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ABSTRACT

Two studies examined the effectiveness of the PASS (Planning, Attention, Simultaneous, and Successive cognitive processes) theory of intelligence in predicting reading achievement scores of normally achieving children and distinguishing children with reading disabilities from normally achieving children. The first study dealt with predicting reading vocabulary and comprehension scores. Subjects, 74 children in grades 4 and 5 from 4 schools in Kingston, Ontario, Canada, were given a subset of PASS tests. Results indicated that: simultaneous and successive processing were the main predictors of reading; simultaneous was more related to comprehension than to vocabulary; and planning and attention were less related to reading skills in normally achieving children. In the second study, four groups of children in Peterborough, Ontario, Canada, were given the same set of PASS tests with the addition of speech rate. The groups were 15 grade 4/5 average-IQ learning disabled (LD); 15 high-IQ LD grade 4/5 children; chronological age (CA) group comprised of 15 normally achieving children from the same grade 4/5 classrooms as the LD subjects; and 15 reading age grade 2 students reading at the same level as the LD students. Results indicated that: the average-IQ LD children were remarkably similar to normally achieving children who were approximately 3 years younger; the high-IQ LD performed generally better than the average-IQ LD, and about as well as their CA matches; and successive processing was the area that best discriminated the learning disabled from normally achieving children. Findings support PASS as a framework to guide screening, assessment, and remediation of difficulties in reading. (Three tables and one figure of data are included.) (RS)

PASS and Reading Achievement

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PASS and Reading Achievement

This paper reviews the PASS (Planning, Attention, Simultaneous, and Successive cognitive processes) theory of intelligence (Das, Kirby & Jarman, 1979; Das, Naglieri & Kirby, submitted; Kirby & Das, 1990; Naglieri & Das, 1990), and discusses how the components of this theory are related to reading achievement skills. Two studies are reported, one using PASS measures to predict reading achievement scores in normally achieving children, the second investigating the PASS components which distinguish children with reading disabilities from normally achieving children.

Intellectual assessment and achievement

The theory and practice of intellectual assessment are based upon the notion that the cognitive skills measured by "ability" tests are related to those involved in the successful performance of achievement tasks. Thus we expect children who have scored in the normal range on appropriate ability tests to perform similarly on tests of reading achievement, other factors being equal. Much of the controversy over intellectual assessment can be traced to (a) the plausibility of the preceding argument, especially given the "other factors", and (b) the nature of the relation between ability and achievement skills.

(a) If the cognitive processes which are responsible for achievement could be assessed, independent of the particular achievement context and content, assessment would be of undoubted value. This no longer seems plausible, at least not completely. Content and context are too critical to be ignored; it seems very unlikely that we will ever obtain a full knowledge of reading skills and potential without testing reading. For example, phonological decoding skills seem crucial for reading (Adams, 1991) but unrelated to intelligence (Siegel, 1989). It remains possible, however, that some of the skills or processes involved in reading can be assessed away from reading.

(b) Traditional intellectual assessment has focussed upon abilities which are correlated with reading skill, without specifying how or why this correlation takes place. This is not surprising, given the relative lack of theory underpinning intellectual assessment devices. Assessment without explanation may be suitable for the purposes of prediction, but it does not help us understand the predictive relationship, nor does it provide the educator with guidance for remediation; in some cases it seems to discourage practitioners from even attempting remediation. Some parents may be unsatisfied with the suggestion that their children are not supposed to be able to read very well, and teachers may be equally unhappy to be informed that some of their pupils should be reading more effectively. Cognitive psychologists would hope that the explanations and suggestions both groups seek are based in theory.

PASS and Reading Skills

The PASS theory, following Luria (e.g., 1966), proposes that cognition is organized in three systems. The Planning system is responsible for controlling and organizing behaviour, selecting or constructing strategies, and monitoring performance. The Attention system is responsible for maintaining alertness, and for insuring focus upon appropriate stimuli. The Processing (or Coding) system uses simultaneous and successive processing to encode, transform, and retain information. In simultaneous processing, pieces of information are coded so that relations among them can be seen and the information integrated. In successive processing, pieces of information are coded so that the only links between items are sequential in nature. The PASS processes are conceived of as broad categories of processes, within which other distinctions, such as verbal vs. spatial, may be relevant. Further details about the theory and examples of the tests used to assess each component may be found elsewhere (Das, Kirby & Jarman, 1979; Das, Naglieri & Kirby, submitted;

Kirby & Das, 1990; Kirby & Williams, 1991; Naglieri & Das, 1990). The simultaneous and successive processing components were addressed in the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983), although the planning and attention components were omitted. Das and Naglieri (in preparation) are producing the Das-Naglieri Cognitive Assessment System (DN:CAS), which specifically addresses all four components.

Relationships between the PASS components and reading skills can be predicted from this theoretical base. We have suggested (Kirby & Das, 1990; Kirby & Williams, 1991) that simultaneous and successive processing should be most highly related to reading skills, with simultaneous more strongly related to comprehension and successive more strongly related to word decoding. These predictions derive from the necessity for simultaneous processing in the relating of meaningful units and their integration into higher-level units, and from the involvement of successive processing in the sequential analysis and blending of phonemes and syllables. Planning and attention are less likely to be related to reading, because these aspects of reading should be automated in normal readers; instead, planning and attention may be related to reading skills only in disabled groups.

A number of studies have addressed the involvement of PASS processes in reading. It has been shown that one of the primary characteristics of many children with reading problems is poor successive processing (e.g., Kirby & Robinson, 1987; Leong, 1980). Several studies have shown improvements in reading as a result of training in successive processing (e.g., Krywaniuk & Das, 1976), suggesting that successive processing may be a prerequisite for the acquisition of phonological skills. Other studies have argued for a role for simultaneous processing in comprehension difficulties (Cummins & Das, 1977). Both simultaneous and successive processing are effective predictors of reading achievement (Kirby & Das, 1977). Planning was shown by Prewett and Naglieri (submitted) to be associated with reading ability in reading disabled children. Attention has not been shown to be associated with reading problems, though it seems clear that it should be the source of the difficulties faced by children with "attention deficits".

Study 1: Predicting Reading Achievement

The purpose of this study, conducted with P. Beggs and P. Cox, was to predict reading vocabulary and comprehension scores, using a subset of the new Das-Naglieri PASS tests. The subjects were 74 children in grades 4 and 5, from 4 schools in Kingston, Ontario, which represented a broad range of SES backgrounds. The PASS tests used were Planned Connections and Visual Search (for Planning), Receptive Attention and Expressive Attention (for Attention), Matrix Analogies and Figure Memory (for Simultaneous), and Word Series, Sentence Repetition, and Naming Time (for Successive). Each test score distribution was standardized, and the standard scores were averaged for each PASS component. Two successive scores were calculated, one including Naming Time (Successive-3) and one excluding it (Successive-2); this was done to ensure that the relationship between successive processing and reading was not due to the Naming Time test alone, because this test requires the reading of words. Reading vocabulary and comprehension were assessed with the Gates-MacGinitie reading test.

The correlations between the PASS components and reading scores are shown in Table 1. Each of these correlations is significant at the .05 level. The strongest relationships are for simultaneous and successive processing. The successive score which includes Naming Time is more strongly related than the one which excludes it, but the latter is still a reasonably good predictor of both reading scores. As predicted, simultaneous processing is more highly correlated with comprehension than vocabulary (for the difference, $t(71) = 2.37$, $p < .05$). The correlations for successive processing are less consistent with predictions; Successive-2 is more highly correlated with vocabulary than comprehension, but this difference is not significant, and the two Successive-3 correlations do not differ. Both successive processing scores are more highly correlated with comprehension than would have been expected.

The two reading scores were also regressed upon the PASS components, separate analyses being performed for the model including Successive-2 (called PASS-2) and for that including Successive-3 (called PASS-3). In predicting comprehension, only the simultaneous and successive processing scores had significant unique contributions, in both models. In predicting vocabulary, successive processing was significant in both models, simultaneous processing was significant in one and close to significance ($p = .06$) in the other, and attention was significant in one and close ($p = .081$) in the other. Planning did not have a significant unique effect in any analysis. The R^2's for these analyses are shown at the bottom of Table 1.

These results confirm that (a) simultaneous and successive processing are the main predictors of reading, (b) simultaneous is more related to comprehension than to vocabulary, and (c) planning and attention are less related to reading skills in normally achieving children. It was not clear, however, that successive processing was more strongly related to word-level skills (vocabulary) than to comprehension; this may have occurred because the vocabulary test did not rely primarily upon word decoding. It should also be noted that the PASS model became particularly powerful when Naming Time was included as a successive processing measure. While there is a theoretical rationale for including this measure, this may not be appropriate when reading skills are being predicted, in that reading scores are being predicted (partly) from a test which involves reading. With or without Naming Time, however, these results show that the PASS components account for a reasonably high proportion of the variance in reading scores for normally achieving children.

Study 2: Characteristics of Reading Disabled Children

The purpose of this study, conducted with C. Booth, was to investigate the PASS components which best discriminated reading disabled children from normally achieving children. Four groups of children were selected from schools in Peterborough, Ontario: the Average-IQ LD group consisted of 15 grade 4/5 children with reading disabilities and WISC-R Performance IQ-s between 90 and 106; the High-IQ LD group consisted of 15 reading-disabled grade 4/5 children with WISC-R Performance IQ's from 108 to 132; the Chronological Age (CA) group comprised 15 normally achieving children from the same grade 4/5 classrooms as the LD subjects; and the Reading Age (RA) group consisted of 15 grade 2 children reading at the same level as the LD subjects, selected from the same schools. One subject was deleted from the Average-IQ LD group when it was determined that he had been misidentified as reading disabled by the school authorities. While no IQ data were available for the CA and RA groups, they were described by their teachers as being of normal ability and this was later verified with the Matrix Analogies test. In the absence of standardized reading data, CA and RA subjects were selected on the basis of teacher's recommendations, later verfied by the Woodcock-Johnson reading test.

The PASS tests employed in this study were the same as those from Study 1, with the addition of Speech Rate, a measure of successive processing involving speech but not reading. Reading was assessed with the Word Attack, Word Identification, and Passage Comprehension subtests of the Woodcock-Johnson, which were combined into a Grade Equivalent score.

Means for each group are shown in Table 2. Results were analyzed in terms of five planned comparisons, one comparing the two LD groups, and four comparing one of the LD groups and one of the control groups (see Table 3). The alpha level for examining these comparisons was determined according to Keppel's (1982, p. 148) modified Bonferroni procedure: the new alpha was calculated as the product of the planned alpha level (.05) and the number of degrees of freedom associated with the grouping variable (3), divided by the planned number of comparisons (5); thus alpha was set at .03. Figure 1 shows the means of the two LD groups, expressed as proportions of the difference in performance between the RA (Grade 2) and CA (Grade 4/5) groups. On this scale, RA performance is 0.0 and Grade 4/5 is 1.0. For example, for Planned Connections, the Average-IQ LD mean (247.9) is .525 of the distance between the RA and CA means (311.2 and 190.7 respectively).

With respect to reading scores, both LD groups were different from the CA-matched group. The Average-IQ LD group did not differ from their RA matches, but there was a tendency for the High-IQ LD to be better readers than the grade 2 children.

With respect to PASS test scores, it can be seen in Table 2 and Figure 1 that the High-IQ LD group always performed better than the Average-IQ LD group, but this difference was only significant for Planned Connections, Receptive Attention, Matrix Analogies, Figure Memory and Naming Time. The Matrix Analogies and Figure Memory differences were expected, because these tests should be related to Performance IQ, on which these two groups were selected to differ. The other three measures are all latency scores (as are other measures), but otherwise form no pattern. Simultaneous processing is the only PASS component to consistently distinguish between these two groups.

The contrasts between the LD groups and the control groups showed that the Average-IQ LD were quite similar to the RA matched group, but different from the CA matched group, whereas the High-IQ LD resembled the CA group more than the RA group. The only differences between the Average-IQ and the grade 2 children were for the two planning tests, though the High-IQ differed from the grade 2 subjects on all but the successive processing measures. Though the High-IQ LD were not different from the CA group on any PASS measure, the Average-IQ LD differed from the CA group on many measures, especially those of successive processing. The three non-successive measures which showed differences (Planned Connections, Receptive Attention, and Matrix Analogies) were also areas of difference between the Average and High LD groups; this suggests that the CA group may have been of higher general ability than the Average-IQ LD subjects (the Matrix Analogies test is used as a measure of general nonverbal ability; Naglieri, 1985). This would not explain the successive processing differences, because successive processing is not normally correlated highly with the other components. Successive processing was also the PASS area in which the High-IQ performed least like the CA group (see Figure 1), although these differences were not significant; more sensitive measures of successive processing may be required.

These results reinforce three points: (a) the Average-IQ LD are remarkably similar to normally-achieving children who are approximately three years younger, (b) the High-IQ LD perform generally better than the Average-IQ LD, and about as well as their CA matches, on a range of planning, attention, and simultaneous processing measures, and (c) successive processing is the area which best discriminates the learning disabled from normally-achieving children.

Conclusions

These studies have confirmed two patterns evident in previous research: simultaneous and successive processing are both effective predictors of reading achievement in normally achieving children, and successive processing is the factor which distinguishes reading disabled from normally achieving children. These results are important because the PASS theory allows to go beyond mere actuarial prediction. In theory, successive processing is the *locus* of the difficulties encountered by the reading disabled, not merely a correlate of them. If this is correct, them improving successive processing is a necessary preor co-requisite to improving the basic word-level skills of the reading disabled. In the same way, simultaneous processing is required for more advanced reading comprehension skills; pattern recognition and information integration training should contribute to improvements to reading ability, above and beyond the word level. Successive processing remains important at the comprehension level, either because word level difficulties continue to inhibit performance, or because sequencing is involved in the parsing of sentences and larger units of text.

These results, and those of previous research, support the use of the PASS theory as a framework to guide screening, assessment, and remediation of difficulties in reading.

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Table 1. Study 1 correlations between PASS components and reading scores (top), and proportions of variance accounted for (R^2's) by two regression models (bottom) (N = 74).

PASS component	Reading Score: Vocabulary	Reading Score: Comprehension
Planning	.241	.305
Attention	.331	.296
Simultaneous	.413	.558
Successive-2	.365	.418
Successive-3	.551	.551
R^2's		
PASS-2	.288	.406
PASS-3	.395	.477

Note. PASS components are averaged standard scores; Successive-3 includes Nami- Time, Successive-2 does not; PASS-2 includes Successive-2, PASS-3 includes Successive-3.

Table 2. Means for PASS and reading variables for four groups in Study 2.

Measure N =	Avg-IQ LD 14	High-IQ LD 15	Grade4/5 CA 15	Grade2 RA 15
Planning				
[t]Planned Connections	247.9	186.2	190.7	311.2
[t]Visual Search	134.0	132.6	124.0	179.6
Attention				
[t]Expressive	137.7	126.5	125.7	151.2
[t]Receptive	13.6	9.6	9.6	13.8
Simultaneous				
Matrix Analogies	17.2	22.5	23.3	13.9
Figure Memory	10.8	12.9	11.9	9.5
Successive				
Word Series	8.1	9.8	10.5	9.7
Sentence Repetition	6.6	7.4	7.9	7.1
[t]Naming Time	106.8	89.4	79.3	100.4
[t]Speech Rate	126.9	121.3	111.5	131.3
Reading				
Word Attack	6.1	7.0	13.2	7.0
Word Indentification	27.2	29.3	36.1	25.8
Passage Comprehension	11.3	12.5	15.9	10.9
Grade Equivalent	2.7	3.1	4.8	2.6

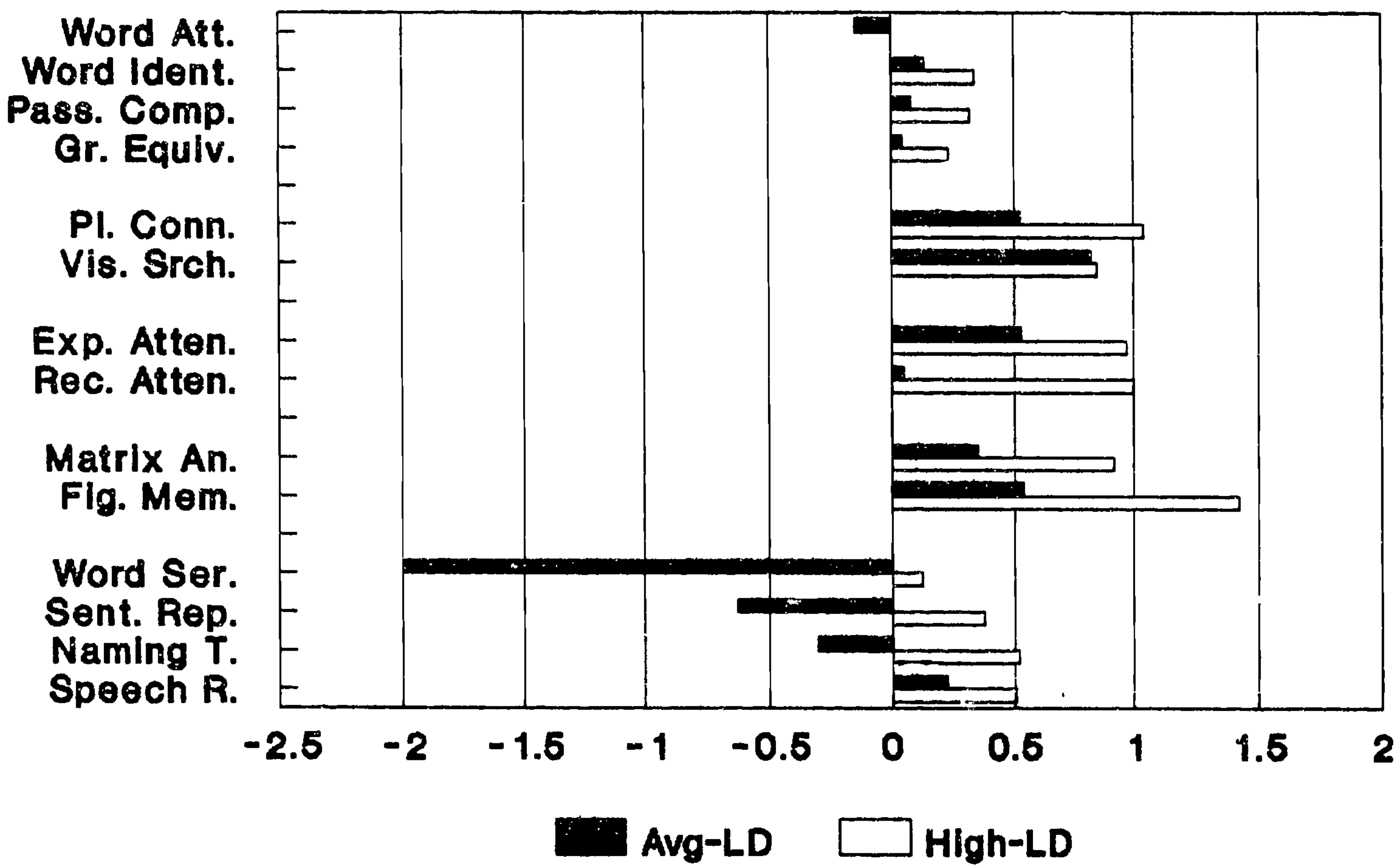
Note. [t] indicates a timed test, in which higher scores represent less efficient performance.

Table 3. Probability levels for t-tests for PASS and reading variables in Study 2 (for 5 comparisons, alpha set to .03).

Measure	A-LD/ H-LD	A-LD/ Grade2	A-LD/ Grade4/5	H-LD/ Grade2	H-LD/ Grade4/5
			Comparison		
Planning					
[t]Planned Connections	.014	.024	.023	.001	ns
[t]Visual Search	ns	.019	ns	.013	ns
Attention					
[t]Expressive	ns	ns	ns	.012	ns
[t]Receptive	.011	ns	.011	.001	ns
Simultaneous					
Matrix Analogies	.001	ns	.001	.001	ns
Figure Memory	.024	ns	ns	.001	ns
Successive					
Word Series	ns	ns	.022	ns	ns
Sentence Repetition	ns	ns	(.038)	ns	ns
[t]Naming Time	.012	ns	.001	ns	ns
[t]Speech Rate	ns	ns	(.05)	ns	ns
Reading					
Word Attack	ns	ns	.001	ns	.001
Word Indentification	ns	ns	.001	.021	.001
Passage Comprehension	ns	ns	.001	(.040)	.001
Grade Equivalent	ns	ns	.001	(.032)	.001

Note. Figures in parentheses indicate $.03 < p < .05$; ns indicates $p > .05$.

Performance of Average and High LD Groups relative to Grade 2 & Grade 4/5



Note: Grade 2 = 0.0, Grade 5 = 1.0