlled computer game that required a timed response while the control group spent the same amount of time playing a computer based matching game that did not require a timed response. Both groups repeated a test of choice reaction time (CRT) that they had completed prior to the intervention. The intervention group made more accurate switch presses with repeated sessions while receiving less help from the tutor who sat alongside them. The intervention group also showed a significant reduction in their CRT from baseline while the control group did not.

1. INTRODUCTION

People with intellectual disabilities are amongst the most socially excluded and vulnerable groups in many countries and the intention of current policy (eg Department of Health, 2001) is to enable them to have as much choice and control as possible over their lives, be involved in their communities and to make a valued contribution to the world at work.

However, research suggests that they have difficulty making choices or decisions. For example, Jenkinson and Nelms (1994) found that they were less likely to produce responses that reflected a systematic evaluation of possible alternatives than were people without intellectual disabilities. Although the terms “decision” and “choice” making are quite often used interchangeably in the literature, Mincemoyer and Perkins (2003) describe choice making as selecting from among identified alternatives and only one component of decision making. Similarly, Jenkinson and Nelms (1994) state that being able to choose among options is a necessary prerequisite to decision-making and that decision making involves more than a simple expression of preferences. It involves an understanding of an issue, identification and informed evaluation of options, communications of a decision and commitment to action. Distinguishing the terms in this way is helpful and underlines the benefits that might follow from promoting choice making.

Two areas of research suggest that there may be potential for promoting the ability to make choices in people with intellectual disabilities. First, Cooper & Browder (2001) see their inability to make choices as resulting from a constant denial of choice. This leads to an inability to respond to stimuli in the community and as a result they may never acquire skills that enhance their independence. Research examining opportunities for choice making consistently identifies ability as a determinant (eg Stancliffe et al, 2000). However, reduced intellectual capacity need not necessarily lead to the inability to make choices as even people with severe and complex disabilities can express stable preferences when provided with choices (Lancioni et al, 1996). Cooper & Browder (2001) demonstrated how embedding choice opportunities in a trip to a fast food outlet can enhance choice making. They set out to increase the opportunities for choice making

in a group of eight people with severe intellectual disabilities with a staff training package. They trained staff to offer a series of two options (eg which of two doors through which to enter; two photos of food or drink options) when using fast food restaurants. Compared with baseline, the people with intellectual disabilities increased the number of choice responses they made both prompted and independent. They also required a much lower level of prompting to make these choices after the intervention.

The implications of this study are that carers of those with intellectual disabilities need to present them with options on as many occasions as possible. Options presented by carers in day to day activities may well be the most ecologically valid way of increasing the opportunities for making decisions. However, they are often pressed for time, wary of letting their charges take risks and may also find it difficult to suppress their natural inclination to take over before allowing the person sufficient prompts for them to perform the selection independently. The second area of research suggests that interactive computer software should be explored as a low risk means of supplementing these limited opportunities.

There is now an increasing body of work exploring the effects of interactive computer software on cognition. Green & Bavelier (2003) found that computer games requiring frequent switches of attention had a beneficial effect on visual attention that generalised to a different task in non-disabled young people. In a review of both the positive and negative effects of playing videogames, Griffiths (2004) describes the role of videogames in cognitive rehabilitation for example in perceptual disorders, conceptual thinking, attention, concentration and memory in patients with brain damage following stroke or trauma. Claims have also been made for the beneficial effects on cognitive skills of virtual environments (VE). Preliminary work suggests they have a role in improving memory (Rose et al, 1999) and attention (Rizzo et al, 2000) in those recovering from brain injury and other neurological disorders.

One easily measured aspect of choice making is reaction time. To investigate whether this improved after use of VE by people with severe intellectual disabilities, Standen & Ip (2002) devised two tests to measure choice reaction time at baseline and post intervention. The first consisted of 10 cards depicting a familiar object on one side that were shuffled and placed face down before the participant was asked to pick one depicting a particular object eg apple. Time taken to do each of 10 trials was recorded. The second task involved the participant choosing two items from each of 10 pictorial shopping lists displayed on a computer monitor. Again, time taken was recorded. To avoid habitual responses, on three trials, after the time for the second choice had been recorded, participants were told that one of the items was no longer available and they had to choose something else. Data from 9 individuals who had six sessions using virtual environments (the active group) indicated a significant ($p < 0.003$) reduction from baseline in their time to make a choice in the card game and the shopping list. Although there was some improvement when they were forced to make an alternative choice in the shopping list this reduction did not reach significance. A control group of 6 individuals who sat alongside a matched active partner during the intervention showed no improvement on all three measures.

Although these results are encouraging, the outcome measures for this study can be criticised. The shopping list task was computer based and any improvement on this task may have merely demonstrated increasing familiarity with using a computer. For the non-computer based outcome measure (the card game) timing was dependent on the reaction time of the research assistant who used a stopwatch to record time to make a choice. In addition, members of the control group were reluctant to continue with the study even though they were promised sessions using the VE after the study had finished. The current study was designed to avoid these drawbacks by using a non-computer based outcome measure with accurate electronic timing and by giving the control group a task to complete. In order to involve participants who had difficulty controlling the interfaces for the three dimensional VE, the intervention was a game that could be controlled by a switch. As a more disabled group was taking part the first aim of the study was to see whether they could learn to play the game. The second aim was to see whether repeated sessions playing the game resulted in a decrease in choice reaction time (CRT).

2. METHODS

2.1 Design

To test the first aim, for the intervention group the change over repeated sessions in the proportion of switch presses made that were made at the right time (correct switch presses) was compared with chance level. The proportion of correct switch presses was correlated with help received to determine whether switch pressing was made independently. To test the second aim, baseline CRT was compared with post intervention CRT in the intervention group and a matched control group.

2.2 Participants

24 people from a day centre for adults with intellectual disabilities were nominated by their specialist carers at the centre if they matched the inclusion criteria below:

1. Severe intellectual disabilities indicated by their scores on the Adaptive Behaviour Scale (ABS) (Nihira, Leyland and Lambert, 1993).
2. No visual impairment, which prevented viewing the screen
3. Sufficient motor and cognitive ability to operate a simple microswitch
4. No previous exposure to microswitches or similar software

Only 16 of those nominated could be included in the study as 8 were unable to react within the recording limit of 1750 milliseconds on a minimum of 5 of the 20 baseline choice reaction trials. The remaining participants were grouped into pairs matched in terms of their age, ABS score and mean baseline CRT and members of each pair were randomly allocated to either the intervention or the control group. Their characteristics are shown in Table 1. Although the mean CRT is longer for the control group this difference is not statistically significant.

Table 1. *Characteristics of participants.*

	Intervention Group n=8	Control Group n=8
Mean (SD) Age in Years	37.5 (15)	35.5 (8)
Mean (SD) ABS scores	37.1 (8.6)	37.0 (7.7)
Mean (SD) baseline CRT in milliseconds	1272.7 (247.3)	1352.9 (231.7)
Male: Female Ratio	5:3	4:4
Ethnicity	7 Caucasian:1 Asian	7 Caucasian:1 Asian

2.3 Interventions

The computer game was designed specifically for people with severe to profound intellectual disabilities by the fourth author. It involved a man jogging across the screen and encountering several obstacles such as a log or a large rock. A screen shot from the game is shown in Figure 1. The aim was to jump over these hurdles and to make it to the finish line when audio (a cheering sound) as well as visual (a rotating trophy) signals appeared as a reward. The man was made to jump by a single press of a 'jelly bean' microswitch which if made at the appropriate time would allow the man to clear the obstacle. However if the switch was continuously pressed, there was no observed effect within the game. The game recorded the number of switch presses that resulted in the running man clearing the obstacle and the total number of switch presses made.

The control task involved the participant trying to match pictures of familiar animals or objects from a series of cards to those displayed on a computer monitor. The participant sat in front of the monitor and ten cards faced down were placed on the table in front of her. On the other side of each card was a different picture depicting an object familiar to the participant (eg animals, food). When a picture appeared on the monitor the participant had to find the card with the matching picture. The rate at which the pictures appeared on the computer monitor was controlled by the researcher and a new picture only appeared once the participant had found the card with the matching picture.

2.4 Outcome measures

Choice reaction time. This device, designed by Piercy Adams Ltd. Cambridge, involved a series of 6 outer red LEDs as well as a central green LED, all of which were placed within a close proximity to their respective light sensitive diodes (see Figure 2). The device measured choice reaction time by assessing how quickly a user could shift his/her hand from the central green LED to the appropriate outer red LED which became illuminated at random. A new light was only illuminated once the participant had responded to the

previous one. However the timer would only record choice reaction times with a maximum duration of 1750 milliseconds and therefore any reaction time above this was not recorded but noted as the maximum.

Help received. All sessions with the intervention group were videotaped and analysed using OBSWIN (Oliver et al, 2000) to measure amount of tutor assistance (measured as an event variable). The definition of assistance given was taken from a methodology previously established by Standen et al (2002). It referred to any help given to the participant to carry out a correct switch press or to direct the participant's hand closer to the switch.



Figure 1. Screen shot from computer game.



Figure 2. The Piercy Adams Choice Reaction Timer.

2.5 Data collection

Data collection took place in the day centre attended by the participants. And all data collection was carried out by the same member of the research team (RK).

Measuring CRT Before baseline measures were recorded the test was demonstrated to the participant and a verbal explanation given if they could understand it. They were then encouraged to complete 20 trials and if they could manage at least 5 they went on to be included in the study. At post intervention, they received another demonstration from the researcher if it was required before being asked to complete another 20 trials.

The intervention Each participant spent 8, twice weekly sessions that lasted up to a maximum of 10 minutes but could be terminated earlier if the participant did not wish to continue.. This session length was kept the same for intervention and control participants of each matched pair. One of the research team (RK) sat alongside the participant to give them assistance and encouragement.

2.6 Analysis

As the upper limit for a reaction time was set at 1750 milliseconds, for each participant the median of their CRTs for each 20 trial block was calculated. As these values were normally distributed the comparison between their baseline and post intervention median CRT was made using a paired t-test. To take account of any variation in timer playing the game and a strategy of high levels of switch pressing, the number of correct switch presses from the computer game was converted to a proportion of the total number of switch presses made. All videotapes were analysed by the same researcher who had collected the data so in an attempt to minimise bias resulting from knowledge of how many sessions the participant had completed, the order of the tapes for analysis was scrambled. Video collected data were expressed as a percentage of session duration. Comparisons between first and last sessions for both correct switch presses and help received were made using a paired t-test. The relationship between these two variables was examined using Pearson's correlation coefficient. The comparison of the change in the proportion of correct switch presses with chance level was made using regression analysis.

3. RESULTS

3.1 Change in the proportion of accurate switch presses with increasing sessions

The proportions of accurate switch presses by the intervention group increased significantly ($p < 0.0001$) from first to last session. Regression analysis produced a significant ($p < 0.00003$) adjusted R squared value of 0.956 indicating that over 95% of the increase in proportion of accurate switch presses was explained by session number (i.e. increased exposure to the game). A beta value of 0.038 ($p < 0.00002$), indicates that with

each session, the proportion of accurate switch presses increases by approximately 0.038. Figure 3 shows the group means for each of the eight sessions.

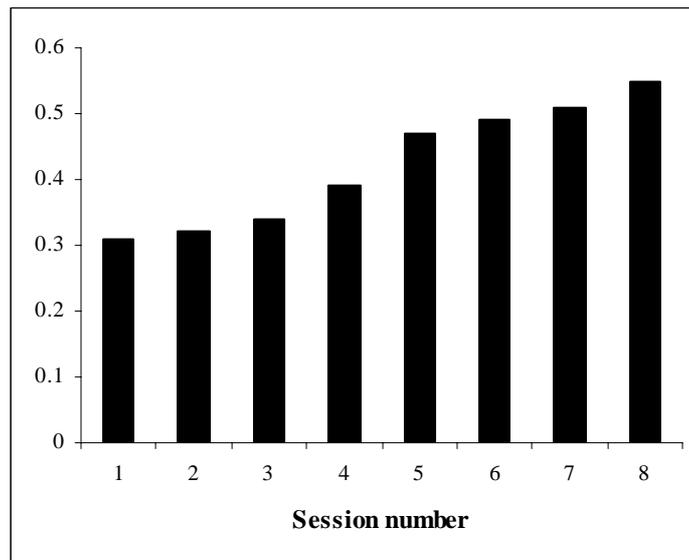


Figure 3. Mean proportions of accurate switch presses by session.

The increase in the proportion of accurate switch presses was not dependent on help from the tutor as the percentage of the session in which participants received help from the tutor decreased significantly ($p < 0.0002$) from sessions 1 to 8 and was significantly ($p < 0.00007$) negatively correlated with the proportion of accurate switch presses made increased. Figure 4 shows the group means for each of the eight sessions.

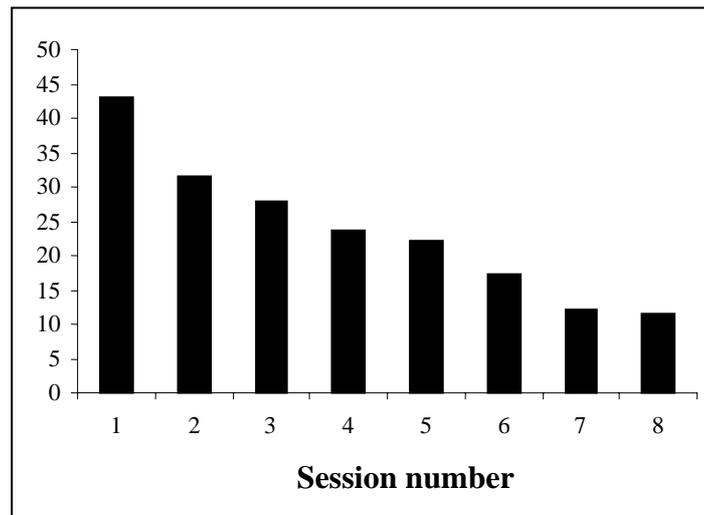


Figure 4. Mean percentage of sessions spent receiving physical assistance

3.2 Change in CRT from baseline to post intervention

Mean choice reaction times are shown in Table 2. The intervention group showed a significant ($p < 0.003$) decrease from baseline to post intervention in mean choice reaction time whereas the decrease observed in the control group failed to reach significance.

Table 2. Baseline and Post intervention mean Choice Reaction Times in milliseconds.

	Intervention Group		Control group	
	Baseline	Post intervention	Baseline	Post intervention
Mean CRT (msec) (SD)	1273 (247)	990 (170)	1353 (232)	1302 (229)

4. DISCUSSION

Even with the limited time playing the switch controlled game, the intervention group learnt how to play as evidenced by the increase in successful switch presses expressed as a proportion of the total number of switch presses. From this we can conclude that the design of the game matched their level of ability and that their interest and attention could be sustained over eight sessions. As with all of our research, someone sat alongside the participant and there is always the possibility that the researcher or tutor can cross the fine line between facilitating the participant's performance and controlling it. In initial sessions the participants will inevitably require high levels of help from the tutor but as they become more familiar with the game and more skilled the level of help from the tutor should diminish. The results indicate that this was happening so it can be concluded that the increasing proportions of correct switch pressing are evidence of learning or increased ability in the participant. For a group of people who may experience very low levels of stimulation or social interaction such an activity can have a range of benefits. According to Lancioni et al. (2001) who reviewed several studies on the use of microswitches "the establishment of successful responding may have immediate benefit in terms of increased alertness and positive interaction with the surrounding world".

The intention of this study was to explore whether any other benefits could be detected from the continued use of a switch in order to play a computer game. When compared to the control group who spent the same amount of time playing a game without a time limited response, the intervention group showed a significant decrease in choice reaction time after eight sessions playing the game and this in spite of small sample sizes. Both groups had equal lengths of time sitting in front of the computer screen and similar rates of tutor interaction, suggesting that the time pressured nature of the task faced by the intervention group was the influential element.

There are obvious limitations in this study in addition to the small sample size. The sample was also fairly carefully selected so that there was limited variation in their ability so these findings may not generalise to other groups. The participants only received a limited exposure time to the intervention and the equipment to measure CRT limited the type of participants we could involve. Although measures were taken to avoid researcher bias there is always the possibility that knowledge of which group the participant belonged to might have subtly influenced the encouragement given by the researcher when CRT was measured post intervention. Unlike non-disabled groups, these participants cannot be left alone in a separate room to minimise extraneous influence when using such equipment.

Even if these findings are robust and would be repeated with a larger sample size, questions still remain. Can we identify groups who would benefit from such an experience while others would not? Does improving CRT actually facilitate choice making as in the selection from options? Does this ability facilitate decision making as suggested by Jenkinson and Nelms (1994)? While using interactive software in the form of computer games may well improve alertness and responsiveness, the facilitation of the selection from among options or decision making may require more complex games or virtual environments. By depicting more complex every day situations such software might be used to facilitate other components of the decision making process such as the understanding of an issue and the identification and informed evaluation of options which Jenkinson and Nelms (1994) consider essential parts of the process. This software could also be used to depict situations in which participants can practice these skills.

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