Independence of speed and accuracy in visual search: evidence for separate mechanisms

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Running head: Speed and accuracy in visual search

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Abstract

Data from two studies that tested children's attention using visual search for a series of targets in a complex display and a sustained attention task waiting for signals in a similar display were subjected to Factor Analysis to explore previous indications that speed and accuracy (the number of false alarms to non-targets) on this task reflect different mechanisms. The two factors identified confirmed the separation of these two measures and also suggested that the speed factor was related to Mental Age, while the accuracy factor was related to ratings of attentional ability. It is suggested that ratings of attentional ability reflect the efficiency of Executive Functions, displayed in the ability to inhibit responses to non-targets in these tasks, while speed of search is related to processing speed in the nervous system. Therefore Intelligence and Attentional Ability depend on different underlying features of the nervous system.

There is a long tradition in psychology of distinguishing different varieties of attention, such as selective attention, divided attention and sustained attention, plus a system of attentional control (for example Parasuraman, 1998; Shapiro *et al*, 1998, Manly *et al*, 2001). However, such distinctions are not strongly based on empirical evidence and no consistent divisions of this nature have emerged from attempts to analyse different varieties of attention (e.g. Posner & Petersen, 1990; Mirsky, 1996; Shapiro *et al*, 1998). Meanwhile other research has begun to identify more detailed component *processes* of specific attention tasks (such as Posner and Petersen's, 1990, disengage, move and engage components that were derived from a spatial orienting task) and to draw distinctions such as that between exogenously controlled and endogenously controlled attention (Jonides, 1980, 1981). Such approaches may be more profitable in understanding the functioning of the whole attention system than attempts to group tasks according to the variety of attention that they are assumed to involve.

In an attempt to identify distinct varieties of attention, Wilding, Munir and Cornish (2001) administered several tasks to children that are traditionally employed to make such distinctions. They found that groups differing in attentional ability, as rated by teachers, differed significantly in performance on a number of these tasks. They carried out Principal Components Analysis (PCA) on each task in turn, using several measures taken from the tasks, and extracted a single component in each case. A representative measure from each task was then used in a further PCA to test whether the tasks could be partitioned into distinct groups as tests of different aspects of attention, such as those suggested above. Two components emerged, one of which was related to attentional ability as rated by the children's teachers, but the precise nature of these components was unclear.

However, subsequent research (Wilding, 2003, Cornish, Wilding & Hollis, 2006) has shown that the measures taken from some of the above tasks need to be modified. The original study included versions of a visual search task in which the children searched a complex computer display showing a scene with a river, trees and "holes" of different shapes and colours. Children were told that monsters were hiding in one type of hole (e.g. vertical black ellipses) and they could find them by clicking with the mouse on these holes. They were to try and find the king monster, who was in one of the holes. Hits were indicated by the appearance of a small monster and when the twentieth target was found (or 50 clicks were made in all) a larger monster appeared to indicate that the task had been completed. In the original study, time per target found, distance travelled between targets and the number of false alarms made on non-targets or background were recorded, and all these measures differed significantly between children with good attentional ability, as rated by teachers, and those with poor attentional ability. However the measure of mean time per target found included time spent in making false alarms by clicking on non-targets (the same was true of the measure of mean distance travelled between targets, but this measure has not subsequently proved useful and will not be considered further here). When the contribution of errors was removed, time per target (and distance) no longer differed significantly between the two groups in any of these studies, while the number of false alarms continued to differentiate the groups.

Furthermore Cornish *et al* (2006) have provided evidence that speed and false alarms on this task depend on different mechanisms. They found that time was significantly related to IQ, while the number of false alarms was significantly related to attentional ability. Chronological Age (CA) was significantly related to both dependent measures. These findings suggest that it may be profitable to tease out the component processes of these tasks, as well as (or instead of) attempting to identify differences in the attentional demands of different tasks. Such a strategy would be similar to that adopted by Posner, using the spatial orienting task referred to above.

As is apparent from the above discussion, the conclusion of Wilding *et al* (2001) that the different measures from the visual search tasks (time, distance, errors) reflected a single performance component was almost certainly due to the contribution of errors to all three scores. As a result the selection of one of these measures (distance travelled) as a representative measure for the subsequent PCA, which attempted to establish groups of tasks testing different aspects of attention, was questionable and the overall PCA that produced two ill-defined components of attention needs to be clarified. Hence the apparent independence of time and false alarm rates that has emerged in subsequent studies is suggestive and needs further investigation.

The present paper first reports a partial reanalysis of the data from Wilding *et al* (2001) using measures of time that are purged of time spent on errors, in order to determine whether separate time and accuracy components of performance in these visual search tasks can be discriminated. To anticipate, this reanalysis confirmed such a dissociation and results from a new data set were then examined in a further test of this finding.

The studies presented here, therefore, rather than attempting to identify different varieties of attention, are concerned to distinguish different component processes within several versions of a task commonly employed as a test of selective attention, namely visual search.

Study 1

Wilding *et al* (2001) employed three variants of the computerised visual search task described above. Two single target tasks (Task 1 with vertical black ellipses as targets and Task 2 with horizontal brown ellipses, both of which shared features with non-targets) were followed by a dual target task (Task 6) in which the child was required to alternate between these two types of target (Tasks 4 and 5 from the battery were not employed in this study). Single target search tasks are widely employed as test of selective visual attention and the dual target search task tested attentional switching, widely regarded as requiring control or executive functions. There were 25 targets randomly positioned among 100 holes in all in the single-target tasks and 15 of each type of target in the dual-target task. Each run took about a minute to complete. The task ended if the king was not found after 50 clicks. Mean time per hit was calculated, and the total number of false alarms (clicks on non-targets or background and repetitions on already located targets, plus failures to switch target in the alternating task). Mean time per hit was measured from the previous response in all cases, whether that previous response was a hit or an error; hence time spent on errors was removed from this measure. Mean distance per hit was not considered in this study, since Wilding (2003) and other unpublished studies have demonstrated that time and errors are the key performance measures.

This study also used a sustained attention task using a similar display to the visual search task and making similar demands but with an added requirement to maintain attention on the screen while awaiting the appearance of targets. At irregular intervals (ranging from 4 to 14 sec) a monster appeared at the site of one of the target shapes and the child was required to click on it to cause it to disappear again. There were 20 targets in all and the task lasted about 4 minutes. The measures employed were mean time per hit and the number of false alarms (i.e. clicks on non-targets or background). The number of hits was generally close to ceiling, and therefore was not a sensitive measure.

The study also included two additional tasks testing visual search, drawn from the Test of Everyday Attention in Children (TEA-Ch – Manly *et al*, 2001) and measures from these tasks were included in this re-analysis (Skysearch time per hit and Mapsearch time per hit). Skysearch requires a display of pairs of spaceships to be searched; in some pairs both ships are identical and have to be circled. Twenty targets are present but the children are told to stop when they think they have found all the targets. Time per hit was calculated. Mapsearch requires search of a map with a variety of symbols on it; as many knife-and-fork symbols have to be circled as possible in one minute and time per hit was again calculated. No measures of false alarms were available for these two tasks to match the measures from the Wilding *et al* search tasks.

Data from two other tasks were reported in the original study, the Wilding Monster Search Task (WMST), analagous to the Wisconsin Card Sorting Task of Heaton (1981), and the WALK task from the TEA-Ch, but the demands of these tasks differ considerably from the above search tasks and they will not therefore be considered further here. In addition Wilding *et al* (2001) measured Verbal and Non-verbal Mental Age (VMA and NVMA) and obtained teacher ratings of attentional ability. The short form of the British Picture Vocabulary Scale (BPVS - Dunn, Dunn, Whetton and Pintillie, 1982) was used to measure VMA, the short form of the Matrix Analogies Test (MAT - Naglieri, 1985) measured NVMA and a shortened form of the ACTeRs rating of attention (Ullman, Sleator and Sprague, 1984) assessed attentional ability. The BPVS requires the child to select from four pictures the one matching a spoken name. VMA is calculated from the raw score using the norms provided. The MAT requires selection from six choices of a part to complete an abstract design. NVMA is calculated from the norms provided. ACTeRs requires teachers to rate children on a five-point scale for six attention items and five hyperactivity items. Since these two measures were highly correlated ($r(92) = .91$) only the attention ratings were employed in the current study. High scores indicate good attention. With the addition of CA, this produced 14 scores, more than are appropriate for PCA of a data set of the size available, so these were reduced to 12 scores by averaging measures for the two single target visual search tasks (Task 1 and Task 2).

On the basis of the findings reported by Cornish *et al* (2006) it was predicted that two factors would be identified in Factor Analysis of these measures, one reflecting speed of performance and the other reflecting errors (more specifically false alarms). Furthermore it was predicted that the speed measures would cluster with VMA and NVMA, while accuracy measures would be associated with rated attentional ability. Earlier results did not enable any firm prediction as to which measure would be associated with CA.

Method and procedure

Participants

Full details of the recruitment procedure are given in Wilding et al (2001). In brief, seven schools in the Nottinghamshire area of England were originally asked to nominate pairs of boys approximately matched in age and general ability but one with good attentional ability and one with poor attentional ability. Teachers completed the ACTeRs scale for each boy. From the wider sample 50 boys were selected who scored above the 50th percentile on the ACTeRs scale and 50 who scored below the 25th percentile. Parental consent was obtained for their participation. None of these boys was diagnosed with any learning disability or attention disorder.

Procedure

Children were tested in two sessions of 35 minutes each with a 15 minute gap. Tasks were given in the same order for all the children and it was established beforehand that they all had experience of using a computer and mouse (see Wilding *et al*, 2001 for full details). There were 94 participants, all male, aged five years two months to fifteen years six months (mean age 124.2, *sd* = 31.63). The 12 scores identified above were subjected to Maximum Likelihood Factor Analysis with Varimax rotation, specifying two factors.

Results

Table 1 gives the means for the measures that were entered into the Factor Analysis.

[Table 1 about here]

The two components that emerged from the Factor analysis accounted for 47% and 13% of the variance after rotation. Table 2 shows all loadings over .4. The separation of time and accuracy measures was clear, with one exception: the Skysearch mean time per hit loaded on both components. Skysearch required the child to find as many targets as possible, then decide when to stop and there was a significant relation between the number of targets found and time ($r = -.46$) indicating that slower children gave up after finding fewer targets; hence the time measure also reflected one aspect of accuracy. This may explain the ambiguous status of this measure in the Factor Analysis.

[Table 2 about here]

As predicted, the Mental Age measures (and CA) loaded on a different component from the ACTeRs rating. MA, both verbal and non-verbal, clustered with the time component, as did CA, while the ACTeRs rating was related strongly to the accuracy component. Children with higher CA and MA were faster and children with a better attention rating made fewer false alarms. Relations between MA or CA and accuracy were weak, as were those between attention ratings and time.

It is, however, possible that the absence of any relation between the accuracy measures and the CA and MA measures occurred because error rates reached a floor at some point on the CA and MA scales, yielding a non-linear relation between the accuracy measures and the independent variables. To check this possibility, curve-fitting regression analysis was employed to extract linear and quadratic components for the regression of each time and accuracy measure on the CA, VMA and NVMA measures. These analyses all demonstrated that, while accuracy measures were linearly (but rather weakly) related to the independent variables, with no significant quadratic component, the visual search and vigilance time measures exhibited strong quadratic relations to them (however, the Skysearch and Mapsearch times exhibited only linear relations). The quadratic relations were due to mean times reaching a floor between ages 130 and 140 months and thereafter showing no further decline. Figure 1 shows examples of the scatter plots of the two measures against CA (specifically for time and false alarm rates for the single target visual search tasks).

[Figure 1 about here]

These findings are the opposite of the postulated explanation for the results of the Factor Analysis, but to check whether they were distorting the findings in any way a sub-sample was selected with CA below 130 months (n = 65). This reduced sample size to the bare minimum for the 12-variable Factor Analysis, but nevertheless this was carried out and produced exactly the same pattern of loadings as for the full analysis shown in Table 2. The two factors accounted for 45% and 16% of the variance and the loadings of CA, VMA and NVMA on the time factor and of the Attention rating on the accuracy factor were somewhat higher than in the analysis of the full sample.

To illustrate the dissociation between the two factors more clearly the Factor Analysis on the full sample was recalculated with the CA, MA and attention measures excluded (i.e. including only the performance measures) and the scores on the two resulting components were employed as dependent variables in two forced entry multiple regressions, with CA, VMA, NVMA and attention rating as the independent variables. The results were unequivocal. With the time factor as the dependent variable, the only significant predictor was NVMA (adjusted R squared = .43, $F(4,86) = 17.77$, $mse = .57$, $p < .001$; for NVMA $beta = -.42$, $t = 3.63$, $p < .001$). Higher NVMA was associated with faster times. No additional variance was explained by VMA and CA (correlations between the three measures were .57 for CA and NVMA, .86 for CA and VMA and .70 for VMA and NVMA).

On the other hand, with the accuracy factor from the Factor Analysis as the dependent variable, the only significant predictor was the ACTeRs attention rating (adjusted R squared = .39, $F(4,86) = 15.26$, $mse = .55$, $p < .001$; for attention rating $beta = -.50$, $t = 5.44$, $p < .001$). Better attention ratings were associated with fewer false alarms. The MA and CA variables added nothing significant to the prediction (correlations of ACTeRs with the age measures were .34, .24 and .07 for NVMA, VMA and CA respectively).

Study 2

The dissociation of time and accuracy measures in these tasks was explored further using a previously unpublished data set.

Method and procedure

Participants

One hundred children took part. All were pupils in full-time standard education, drawn from 4 schools varying widely in character (two were private schools, and 2 were state schools in less affluent areas of South-East England). All available children in the relevant age groups who were not diagnosed with any learning disability or attention disorder were rated by teachers on the ACTeRs scale and did the tasks. Ages ranged from 6 years 3 months to 11 years 11 months (mean age 105.23 months, SD = 16.77) and 53 girls and 47 boys completed all the tasks. This study was originally designed to establish norms for the tasks from a representative sample of children, and no measures of MA were included. However in Study 1 CA and NVMA were significantly correlated, as might be expected in a sample drawn from the general population, and their relations to the performance measures were very similar. Thus though it will not be possible with this sample to confirm whether or not the critical relation is between time measures and NVMA, the general thesis can be tested that time measures and false alarm rates show different patterns of relations to measures of age and measures of attentional ability.

Materials

The same three variants of the visual search task, together with the sustained attention task, were employed and the measures taken were the same as those described above. The sustained attention task differed in some details from that used in Study 1. Instead of a monster face appearing intermittently at a target location, a yellow line appeared round one of the targets; this was designed to make the task somewhat more demanding. Children were told that the monsters were at home only when the light showed and the monster would appear if they clicked on the hole when the light was showing. They were told to search for the king monster, who in fact appeared only when the child clicked on the sixteenth target to show.

Procedure

It was first established that all children had experience of using a computer mouse. A demonstration was given in each case and the child then performed the main task for the two single target visual search tasks and the dual target visual search task, followed by a demonstration and the main task for the sustained attention task. Data were recorded automatically, including participant details (age and sex), and processed later.

Results

Means on the measures employed in the Factor Analysis are shown in Table 1, and were similar to the parallel scores obtained in Study 1. To check for sex differences, unrelated t-tests were carried out on each measure and no significant differences emerged (t values ranged from .16 to 1.46). Commonly boys show inferior performance to girls on measures of attention and a higher incidence of attentional disorders. The absence of any differences here may reflect the exclusion of cases of diagnosed attention disorder and greater facility with computers in the boys (the study was carried out before computers were so widely available as they have since become).

These measures were entered into a Maximum Likelihood Factor Analysis, with Varimax rotation, specifying two factors. Results for the two single target visual search tasks were averaged as before, so there were 6 scores, plus CA and attention rating (as already stated, no measures of MA were available). The two factors obtained accounted for 27% and 17% of the variance. Table 2 gives the loadings that exceeded .4 on these components. Though the proportion of variance explained by the first factor was much lower than in Study 1 and the loading of the false alarms from the sustained attention task on the accuracy factor was rather low (but much higher than its loading on the speed factor which was only .15), there was again a separation of time and accuracy measures. CA did not load strongly on either component but the attention rating again loaded highly on the accuracy component.

[Table 3 about here]

To check for any differences between males and females, the analysis was run separately on data from the two groups. The same pattern emerged in both cases, with one exception. CA loaded strongly with the time measures (-.40) in the females but not in the males (-.13), so the weak relation found in the combined sample was largely due to the absence of such a relation in the males.

As for Study 1, the Factor Analysis on the whole sample was rerun after removing CA and the attention rating and the resulting scores were subjected to regression with CA and the ActeRs rating as independent variables. Just as in Study 1, only CA was a significant predictor of time (adjusted *R* squared = .09, $F(2,96) = 4.47$, for CA *beta* = -.34, $t = 2.9$, $p = .003$) and only ACTeRs was a significant predictor of false alarm rate (adjusted *R* squared = .13, $F(2,96) = 7.28$, for ACTeRs *beta* = -.35, $t = 3.6$, $p < .001$). The relations were, however, weaker than those observed in Study 1.

General Discussion

Both studies have supported indications in earlier data that in this type of visual search task that requires a series of targets to be located (including the version that requires maintenance of attention while awaiting infrequent targets), time and false alarms depend on different mechanisms. While it is not surprising that time measures should be correlated across a number of similar variants of this type of task, and that the number of false alarms should likewise be correlated across the different versions of the task, it is generally assumed that time and accuracy both reflect overall performance within such tasks and will therefore also be related to each other. This relation may be negative, reflecting a speed-accuracy trade-off that is due to differing individual decisions on whether higher priority should be given to fast performance or accurate performance. Or the two variables may be positively related if less able individuals perform both more slowly and make more errors. In both these cases the implication is that speed and accuracy both reflect underlying efficiency at performing the task and should therefore load on the same factor. The present results indicate that this assumption is unjustified in the case of these tasks and that, to some extent at least, time and false alarms reflect distinct aspects of performance and are related to different measures of individual ability.

Study 1 suggested that NVMA (rather than VMA and CA) was the strongest predictor of the speed factor and Cornish et al (2006) have found that both IQ and, less strongly, CA predicted speed of performance in these tasks. However it was not possible to confirm the relation of NVMA to speed in Study 2 since no measure of the latter was available. CA did show a significant relation to speed when NVMA and VMA were removed from the regression analysis in Study 1, and showed a similar, but weaker, relation in Study 2. Differences in the gender and age composition of the samples may have contributed to the obtained differences. Thus, while a clear difference has emerged in the individual difference measures that are related to speed and accuracy in these tasks, further evidence will be necessary to determine precisely which aspect or aspects of intellectual maturity are the major factors affecting speed in particular.

How then might we better define these two apparently distinct aspects of performance and is any other evidence available in support of the above conclusion? There is a considerable body of literature suggesting that IQ is related to speed of information transmission in the central nervous system (see, for example, Anderson, 1992), and the data from Study 1 (and also those of Cornish *et al*, 2005) showing a relation between the time measures and MA are consistent with this suggestion. However higher speed of neural transmission does not guarantee precise activation of the appropriate neural pathways (just as a fast new computer does not guarantee better performance than the slow old one if the same faulty program is run). A plausible suggestion is that in complex tasks reliable associations between given inputs and specified responses depend on aspects of Executive Function. EF is a somewhat ill-defined construct, incorporating such processes as planning, switching attention or response, inhibition of irrelevant inputs and responses and updating information in Working Memory (Miyake *et al*, 2000). Wilding (2005) has argued that, in continuous search tasks of the type used here (including the Skysearch and Mapsearch tasks used in Study 1), avoidance of false alarm errors would require such processes as selection of relevant information, setting criteria to specify targets and control emission of responses, initiating and controlling sequences of actions and (in the alternating search task) continuous switching of attention from one set of stimulus features to another. Also, and critically, responses to non-target stimuli must be inhibited. The latter function is also very important in the vigilance task.

All these functions can readily be related to widely recognised aspects of EF and impairments in such functions have frequently been suggested as a likely source of attentional weaknesses (e.g. Pennington & Ozonoff, 1996). The greater differences obtained between good and poor attention groups in the more demanding versions of the search tasks (Wilding, 2003) strengthens the case for regarding such group differences as a reflection of EF function. Attention Deficit Hyperactivity Disorder is known to involve abnormalities in the frontal lobes that are likely to involve EF functioning. (Though the children with poor attention in the current studies were not formally diagnosed as suffering from ADHD, they demonstrated many similar features of behaviour.) A weakness in inhibition in particular has been suggested as a key feature of Attention Deficit Hyperactivity Disorder (ADHD, Barkley, 1979, see also Nigg, 2001). A weakness in inhibiting responses to non-target stimuli could result from impairments of various kinds (poor functioning of the relevant frontal lobe systems that pass instructions to posterior stimulus-processing systems, poor communication between frontal executive systems and the posterior systems carrying out stimulus analysis, weak interconnections within the latter that fail to inhibit responses to weak signals from non-targets etc).

We suggest, therefore, that the attention ratings in the studies reported here were reflecting efficiency in aspects of the control systems in the frontal lobes and that weaknesses in some of the component functions of these systems, particularly the inhibition of responses to inappropriate stimuli, result in high false alarm rates in the tasks employed in these studies, but such weaknesses do not affect the speed of processing, which is related rather to measures of general ability or cognitive maturity. Impairments of the frontal lobes do produce effects that are, to some extent, unrelated to conventional measures of intelligence (Duncan *et al*, 1993), and this is consistent with the dissociation of the MA and attentional ability measures in the first study.

Recently Prinzmetal, McCool and Park (2005) have also produced evidence for a dissociation of speed and accuracy in an attention task, with the implication that accuracy depends on EF function. They demonstrated that, while exogenously controlled attention (i.e. an automatic switch of focus toward a stimulus change) may speed up responses to a subsequent stimulus at that location, improvement of accuracy in identifying the latter only occurs when endogenous attention is involved. Engagement of endogenous attention occurs when a semantic cue is given about the subsequent stimulus location or features (e.g. a central arrow or prior instructions) and a sufficient interval occurs before stimulus onset. Therefore it seems that it is only when the executive control processes that are required to organise endogenous attention are activated that processes analysing the input can be "fine-tuned" to improve accuracy, with well-defined input-response connections and inhibition of these same responses to other inputs. Such preparation would involve establishing a pre-set pattern of excitation and inhibition.

Thus, we suggest that in the experiment of Prinzmetal *et al* the experimental manipulations of type and timing of cue affected the ability to deploy control processes that in turn affected accuracy. In the search tasks used here we suggest that individual differences in attentional ability, as reflected in teacher ratings, are an index of control efficiency and are therefore also related to accuracy, more specifically ability to inhibit false alarms in these tasks. The two results therefore point toward a consistent conclusion that endogenous control of attention affects response accuracy and that the measures of the latter, rather than speed, should be employed when testing competence in attention tasks that are sufficiently complex to engage control systems.

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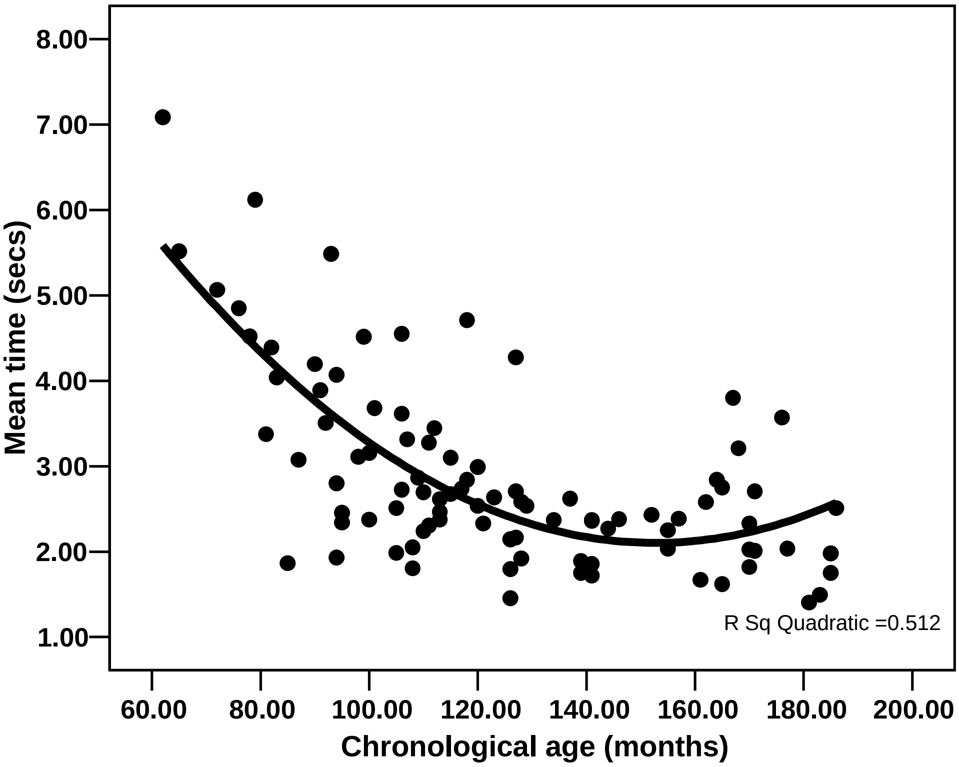
Figure 1 Scatter plots and best fitting functions for mean response times and false alarm rates (logarithmically transformed) plotted against CA for the single target visual search tasks in Study 1. For mean response times the quadratic function provided a significantly superior fit to a linear function (R squared = .51), while for log false alarms, the quadratic function was not significantly superior to the linear function (R squared = .16).


8.00
7.00
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4.00
3.00
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1.00
Mean time (secs)
R Sq Quadratic =0.512
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
Chronological age (months)

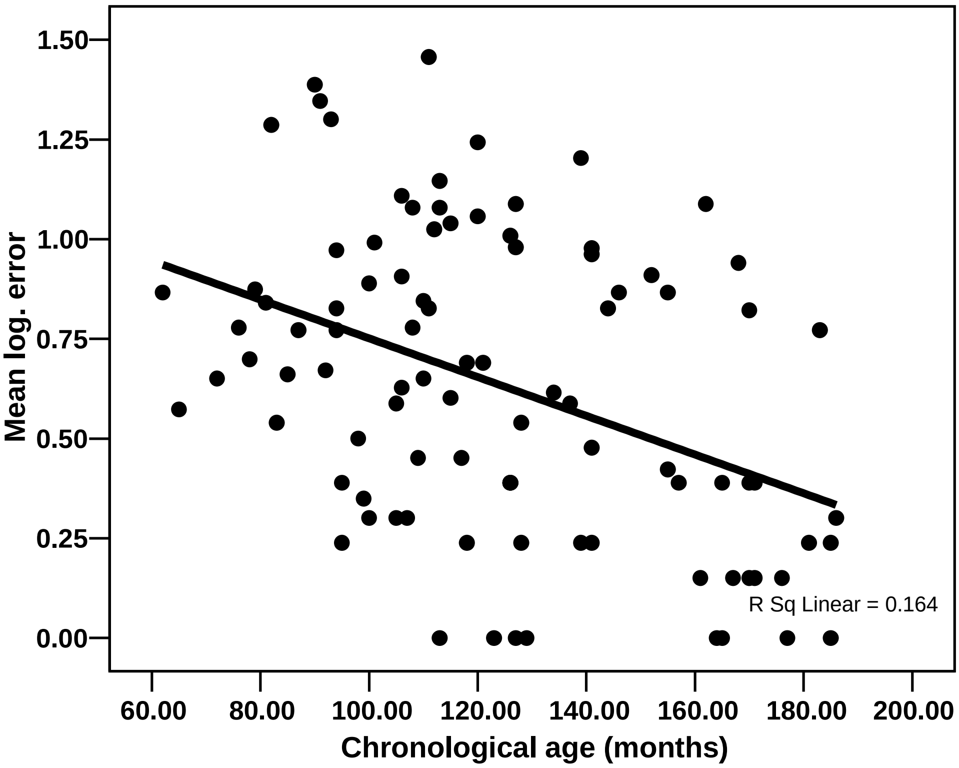
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Mean log. error
R Sq Linear = 0.164
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
Chronological age (months)

Table 1 Means and standard deviations for the variables in Study 1 and Study 2

	Study 1	Study 2
Mean correct time VISEAR1 + 2	2.86 (1.09)	2.94 (1.05)
Mean correct time VISEAR6	3.72 (1.75)	3.70 (.94)
Log errors VISEAR1 + 2	.63 (.38)	.60 (.32)
Log errors VISEAR6	.68 (.44)	.80 (.39)
Mean time per hit VIGILAN	2.76 (.91)	2.94 (.94)
Log false alarms VIGILAN	.61 (.24)	.55 (.36)
Skysearch mean time per hit	5.14 (1.84)	
Mapsearch mean time per hit	1.93 (.71)	
Chronological age	124.20 (31.63)	106.1 (14.1)
Verbal mental age	116.79 (31.26)	
Non-verbal mental age	101.58 (23.02)	
ACTeRs attention rating	19.91 (8.76)	22.1 (7.00)

Table 2. Loadings over .4 on the two factors extracted in Study 1.

	Factor	
	1	2
Mean correct time VISEAR1 + 2	.91	
Mean correct time VISEAR6	.80	
Log errors VISEAR1 + 2		.87
Log errors VISEAR6		.77
Mean time per hit VIGILAN	.74	
Log false alarms VIGILAN		.53
Skysearch mean time per hit	.44	.44
Mapsearch mean time per hit	.72	
Chronological age	-.73	
Verbal mental age	-.75	
Non-verbal mental age	-.70	
ACTeRs attention rating		-.59

Table 3. Loadings over .4 on the two factors extracted in Study 2.

	Factor	
	1	2
Mean correct time VISEAR1 + 2	.99	
Mean correct time VISEAR6	.64	
Log errors VISEAR1 + 2		.66
Log errors VISEAR6		.83
Mean time per hit VIGILAN	.63	
Log false alarms VIGILAN		(.35)
Chronological age		
ACTeRs attention rating		-.42