Effects of Speed and Accuracy instructions on performance in a visual search task by children with good or poor attention.

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Abstract

Children rated by teachers as having good or poor attention ability carried out a visual search task in which they were required to find a series of targets in a complex display. Different groups were told to concentrate on either Speed or Accuracy. Previous studies using this task have consistently shown that children rated as having poor attention make more errors (false alarms to non-targets in the display) but do not differ in the time to make a correct response; this result was replicated. Though the instructions produced big differences in speed and error rates in the expected directions, these differences were similar in both attention groups and the differences in error rates between the two groups remained unchanged.

It is suggested that these findings are not compatible with the view that children with poor attention make errors primarily due to fast impulsive responding, nor with an explanation in terms of slower processing of the input by such children. An alternative explanation of the high error rates in such children is offered in terms of weak Executive Function resulting in poor ability to inhibit false alarms to non-targets.

Recent studies of children with poor attention, as rated by teachers, have consistently shown that these children make more errors (false alarms to non-targets) when searching for targets in a cluttered display on a computer screen than children rated as having good attention (Wilding, Munir and Cornish, 2001; Wilding, 2003; Cornish, Wilding and Hollis, 2006; Wilding and Burke, 2006). Thus they tend to respond by clicking the computer mouse on non-targets or background, or in some cases repeat responses on already located targets. However time taken for each correct response (and also for each error response) did not differ significantly between the two groups. Manly *et al* (2001) using the Skysearch task in the Test of Everyday Attention for Children (TEA-Ch) also found no difference in time between groups differing in attentional ability. In the above computerised visual search task the difference in error rate between groups was more reliable in more difficult versions of the search task, which required a difficult discrimination between targets and foils or alternation between two different targets. However children with poor attention showed no tendency to adjust their speed less appropriately than children with good attention on these more difficult tasks compared with the simpler ones (Cornish *et al*, 2005), and hence there was no indication that the increased difference in errors was due to more impulsive responding by these children in the more difficult conditions.

Impulsivity is a commonly accepted component of Attention Deficit Hyperactivity Disorder and it is frequently implied that in consequence children diagnosed with ADHD will make errors due to premature responding without adequate analysis of the stimulus situation. However the above results offer no support for this assumption in that the two groups did not differ in speed of responding but did differ in accuracy. Furthermore time and error rate were not correlated in these studies and these measures were related to different measures of individual differences (time was related to measures of general ability and accuracy to attentional ability; see Wilding, 2005, for a review). Even though the children in the poor attention group were not formally diagnosed with ADHD, the rating scale that was used incorporated standard criteria for this condition and included both attention and hyperactivity ratings, which were highly correlated in the samples tested. Though the studies of Wilding *et al* (2001), Wilding (2003) and Wilding and Burke (2006) did not select children with extreme impairments on the distribution of these ratings, Cornish *et al* (2006) compared children from the top and bottom 5% of the distribution on the rating scale they employed and obtained essentially the same results as in the other studies, so it is reasonable to conclude that the results are generalisable to children with a clinical degree of impairment in attention.

In fact the available evidence that children with high impulsivity make errors due to premature responding is not strong and there is no clear evidence that children with ADHD perform in this way. In many studies such children have been found to respond more *slowly* than children with good attention. Though there is more reliable evidence that such children are intolerant of requirements to delay responses, this may well depend on different mechanisms. Their response time is also more variable than that of children with good attention (Kuntsi, Oosterlaan & Stevenson, 2001).

In a complex study, Sergeant and Scholten (1985) tested three groups (with only eight participants in each group), overactive and distractible, normally active and distractible, and normally active and attentive (in more widely used terminology these equate to groups with Attention Deficit Disorder with Hyperactivity, Attention Deficit Disorder without Hyperactivity and a control group). There were three instruction/incentive conditions given to each group: no instructions always given first, speed instructions and accuracy instructions, given in a balanced order. Displays were presented consisting of two, three or four letters and a decision was required as to whether a target letter was or was not present. Analyses were carried out on response times only. Errors varied appropriately between conditions and did not differ significantly between groups.

Though the precise implications of the complex pattern of findings that the authors report are unclear, they certainly did not demonstrate fast inaccurate responding as the main source of poor performance in the overactive-distractible group. This group demonstrated no inclination to perform quickly in the speed condition (cf Stevens *et al*, 1967, Stevens, Stover and Backus, 1970), suggesting some problem in control systems (presumably in the frontal lobes) responsible for adjusting response strategies to match task requirements. Furthermore, examination of error rates at different response times showed that, while both the distractible and control groups showed a very pronounced trade-off of speed for accuracy, there was almost no sign of such a trend in the overactive-distractible group, who produced almost as many errors on slower responses as on faster ones. This demonstrates that many errors in this group were not due to impulsive responding.

Van der Meere, Gunning and Stemerdink (1996), using a similar scanning task, presented one or two targets followed by a display of four items. The probability of a target occurring in the display was 0.5 or 0.25 in different conditions. There were no differences in scanning speed between the ADHD and control groups (indexed by the slope of response time against memory load), nor any differences in the effects of target probability on speed or errors. The ADHD groups were slower and less accurate overall, but the authors concluded that inefficiency in these groups was not due to inefficient processing or favouring speed against accuracy (i.e. impulsive responding) or poor ability to switch set when the less frequent response was required in the condition with low target probability. They suggested that the differences were due to delayed motor processing, but do not elaborate on this proposal nor suggest why such a delay would produce more errors

Leung and Connolly (1997) compared a hyperactive group with a hyperactive plus conduct-disordered, a conduct-disordered and a control group on a priming task and a task requiring delayed responses. When no delay in responding was required there were no differences between the three clinical groups, but when delay was required the hyperactive group had difficulty in withholding responses.

Sonuga-Barke has also found in a number of studies that children with ADHD are impaired when a task requires response delay or there are delays between stimuli (see Sonuga-Barke, 2002, for a discussion of possible explanations).

Thus the available studies do not support the view that children with ADHD sacrifice accuracy for speed. There is some indication that they may be less efficient in varying the trade-off between speed and accuracy to match task demands and there is evidence that they find it difficult to delay responding once the input has been processed and identified. Both these findings are consonant with the view that ADHD is a disorder of some control functions rather than of selective operations in stimulus processing. This suggestion will be elaborated later.

Some other studies have looked, not at ADHD groups, but at the difference between adults categorised as high or low on the personality dimension of impulsivity as measured by the Eysenck Personality Inventory. Dickman and Meyer (1988) used a task of deciding whether complex figures were the same or different, varying the monetary pay-off for speed v. accuracy in different conditions. High impulsives were consistently faster and less accurate than medium and low impulsives, but were actually more accurate than the other groups in the fastest speed condition. In a further experiment Dickman and Meyer varied the difficulty of the comparison and the complexity of the response (one or two keys) and found the former factor interacted with impulsivity and the latter did not. They suggested that high impulsives tended to make a global judgment while low impulsives were more likely to make a detailed comparison of figure elements. However Exposito and Andres Pueyo (1997) varied the same two factors and derived the opposite conclusion on which stage was affected by impulsivity, as did Orlebeke *et al* (1990). But these last two experiments did not agree with each other on which group was more affected by response complexity. Thus these studies produced no consistency on either the direction or nature of the effect of impulsivity on reaction time and accuracy.

The above studies on speed-accuracy trade-off all used the common method in visual search of presenting displays one at a time for a decision on whether or not a target was present. Wilding (2005) has argued that in the case of visual search there may be important differences between single-frame visual search of this type and continuous visual search where the participant has to search a display for a series of targets; letter cancellation is one form of this, with a structured display, and also the Skysearch task from the TEA-Ch battery (Manly *et al*, 2001), while the Wilding visual search task and the Mapsearch task from the TEA-Ch battery employ unstructured displays. Wilding suggests that in continuous search tasks there are more demands on Executive (control) Functions (EF), particularly when the task is made difficult in the ways that have been shown to produce the most reliable differences between good and poor attention children. These more complex tasks may evoke differences in strategy, including speed-accuracy trade-off, more reliably than single-frame tasks, where the simpler single decision required for each display may minimise such differences, and therefore may discriminate better between groups with good and poor attention.

As indicated already, no differences in speed have emerged between good and poor attention groups in the studies using continuous visual search, but only differences in error rates. This suggests that impulsive premature responding is not the main source of the increased errors in children with poor attention. It is, however, possible that the poor attention groups may have slower processing systems, but fail to adjust their response time to take account of this in order to match the accuracy of the good attention groups. Thus they would be performing at a faster than optimal speed, given the relative inefficiency of their processing systems. If this were the case, then an instruction to perform the task as quickly as possible would have a smaller effect on this group than on the good attention group, both on time and on error rate; the good attention group would therefore reduce their times more than the poor attention group and the group difference in errors would be eliminated or at least reduced. The result of Sergeant and Scholten described above offers some support to this prediction, in that their overactive-distractible group did not modify their response times at all under the speed instruction, while the control group did.

Predictions on the effect of an accuracy instruction depend on assumptions about the ability of the poor attention group to adjust speed in response to this instruction. If they find such an adjustment difficult, we would anticipate little or no increase in time and little or no reduction in errors in this group. Superior ability to adjust in the good attention group would then produce a time difference between groups (with the good attention group being slower) and an increased difference in error rates (with the good attention group showing greater superiority than when fast responding is required). Alternatively, if both groups are sensitive to the instructions, group differences in error rates might be reduced because the poor attention group has more scope for reducing errors by slowing down.

What if poor attention involves less efficient processing of the input rather than impulsive responding, so that more time is needed to analyse the input adequately? Making the reasonable assumptions that the probability of a correct response is a negatively accelerated function of processing time and the rate of improvement is faster in the good attention group, we would predict that the difference in accuracy between the two groups would increase with time (until performance ceases to improve with further increases in time). Hence the difference should be greater under accuracy instructions than under speed instructions.

There are therefore several possibilities and it was decided to test the effects on the continuous visual search task of instructions either to perform the task as quickly as possible or as accurately as possible.

Method

Participants

Four schools were asked to select about 12 pairs of children in the 8 to 10 year age range, one with good attention in the classroom and one with poor attention. Pairs should be of the same sex and approximate age and also of similar general ability.

Subsequently children were rated by teachers on the SWAN ADHD scale (see below) to provide a more reliable measure of attentional ability. 97 children were tested but SWAN scores were not obtained for four of these, leaving 93 who provided complete data (52 males and 41 females). Children were assigned to the good or poor attention group on the basis of a median split of the SWAN scores and were assigned alternately to Speed and Accuracy instructions. Table 1 gives the number of males and females in each of the four subgroups, together with details of Chronological Age (CA) and SWAN score.

[Table 1 about here]

Design

A mixed Design was employed, with two Between-Subjects factors (Attention group with Good and Poor levels and Instructions with Speed and Accuracy levels) and one Within-Subjects factor (Task with 4 levels). Analyses of covariance were carried out with two Between Subjects factors and one Within Subjects factor, as above, and CA and Verbal Mental Age (VMA) were used as covariates.

Materials

The SWAN ADHD Scale

The SWAN scale (Swanson, McStephen, Hay & Levy, 2001) includes 18 symptoms incorporated in the DSM-IV ADHD diagnostic criteria (American Psychiatric Association, 1994). The 18 SWAN items are divided into two sub-sets each of 9 items corresponding to the domains of Inattention (items 0-9) and Hyperactivity/Impulsivity (items 10-18). Only the attention items were used in the present study; Cornish *et al* (2006) obtained a correlation of 0.92 so the two scales measure essentially the same variable. The SWAN uses a 7-point scale anchored to average behaviour for each item in the population being rated (Far above average = -3 to Far below average = 3). Total scores thus range from –27 to 27 for each sub-scale, with high scores indicating problematical behaviour.

Verbal Mental Age

The British Picture Vocabulary Scale (BPVS) Short Form (Dunn, Dunn, Whetton and Pintillie, 1982) was also administered. This requires the child to select from 4 pictures the one which matches a spoken word. VMA was calculated from the raw scores.

Visual search task

The four variants of the search task have already been described by Wilding (2003), the easy single target search task (two versions with different targets), the difficult single target search task and the dual target search task. In brief, participants saw on a computer screen a display consisting of a river and trees on a green background, with "holes" of different shapes and colours. They were told that monsters were hiding in some of the holes (e.g. upright black ellipses) and asked to click with the computer mouse on these holes to search for the king of the monsters. Small monster faces appeared when a hole was clicked on and in fact the king (a larger head with a crown) only appeared when the twentieth target was located. If 50 clicks were made without finding 20 targets, the king appeared and the program terminated.

In the easy single target search task 25 targets were present among 100 shapes in all. In one version the target was a vertical black ellipse (Easy Single Target A) among foils consisting of black and brown circles and ellipses, both vertical and horizontal, and in another version it was a horizontal brown ellipse in the same display (Easy Single Target B). In the difficult single target search task (Difficult Single Target) 40 additional foils were added. These were horizontal brown ellipses similar in shape to the targets in Easy Single Target B; the latter had a horizontal to vertical ratio of 3:2 and the additional foils had a horizontal to vertical ratio of 2:1, maintaining the same horizontal size. In the dual target search task (Dual Target Alternating) participants were required to click first on a black vertical ellipse then on a brown horizontal ellipse and so on (only the easier brown ellipse was present). The time taken per target found (hit), removing time occupied in false alarms, was calculated, and the number of errors (false alarms to non-targets or background).

Procedure

Teachers rated the participating children on the SWAN scale at a convenient time. Children were tested in a quiet area on a laptop computer. The BPVS was given first then the computerised attention tasks.

After checking that all children had experience of using a computer mouse (all did have such experience) children carried out the visual search tasks as follows: Easy Single Target search (first with Target A then Target B), then the Dual Target Alternating task and finally the Difficult Single Target task. This order was used in all cases since it was found previously that children given the Difficult Single Target task before the Dual Target Alternating task sometimes thought that the more difficult horizontal brown ellipses were still present in the latter task. Each task was preceded by a demonstration and practice until it was clear that the task was understood. The children were instructed that they had to find the king monster by clicking on holes of the specified shape until he showed his face. They were told that most of the holes had small monsters in them, but they should continue till they found the king. For the Dual Target Alternating task they were shown that they must first click on a black vertical ellipse then a brown horizontal ellipse and so on until they found the king.

Children given Speed instructions were told, “I want you to try and find the king as quickly as you can. Make a big effort to go fast.” Children given Accuracy instructions were told, “I want you to try and be as careful as you can, and make as few mistakes as possible. Make a big effort to look only in the right kind of holes.” Instructions were repeated before each version of the task, all versions being run with the same instructions for a given child.

Results

The SWAN ratings had an overall mean of 1.35 (s.d. 12.30), close to the expected mean of zero. The children were split at the median into a poor attention and a good attention group, each subdivided into those given Speed instructions and those given Accuracy instructions. Preliminary analysis was carried out testing for sex differences. Boys made more errors than girls (6.47 per run compared with 3.98 for girls, $p < 0.05$) but including this variable did not alter the pattern of results and sex did not interact with any other variable. Therefore the analyses to be presented did not include this variable.

Analyses of covariance were carried out on mean time per hit with error time removed and on the number of errors (transformed logarithmically, after adding one to avoid cases of log zero, because the error distributions were heavily skewed positively). CA and VMA were employed as covariates, even though the groups did not differ significantly on either variable, because previous studies have demonstrated interesting and significant relations between these measures and the dependent variables. Means for time per hit and errors are shown in Table 2 and results of the analyses for the Attention and Instruction factors and the covariates are shown in Table 3.

[Tables 2 and 3 about here]

We first consider task differences. The analysis of time per hit demonstrated a significant interaction of Task X Instruction ($F(3,85) = 4.87$, $p = 0.004$, eta squared = 0.05, using the Greenhouse-Geisser correction). Differences due to instructions were greater on the tasks with Easy Single Target A, the first task attempted and the Difficult Single Target, the most difficult of the four tasks. The same interaction approached significance in the case of errors, as did that between Task and Attention Group. Errors with the Difficult Single Target were more sensitive to the instructions and the difference between the two attention groups was also largest for this task, sizeable with the Dual Target Alternating task and small for the two Easy Single Target tasks; $F(3,85)$ values from the analysis of errors were 2.43 for Task X Instruction and 2.33 for Task X Attention Group ($p = 0.07$ and $p = 0.08$ respectively, with eta squared 0.03 in both cases, using the Greenhouse-Geisser correction). There was no indication that groups responded differently to the instructions in only the harder tasks (F for the triple interaction was 0.99).

Turning now to the results of principal interest shown in Table 2, we first note that the instructions were generally highly effective in varying time and errors. There is only one reversal in the pattern of increased time and accuracy under Accuracy instructions, for Easy Single Target A errors in the Poor Attention group, where errors under the Speed instruction were atypically low. Secondly, as found in earlier studies (Wilding, 2003; Cornish *et al*, 2006, Wilding & Burke, 2006), the two Attention Groups did not differ in speed ($F < 1$) but differed in accuracy ($F = 5.69$, $p = 0.02$, eta squared = 0.06). Thirdly the effects of Instructions were no different in the two Attention Groups. The Poor Attention group varied their speed to the same degree as the Good Attention group and reduced errors by the same absolute amount between the Speed and the Accuracy instructions. Hence their error rates remained higher by the same amount in both instruction conditions (F values for the interactions of Attention Group and Instruction Group were well below 1 for both time and errors).

There were marginally significant relations between both CA and VMA and time (p = 0.04 and eta squared = 0.05 in both cases), but not between these two variables and errors, in line with previous findings.

A comprehensive analysis of times for errors was not feasible because in the Accuracy conditions large numbers of participants made no errors in Tasks 1 and 2, (and to some extent in Task 6). Hence correct and error times were examined for the Difficult Single Target task for those participants who made at least one error in this task (n = 89). Means are shown in Table 4, but there were extreme outliers in some cases, as indicated by the high standard deviations. Therefore a logarithmic transformation was employed before the Analysis of Covariance which showed that only the effect of Instructions was significant ($F(1, 83) = 29.31$, $p < 0.001$, eta squared = 0.26). There were no traces of significant effects of Attention Group or significant interactions of this variable with Instruction or Response Type (correct/incorrect) (for Attention Group $F(1,83) = 1.64$ and for the interactions $F < 1$ in both cases).

[Table 4 about here]

Discussion

The results have extended previous findings using the computerised visual search task which demonstrated that groups differing in attentional ability as rated by teachers show no differences in speed of visual search in this task, but do show a difference in error rate, especially in the more difficult versions of the task (the interaction of Attention Group and Task in the analysis of errors only approached significance with p = 0.08, but was consistent with the results of Wilding, 2003). The previous results were therefore replicated in the current study when closer control was exerted over speed-accuracy trade-off, as opposed to the neutral instructions employed in previous studies.

The pattern of relations between CA and VMA and the search performance measures is similar to that found in previous studies, with these variables being related to time, but not to accuracy.

However the findings clearly do not match any of the possible predictions made earlier and are in agreement with the overall picture from earlier studies indicating that poor performance in this task by children with poor attention is not in general due to fast and inaccurate responding. In the present study, when both groups were forced to respond as quickly as possible, both achieved similar mean times that were significantly faster than those produced when they were asked to concentrate on accuracy, but the error rate in the Good Attention group remained below that of the Poor Attention group. This confirmed the previous findings that, even when the groups did not differ in speed under neutral instructions, the latter group performed less accurately. Likewise the Poor Attention group increased time in the Accuracy condition by the same amount as the Good Attention group, but this did not reduce the difference in error rate between the two groups. Nor indeed, was there any significant indication that increased response time was more beneficial to the Good Attention group, as might be predicted if their stimulus processing mechanisms were more efficient. The interaction effects between Attention group and Instruction group were all very small.

The results therefore demonstrate that input processing resulting in a correct response proceeds at a similar rate in both Attention groups and that the time criteria for response can be modified according to instructions in a similar way by both groups. This finding is similar to that of Van de Meere *et al* (1996) but differs from that of Sergeant and Scholten (1985), who found that an overactive and distractible group failed to modify their speed in response to speed instructions, maintaining the same mean time in this condition (though increasing error rate) as in a condition with neutral instructions. The reason for the latter difference is unclear, but it can be argued that the computerised visual search task is less artificial and offers more scope for adapting strategy to match the instruction.

The limited analysis of times for errors showed no significant differences between correct and incorrect response or between groups. Cornish *et al* (2005) did find that errors were faster than correct responses in the visual search task, but this was with neutral instructions so does not conflict with the current finding.

How then can the difference in error rates be explained? Van der Meere *et al* (1996) attributed the slower responding and greater error rate in ADHD groups in their study to delayed motor processing, but it is unclear how this could explain greater error rates. In the present study responding was not slower in the poor attention groups but was less accurate and we suggest an explanation which has some relation to that of van der Meere *et al* but is more specific. Following instructions, respondents have to set up a “plan” linking a specified input to a specified response, and inhibiting this response when other inputs are detected. Executive Function in the frontal lobes of the brain, Posner's anterior attention system (Posner & Petersen, 1990), is generally accepted as the site of such planning functions, which passes them to the posterior attention systems responsible for implementing input selection and processing and response initiation. There is evidence that the anterior executive systems are impaired in children with Attention Deficit Hyperactivity Disorder (ADHD, e.g. Pennington & Ozonoff, 1996) and hence they are likely to be weak in the group rated as having poor attention in the current study (which used a rating scale using the same criteria as are used to diagnose ADHD). Barkley (1997) has argued for a weakness in inhibitory functioning in ADHD, a key component of EF. Thus a plausible explanation of the greater frequency of errors in children with poor attention in the visual search tasks is that their ability to inhibit responses to foils in the display is impaired. Their errors are not primarily due to impulsive responding (in the sense of premature fast responses), nor to slow stimulus processing, but result from failures to inhibit responses to non-targets. Whether this results from faulty signals from the stimulus analysis process to the response selection system (i.e. target signals forwarded even when processing a foil), or from faulty linkage between a correct stimulus identification and response selection, or from weak inhibitory interactions (and hence more cross-talk) between response alternatives, cannot be decided on the basis of current evidence, but the latter possibility is perhaps the most plausible consequence of poor inhibitory control resulting from impairment of the anterior attention system.

A further question is whether, if foils can evoke erroneous target responses, do targets frequently evoke non-target responses when these impairments are present? It is not possible to identify the occurrence of these misses in this type of visual search task; even if moves close to targets were recorded, we could not be sure that any processing of the target was taking place. However, if targets were processed and rejected, we would expect a greater number of mouse moves for each response made (both hits and errors). This measure was available in the present data and showed no indication of a difference between groups (the poor attention groups made more mouse moves in total, but this was due to the greater number of errors). This further strengthens the case for attributing the greater incidence of errors in poor attention groups as due to poor ability to inhibit false alarms to foils, rather than inaccurate information extraction during stimulus processing or inaccurate forwarding of stimulus identification to response selection systems. The latter possibilities would imply that false alarms and misses should both occur, whereas inhibition operates to suppress responses to the wrong stimulus, and the latter is the characteristic feature of performance by poor attention children in the visual search task used in the studies reported here and previously.

Consequently we suggest that the hypothesis most compatible with the obtained pattern of results is that children with overall poor attention, as rated by teachers, have a weakness in inhibitory control of responses to inappropriate stimuli, probably due to impairment of executive control systems in the frontal lobes of the brain. This is not a complete explanation of attentional impairment. The frontal lobes are complex structures controlling many functions and impairment in this area is likely to involve more than one function, and the functions affected may differ between individuals. However weak inhibition of this kind has the potential to explain several features of ADHD, the most extreme form of developmental attentional impairment, such as distractibility, impulsive speech, difficulty in working alone and following sequences of instructions. As indicated above, there are several possible ways in which such an impairment might arise and dissecting these possibilities will require careful targeted research.

Meanwhile the results have some implications for methods of remediation for attentional weaknesses. If the above interpretation is correct, simply encouraging the child to “slow down and think” before responding may well have a delaying effect on responding, but is unlikely to reduce inappropriate responses. Remedial strategies need to focus on reducing responses to inappropriate stimuli; simply slowing the child down will not achieve this, without developing some method for encouraging second thoughts. This assumes that the effectiveness of inhibiting inappropriate responses fluctuates and initial failure in response selection may, at least sometimes, be counteracted through further processing. Of course this also runs the risk of an initially correct response being replaced by an error, and further examination of such remedial possibilities will be necessary to investigate their effectiveness.

In addition there are a number of other ways in which these findings might be extended. The present study employed independent groups in the speed and accuracy conditions, since it was felt that using a repeated-measures design in which the children performed under both speed and accuracy instructions might add a further complication if good and poor attention children have differential ability to change strategy. However it would be of interest to employ the latter type of design with a view to plotting Speed-Accuracy trade-off curves for the different levels of attentional ability. Another possible development would be to investigate the effects of speed and accuracy instructions in younger groups, using the simpler version of the search task employed by Wilding and Burke (2006).

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Table 1. Numbers of males and females in each group, with details of Chronological Age and SWAN scores.

	Number of males and females	Mean Chronological Age, s.d. and Range	Mean SWAN rating, s.d. and Range
Good attention: Speed	11 + 11	109.18 (5.17) 95 to 119	-9.95 (8.13) -27 to 1
Good attention: Accuracy	12 + 11	110.61 (7.81) 95 to 126	-8.13 (7.18) -24 to 0
Poor attention: Speed	13 + 8	111.10 (5.78) 103 to 126	10.14 (5.73) 2 to 23
Poor attention: Accuracy:	16 + 11	112.04 (6.72) 101 to 125	11.81 (7.04) 2 to 25

Table 2. Means for each group for Verbal Mental Age, mean time per hit excluding time on errors, and number of Errors in the four visual search tasks.

	Verbal Mental Age	Task							
		Easy Single Target A		Easy Single Target B		Difficult Single Target		Dual Target Alternating	
		Time per hit	Number of Errors	Time per hit	Number of Errors	Time per hit	Number of Errors	Time per hit	Number of Errors
Good attention: Speed	95.82 (21.82)	2.34 (0.69)	2.36 (6.49)	2.00 (0.51)	2.55 (4.30)	2.65 (0.72)	11.14 (10.10)	3.18 (0.82)	4.55 (7.27)
Good attention: Accuracy	101.13 (25.02)	3.22 (0.74)	1.17 (1.90)	2.58 (0.59)	1.00 (1.51)	3.98 (1.33)	6.30 (7.86)	3.70 (1.13)	4.09 (10.20)
Poor attention: Speed	95.71 (26.38)	2.09 (0.57)	1.62 (2.29)	1.99 (0.31)	4.14 (5.92)	2.50 (0.76)	17.10 (11.70)	3.10 (0.70)	9.24 (10.38)
Poor attention: Accuracy	92.22 (16.61)	3.32 (1.21)	2.85 (6.93)	2.70 (0.70)	1.15 (2.33)	3.69 (1.04)	11.89 (10.18)	3.94 (1.19)	5.30 (6.80)

Table 3. Results of Analyses of Covariance on the mean times per hit and the number of Errors, showing effects of Chronological Age, Verbal Mental Age, Attention Group and Instruction Group.

	Chronological Age		Verbal Mental Age		Attention Group		Instruction Group		Attention Group X Instruction Group	
	F	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Time per hit	4.25	0.04	4.36	0.04	0.06	NS	48.30	0.001	0.13	NS
Log. Errors	0.31	NS	3.09	NS	5.69	0.02	10.69	0.002	0.04	NS

Table 4. Mean times for correct responses and errors for the Difficult Single Target search task for the different groups.

	Correct responses	Errors
Good attention: Speed	2.65 (0.72)	3.30 (2.67)
Good attention: Accuracy	3.92 (1.38)	5.62 (4.94)
Poor attention: Speed	2.49 (0.80)	2.22 (0.77)
Poor attention: Accuracy	3.71 (1.05)	4.50 (2.79)