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PASS cognitive processes, phonological processes, and basic reading performance for a sample of referred primary-grade children

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The purpose of this study was to explore the relationships among cognitive processing, phonological processing and basic reading skill performance. Cognitive theorists propose that Planning, Attention, Simultaneous and Successive (PASS) processes are related to various phonological skills. A sample of 62 Primary Grade children referred for reading problems were administered measures of cognitive processes (Cognitive Assessment System), phonological processes (Comprehensive Test of Phonological Processing) and basic reading achievement (Woodcock-Johnson Tests of Academic Achievement-III). Findings indicated that some cognitive processes were significantly related to phonological processes as well as basic reading skills. The strongest relationships were found between phonological memory and successive processes and between phonological awareness and basic reading performance.

There have been numerous studies revealing that phonological processes, rather than intellectual ability, are better predictors of word recognition for children in the early primary grades (e.g. Share, McGee & Silva, 1989; Siegel, 1993; Siegel, 1988; Stanovich, Cunningham & Freeman, 1984; Stanovich & Siegel, 1994; Vellutino, Scanlon & Lyon, 2000). While these studies explored the relationships between phonological processes and basic reading skills as well as intelligence and basic reading skills, there have been few studies that have explored the relationships between intelligence and phonological processes. Studies that have examined the relationships between intelligence and phonological processes employed traditional measures of intelligence such as the Wechsler Scales (e.g. Mutter and Snowling, 1998; Vellutino et al, 1996; Vellutino, Scanlon & Lyon, 2000). Traditional intelligence measures such as the Wechsler Scales are based on measuring general intelligence (vaguely defined) using tests that contain

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verbal and nonverbal content. In response to the need to better conceptualise and measure intelligence, especially in a way that shows relevance to the problems children with learning disabilities in reading experience, new approaches have been proposed. One of the most recent of these approaches is the Planning, Attention, Simultaneous and Successive (PASS) theory of intelligence (Naglieri & Das, 1997).

The PASS theory is operationalised in the Cognitive Assessment System (CAS; Naglieri & Das, 1997) which is a measure of cognitive ability designed as an alternative to traditional intelligence measures. The CAS measures intelligence redefined as essential cognitive processes called PASS. These processes were derived from Luria's (1973) neuropsychological theory of brain functions. Luria (1973) postulated that there were three functional units of the brain. The first functional unit (i.e. brainstem and subcortical regions of the brain) was responsible for arousal and sustained attention. The second functional unit involved simultaneous and successive coding processes (i.e. central cortex region of the brain) and the third functional unit (i.e frontal-lobe region of the brain) involved formulating, regulating and verifying plans.

Based upon the work of Luria (1973), Naglieri and Das (1997) defined intelligence using the PASS constructs and operationalised these processes in the CAS. According to Naglieri and Das (1997), planning is the ability to formulate a strategy, execute the strategy and verify whether the strategy is effective for solving a problem. Attention is defined as selectively attending to relevant stimuli while inhibiting distracting or irrelevant stimuli. Simultaneous processing is defined as the ability to survey several elements to form an integrated whole. Successive processing is defined as the ability to process information in a serial order. Although the CAS purports to measure different constructs from the Wechsler Scales, there is a strong correlation between overall performance on the CAS and overall performance on the WISC-III (Wechsler Intelligence Scale for Children-Third Edition) (Naglieri & Das, 1997).

Analogous to the cognitive processes that make up the overall cognitive model measured by the CAS, phonological processes are just as varied yet interrelated. Torgesen, Wagner and Rashotte (1994) defined phonological processing as 'an individual's mental operations that make use of the phonological or sound structure of oral language when he or she is learning how to decode written language' (p. 276). Wagner, Torgesen and Rashotte (1994) presented three ways in which individuals phonologically process the structure of spoken language: phonological awareness; phonological memory; and rapid naming. These constructs were operationalised into measures that make up the Comprehensive Test of Phonological Processing (CTOPP, Wagner, Torgesen & Rashotte, 1999).

One of the most important components of phonological processing is phonemic awareness because it has been found to be a critical precursor skill to successful reading and spelling performance (Ball & Blachman, 1991; Bentin & Leshman, 1993; Byrne & Fielding-Barnsley, 1991; Griffith, 1991; Hatcher, Hulme & Ellis, 1994; Nation & Hulme, 1997; Stahl & Murray, 1994; Tangel & Blachman, 1992). Phonemic awareness means attending to the smallest units of speech which are individual sounds. Phonemic awareness also involves operating on the sounds of spoken language. Phoneme segmentation, phoneme blending, phoneme deletion and phoneme isolation are many ways of operating on the sounds of spoken language. Phoneme segmentation involves articulating each sound of a spoken word in sequential order. Phoneme blending involves putting individual sounds together to form a whole word. When children say only the beginning, middle or ending sound of a word, they are isolating individual phonemes.

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Children complete a phoneme deletion exercise when they say part of a word once a phoneme has been removed.

Phonemic awareness has been strongly related to phonological memory, especially at the early ages (Wagner et al, 1993). According to Torgesen (1996) phonological memory (sometimes called memory span) is a process by which individuals store phonological codes in their working or short-term memory. Gathercole and Baddeley (1990) found that deficits in phonological memory did not affect elementary school-age children's ability to speak and read known words, but did affect their ability to speak and read words that were unknown to them. Phonological memory becomes more crucial as children grow older and confront new complex words such as multisyllabic words. If children are unable to store all of the sounds or chunks of sounds in their immediate memories, they may have difficulty blending all of the sounds to form a whole word. Thus, phonological memory is a characteristic that distinguishes good readers from poor readers (Muter & Snowling, 1998; Swanson, 1992; Torgesen, 1988; Vellutino et al, 1996).

Although phonological memory involves the storage of phonological codes, rapid naming refers to the efficient retrieval of phonological information (McDougall, Hulme, Ellis & Monk, 1994). In other words, rapid naming is the ability to speak and read fluently. According to Bowers and Wolf (1993), children experienced the greatest difficulty learning to read if they had deficits in both rapid naming and phonological awareness, which are characteristics associated with children who have dyslexia (Aaron & Joshi, 1992).

Kirby and Williams (1991) and more recently Naglieri (1999) theorised that PASS processes have been described as being associated with phonological components of spoken and written language. Planning is said to be associated with the efficient execution and verification of speaking and reading words. Attention corresponds to the alertness to discrete sounds and letters, and inhibiting irrelevant stimuli. Successive processing is associated with sequentially decoding the sounds in words or making one-to-one correspondences with letters and sounds. Simultaneous processing is associated with surveying all the elements of a word and acquiring the sound and letter patterns in a rather hierarchical manner (i.e. understanding that certain letters cue the sounds of other letters in words – such as 'e' at the end of the word 'came' cues the reader to say the 'a' as a long vowel sound).

The relationship between intelligence, phonological processes and basic reading skills deserves examination, especially as the concept of intelligence is being reconceptualised by cognitive theorists such as Naglieri and Das (1997). There have been no studies examining the relationship among recently published alternative measures of cognitive ability or intelligence (e.g. the CAS), recently published comprehensive tests of phonological processing (e.g. the CTOPP) and basic reading skill performance. However, validity studies conducted as part of the CAS standardisation procedures revealed that the PASS processes were rather strongly related to basic reading skills and reading comprehension, especially for children in the upper-elementary and middle-school grades (Naglieri & Das, 1997). The purpose of the present study was to explore the relationships between cognitive processing, phonological skills and basic word identification and pseudoword reading skills with a sample of primary grade children referred for basic reading problems. An additional purpose of this study was to determine which PASS variables best predicted phonological variables, and to determine whether phonological or PASS are best predictors of basic reading performance.

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Method

Participants

At the start of the investigation, parent permission forms were sent to a sub-set of Second and Third-grade students (n = 80). These had been referred by their teachers as students who were demonstrating basic literacy problems because they were reading below grade level and scored below the 35th percentile on the Stanford Reading Achievement Tests. Despite follow-up correspondence, 62 students were given parental consent to participate. The participants therefore consisted of 62 primary-grade students (40 males and 22 females) between the ages of 7 years and 5 months and 9 years and 2 months, with a mean age of 8 years and 4 months. Their teachers judged the participants to be students who were struggling with basic literacy skills. The participants, 60% Caucasian, 25% African-American and 15% Hispanic, resided in families of middle socio-economic status (SES) and attended a suburban school in Central Ohio that contained grades K–3rd. Approximately 40% of the students were receiving services in a Title 1 reading programme, and 60% were referred to an assessment team for suspected learning disabilities or candidates for the Title 1 reading programme.

Instruments

Cognitive processes. The Cognitive Assessment System (CAS, Naglieri & Das, 1997) was used to assess cognitive processes. The administration time is approximately one hour. This instrument is made up of four sub-scales: planning, attention, simultaneous and successive processing. The planning scale was designed to measure a student's ability to formulate a strategy, monitor a strategy and verify whether the strategy works. The attention scale was designed to measure selective attention of relevant stimuli while inhibiting irrelevant stimuli. The simultaneous processing scale was designed to measure the ability to survey and integrate elements to form a conceptual whole. The successive processing scale was designed to detect the ability to process information in a serial fashion. A CAS full scale score measuring overall cognitive functioning is derived from all four sub-scales. Scores derived from the CAS full scale and all four sub-scales are each based on a mean of 100 and a standard deviation of 15.

The planning scale consists of matching numbers, planned codes and planned connections sub-tests. Matching numbers requires children to underline two numbers containing the same order of digits from a row of numbers containing several digits. In planned codes, children are presented a legend at the top of the page filled with boxes with letters on the top part of the boxes and corresponding codes of 'Xs' and 'Os' in the bottom part of the boxes. Below the legend are several rows of boxes with letters on the top part and empty spaces on the bottom portion of the boxes. The children are required to complete the bottom parts of the boxes with codes that correspond to the ones represented with the letters in the legend. To facilitate planning, they are asked to complete this task in any way they choose. The planned connections sub-test involves presenting several numbers presented in a scattered fashion within a drawn box. Children are required to connect numbers and letters in sequential order by drawing a line from one number to the next or from one number to a letter then to a number, and so forth.

The attention scale consists of expressive attention, number detection and receptive attention. The expressive attention sub-test contains a row of printed words that are

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names of colours (e.g. red, blue, yellow, etc). Each word is printed in a colour which does not correspond to its printed form. The children are asked to say the colour the word is printed in rather than read the word. The number detection sub-test involves presenting children with target numbers at the top of the page followed by several rows of target and distractor numbers. Children are to examine the numbers across a page from left to right and underline the numbers that match the target numbers. The receptive attention sub-test involves detecting and underlining pairs of letters with the same name (e.g. Aa, tT).

The simultaneous processing scale is made up of nonverbal matrices, verbal–spatial relations and figure memory sub-tests. The nonverbal matrices sub-test contains geometric patterns with a missing element. The children are provided with several options of geometric shapes to choose from to complete the patterns. The verbal–spatial relations sub-test is composed of items containing pictures depicting spatial relationships. The examiner reads a sentence describing spatial relations between objects, and the children are required to select the picture that best represents the sentence. The figure memory sub-test contains items that consist of abstract geometric figures. Children are presented with a geometric shape printed on a piece of paper for five seconds. Once the shape is removed, children are presented with an abstract geometric design with the previous geometric shape embedded within the figure. Children are asked to find the embedded figure by tracing it with a red pencil.

The successive processing sub-tests include word series, speech rate, sentence repetition and sentence questions. The items on the word series sub-test involve saying a list of words to the children and having the children repeat them in the order they were given. Speech rate involves repeating the same series of words ten times as quickly as possible. Sentence repetition requires the children to repeat sentences that were orally presented to them, and sentence questions requires the children to answer questions about the sentences. Sentence questions allow the examiner to detect whether children understand syntactical structures of language.

Phonological processes. The Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen & Rashotte, 1999) measures children's ability to detect and operate on several phonological components of spoken words (not printed words). It takes approximately 45 minutes to administer the CTOPP. The CTOPP contains a core battery and a supplemental battery. All of the sub-tests that make up the core battery were administered. Phonological awareness, phonological memory and rapid naming are the three composites derived from the sub-tests that make up the core battery. Composite scores are based on a mean of 100 and a standard deviation of 15.

The phonological awareness composite consists of elision and blending words sub-tests. Items in the elision sub-test involve the examiner saying a word and asking the child to say a word with a part of the word removed. For example, children may be required to say the word 'can' and then say the word without saying the /c/. Blending words contain items that require children to blend parts of words together to form a whole word. The examiner provides the sounds of a word such as /s-a-t/, and the child is required to blend the sounds together and say the word 'sat'.

The phonological memory composite consists of memory for digits (forward only) and nonword repetition. Items on memory for digits require the children to listen to a tape recording of numbers. After a series of numbers are stated, the examiner hits the pause button and allows the children to repeat the digits in the same order in which they were presented. Nonword repetition contains items that require the children to listen to

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pseudowords presented on a tape recorder. Children are required to repeat the nonword when the examiner hits the pause button after the completion of each item.

Rapid digit naming and rapid letter naming make up the rapid naming composite. Rapid digit naming contains items with rows of numbers. The children are asked to look at the numbers and say them as fast as they can. Rapid letter naming contains items with rows of letters. The children are asked to look at the letters and say them as fast as they can.

Basic reading skills. Basic reading skills were measured by administering the letter-word identification and word attack sub-tests of the Woodcock-Johnson Battery of Achievement-III (WJ-III; Woodcock, McGrew & Mather, 2000). Scores derived from both sub-tests are based on a mean of 100 and a standard deviation of 15. The letter-word identification sub-test contains items that consist of printed words. Children are asked to read the printed words aloud. Word attack contains printed nonwords, and children are asked to say them aloud.

Data collection procedures

All instruments were individually administered in counterbalanced order to all participants over several sessions in close succession. It took two three-hour sessions and a one-hour session to complete the testing for each student across three consecutive school days, except in the case of absences. The instruments were administered and scored according to standardisation guidelines as prescribed in the respective test manuals. Qualified graduate students in a school psychology programme administered all instruments to the children. Prior to administering the instruments, the examiners successfully completed four courses in the administration of psychological and achievement tests. The instruments were administered in a room with optimal conditions for testing.

Results

Means, ranges and standard deviations for each measure are provided in Table 1. Repeated ANOVAs were conducted to determine if the variation among the mean CAS scale scores were significant for this sample of children, as no significant variation among CAS scores are expected in a sample of normally-achieving students. Findings indicated that there were significant differences in performance on mean CAS scale scores; F (4, 57) = 7.87, $p < 0.001$. Post-hoc analyses (Tukey HSD) revealed that students performed significantly lower on the planning and successive scale than on the simultaneous scale ($p < 0.001$). There were no significant differences between students' performance on the attention scale and the other CAS scales. This variation across CAS scale scores is somewhat unusual as no significant differences among these scale scores are expected in a sample of normally-achieving children.

To examine the relationships between cognitive processes, phonological processes and basic reading performance, multiple correlation coefficients were completed (see Table 2). Examination of the correlations suggested that there were important relationships among the PASS cognitive processes, phonological processes and basic reading performance. The successive scale correlated highly with phonological memory (PM),

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Table 1. Means, ranges and standard deviations of scale, sub-scale and sub-test scores.

Measures	M	Min	Max	SD
CAS				
Planning	92.69	65.00	121.00	13.39
Attention	96.77	68.00	121.00	11.79
Simultaneous	100.61	73.00	140.00	12.99
Successive	93.58	58.00	134.00	12.81
Full scale	94.17	55.00	113.00	13.12
CTOPP				
Phonological awareness	87.37	46.00	113.00	11.67
Phonological awareness	86.64	52.00	109.00	10.34
Rapid naming	92.86	64.00	118.00	10.51
WJ-III Tests of achievement				
Letter-word identification	92.11	57.00	115.00	13.81
Word attack	90.30	63.00	117.00	11.75

Note: Mean and SDs for all measures were 100 and 15 respectively.

accounting for 64% of the variance, and modestly with phonological awareness (PA), accounting for 25% of the variance. Performance on the simultaneous scale was also modestly related to PA, accounting for 25% of the variance. The planning scale achieved less robust correlations with PM and PA. However, planning correlated modestly with rapid naming (RAN). Attention did not significantly correlate with phonological and basic reading skills.

The relationships among PASS processes and basic reading achievement suggested that there were significant relationships between simultaneous processing and letter-word identification and word attack, accounting for approximately 25% of the variance. There were also significant relationships between planning and letter-word identification.

Performance on the overall CAS full scale correlated significantly with performance on all phonological measures and basic reading-skill measures, accounting for 30% and 36% of the variance, respectively. There was a very strong correlation between phonological awareness and basic reading performance (letter-word identification and word attack), accounting for 49% of the variance. However, there were no significant relationships between phonological memory and basic reading performance.

Table 2. Intercorrelations among all the CAS scales and sub-scales, phonological processing sub-scales and basic reading sub-tests.

	ATT	SIM	SUC	FS	PA	PM	RAN	LW	WA
Planning	0.54*	0.32	0.31	0.74*	0.31	0.30	0.50*	0.50*	0.43
Attention –ATT		0.45	0.25	0.75*	0.32	0.15	0.40	0.40	0.33
Simultaneous-SIM			0.41	0.75*	0.50*	0.30	0.34	0.52*	0.50*
Successive-SUC				0.70*	0.50*	0.81*	0.40	0.41	0.41
Full scale-FS					0.55*	0.54*	0.54*	0.61*	0.60*
Phonological awareness-PA						0.50*	0.30	0.71*	0.70*
Phonological memory-PM							0.30	0.44	0.44
Rapid naming-RAN								0.50*	0.33
Letter-word identification-LW									0.80*

Note: To avoid Type 1 errors, a Bonferroni correction was used. Therefore, only $p < 0.001$ is significant. An * denotes values that meet this criterion.

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Stepwise multiple regression analyses were conducted in order to explore which cognitive processing components better predicted phonological processing components. Performance on the successive processing scale best predicted F (1, 60) = 113.55 ($B = 0.81$, $p < 0.001$) and accounted for 65% of the variance in performance on phonological memory. Planning, attention and simultaneous processing did not enter into the equation and therefore did not significantly predict phonological memory. Phonological awareness was significantly predicted by the combination of the coding processes from the CAS, successive processing ($B = 0.35$, $p < 0.001$) and simultaneous processes ($B = 0.33$, $p < 0.01$), F (2, 59) = 14.30, $p < 0.001$, accounting for 33% of the variance. Planning and attention did not enter into the equation and were not significant predictors of phonological awareness. However, planning ($B = 0.39$, $p < 0.001$) and successive processing ($B = 0.25$, $p < 0.05$) contributed significantly to predicting performance on rapid naming, F (2, 59) = 11.20, $p < 0.001$, accounting for 27% of the variance. Simultaneous and attention did not enter into the equation and therefore did not significantly predict performance on rapid naming.

Next, hierarchical regression analyses were conducted to determine to what extent the combination of phonological variables predicted performance on letter-word identification and word attack above and beyond all four cognitive processing variables. When all four PASS variables were entered into the equation as a step followed by all three phonological processing variables, the phonological processes (R^2 change = 0.23) significantly accounted for 23% of the variance in letter-word identification performance above and beyond the PASS variables (R^2 change = 0.40), F (7, 54) = 11.34, $p < 0.001$. When the phonological processes were entered as a step initially, the cognitive variables (R^2 change = 0.05) significantly accounted for less than 1% of the variance beyond which can be predicted from phonological variables (R^2 change = 0.58) in letter-word identification performance, F (7, 54) = 13.09, $p < 0.001$. When determining the better predictor of word attack, PASS variables were initially entered as a step followed by phonological variables. The phonological variables (R^2 change = 0.21) significantly accounted for 21% of the variance in word attack above and beyond the cognitive processing variables (R^2 change = 0.35), F (7, 54) = 9.7, $p < 0.001$. When the phonological variables were entered initially as a step, the PASS variables (R^2 change = 0.05) significantly accounted for less than 1% of the variance beyond which can be predicted from the phonological variables (R^2 change = 0.51) on word attack, F (7, 54) = 9.7, $p < 0.001$.

Discussion

The purpose of this study was to explore the relationships between PASS cognitive processes, phonological processes and basic reading performance, and to determine which PASS cognitive processes best predicted phonological processes and whether PASS or phonological processes were best predictors of basic word-recognition performance for a sample of referred primary-grade children. Generally, the cognitive characteristics (i.e. low successive processors) among the sample of referred primary-grade children in the current study seemed to be consistent with characteristics of poor readers (e.g. Muter & Snowling, 1994; Swanson, 1992; Torgesen, 1988). For the group of children in the current study, there were modest to high relationships among cognitive processes, phonological processes and basic reading performance. The best predictor of

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phonological memory was successive processing. The particularly strong relationship between successive processing and PM occurred due to the similar nature of the tasks that comprise these scales. For instance, the items on both scales require children to recall information in a serial order. Thus, the overlap of PM and successive processing measurement tasks makes it difficult to distinguish between these phonological and cognitive constructs.

Other cognitive and phonological constructs were more distinguishable but significantly related such as the coding processes (successive and simultaneous) and phonological awareness. The significant relationship between successive processing and phonological awareness as well as simultaneous processing and phonological awareness confirmed theoretical hypotheses proposed by Kirby and Williams (1991). These theorists suggested that acquiring parts of speech demands processing elements of spoken language in a serial manner as well as perceiving words as a whole. Clay (1993), the developer of reading recovery, also emphasised the importance of not exclusively attending to the sounds of oral language but also grasping its sequential structure and detecting common sound patterns.

The demands of successfully completing the items on word recognition tasks not only require examination of letter and sound patterns, but also the fluent execution of words. Planning was most significantly related to performance on rapid naming tasks. The tasks that comprise the planning and rapid naming scales demanded control of effort to provide a rapid, fluent, repetition of speech or written symbols within a certain time period. Planning and simultaneous processing, as well as the overall full scale performance, correlated significantly with letter-word identification. However, the best predictor of performance on letter-word identification and word attack (pseudoword naming) was phonological awareness. This particular finding is consistent with previous research demonstrating that phonological awareness is a better predictor of word recognition skills than cognitive or intellectual ability (e.g. Stanovich & Siegel, 1994; Vellutino, Scanlon & Lyon, 2000).

Even though it has been well substantiated that phonological awareness accounts for the largest proportion of the variance in word recognition skills, cognitive processes or intelligence should continue to be examined in relation to reading and reading-related skills. For instance, studying the relationships between cognitive processes and phonological variables may aid our understanding about underlying components of phonological skills as well as the overlap in these constructs and their measures. Therefore, specific cognitive processing variables (e.g. PASS) should not be excluded from empirical investigations that seek to examine factors associated with phonological skills. When intelligence is defined and measured as cognitive processes, it may not be as irrelevant to performance on reading-related activities as once proclaimed by Siegel (1988). Stated another way, cognitive ability measures such as the CAS have relevance to our understanding of reading disabilities defined as processing disorders that are related to phonological precursor skills or other precursor skills of reading.

Educational and psychological evaluators should consider using phonological processing tests that include phonemic awareness measures like the CTOPP when evaluating a student who is suspected of having reading difficulties. Evaluators should also include tests of basic psychological processes such as those measured by the CAS, rather than general or traditional intelligence tests in order to detect processes that are related to phonological skills and to determine whether or not children demonstrate consistent or inconsistent patterns of processing information.

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Limitations and future directions

The sample size was relatively small and was comprised of a group of children referred for reading problems and therefore not representative of the general population.

Some restriction in range was evident among this sample, which leads to underestimates of the magnitude of the correlation coefficients. Not only would it be useful to increase the sample size, but it would also be interesting to extend this study by examining the same variables across various age groups to determine if differences in the relationship between PASS processes, phonological processes and basic reading skills are evident as children grow older. Future studies may also be designed to detect whether differences would exist between the relationship of PASS processes and phonological processes among groups of children with reading disabilities who had IQ-achievement discrepancies, and children with reading disabilities without IQ-achievement discrepancies. These types of studies have been conducted using the Wechsler scales (e.g. Fletcher et al, 1994). Moreover, it may be important to examine the relationships between cognitive, phonological and basic reading skills among children with different PASS profiles.

Researchers may wish to determine if the CAS predicts performance on phonological tasks as well as word recognition tasks above and beyond what is predicted by traditional models of intelligence such as the Wechsler scales. Furthermore, it would be helpful to determine whether the PASS theory better predicts performance on phonological processes than other alternative models of intelligence or cognitive functioning. Spelling was not a variable in this study but it is another basic literacy task that requires sufficient phonological skills as well as an understanding of the orthography (i.e. noting letter sequences or visual pattern of written words) of language. Therefore, it would be important to include spelling along with word recognition measures in a future study of this kind.

References

Aaron, P.G. & Joshi, R.M. (1992). *Reading problems: Consultation and remediation*. New York: Guilford Press.

Ball, E. & Blachman, B. (1991). Does phonemic awareness training in kindergarten make a difference in early word recognition and developmental spelling? *Reading Research Quarterly*, 26, 49–66.

Bentin, S. & Leshem, H. (1993). On the interaction between phonological awareness and reading acquisition: It's a two way street. *Annals of Dyslexia*, 43, 125–148.

Bowers, P.G. & Wolf, M. (1993). Theoretical links between naming speed, precise timing mechanisms, and orthographic skill in dyslexia. *Reading and Writing: An Interdisciplinary Journal*, 5, 69–85.

Byrne, B. & Fielding-Barnsley, R. (1991). Evaluation of a program to teach phonemic awareness to young children. *Journal of Educational Psychology*, 83, 451–455.

Clay, M. (1993). *Reading Recovery: A guidebook to teachers in training*. Portsmouth, NH: Heinemann.

Griffith, P. (1991). Phonemic awareness helps first graders invent spellings and third graders remember correct spellings. *Journal of Reading Behavior*, 23, 215–233.

Fletcher, J.M., Shaywitz, S.E., Shankweiler, D.P., Katz, L., Liberman, I.Y., Stuebing, K.K., Francis, D.J., Fowler, A.E. & Shaywitz, B.A. (1994). Cognitive profiles of reading disability: Comparisons of discrepancy and low achievement definitions. *Journal of Educational Psychology*, 86, 6–23.

Gathercole, S.E. & Baddeley, A.D. (1990). Phonological memory deficits in language disordered children: Is there a causal connection? *Journal of Memory and Language*, 29, 336–360.

Hatcher, P., Hulme, C. & Ellis, A.W. (1994). Ameliorating reading failure by integrating the teaching of reading and phonological skills: The phonological linkage hypothesis. *Child Development*, 65, 41–57.

Kirby, J.R. & Williams, N.H. (1991). *Learning problems: A cognitive approach*. Toronto: Kagan & Woo.

Luria, A.R. (1973). *The working brain: An introduction to neuropsychology*. New York: Basic Books.

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McDougall, S., Hulme, C., Ellis, A. & Monk, A. (1994). Learning to read: The role of short-term memory and phonological skills. *Journal of Experimental Child Psychology*, 58, 112–133.

Muter, V. & Snowling, M. (1998). Concurrent and longitudinal predictors of reading: The role of metalinguistic and short-term memory skills. *Reading Research Quarterly*, 33, 320–337.

Naglieri, J.A. (1999). *Essentials of CAS assessment*. New York: John Wiley & Sons.

Naglieri, J.A. & Das, J.P. (1997). *Cognitive Assessment System*. Itasca, IL: Riverside Publishing Company.

Nation, K. & Hulme, C. (1997). Phonemic segmentation, not onset-rime segmentation, predicts early reading and spelling skills. *Reading Research Quarterly*, 32, 154–167.

Samuels, J. (1988). Decoding and automaticity: Helping poor readers become automatic at word recognition. *The Reading Teacher*, 32, 403–408.

Share, D.L., McGee, R. & Silva, P.A. (1989). IQ and reading progress: A test of the capacity notion of IQ. *Journal of the American Academy of Child and Adolescent Psychiatry*, 28, 97–100.

Siegel, L.S. (1988). Evidence that IQ scores are irrelevant to the definition and analysis of reading disability. *Canadian Journal of Psychology*, 42, 201–215.

Stahl, S. & Murray, B.A. (1994). Defining phonological awareness and its relationship to early reading. *Journal of Educational Psychology*, 86, 221–234.

Stanovich, K.E. (1989). Has the learning disabilities field lost its intelligence? *Journal of Learning Disabilities*, 22, 487–492.

Stanovich, K.E. & Siegel, L.S. (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of phonological-core difference model. *Journal of Educational Psychology*, 86, 24–53.

Stanovich, K.E., Cunningham, A.E. & Freeman, J. (1984). Intelligence, cognitive skills, and early reading progress. *Reading Research Quarterly*, 14, 278–303.

Swanson, H.L. (1992). Generality and modifiability of working memory among skilled and less skilled readers. *Journal of Educational Psychology*, 84, 473–488.

Tangel, D. & Blachman, B. (1992). Effect of phonemic awareness instruction on kindergarten children's invented spelling. *Journal of Reading Behavior*, 24, 233–261.

Torgesen, J.K. (1988). Studies of children with learning disabilities who perform poorly on memory span tasks. *Journal of Learning Disabilities*, 21, 605–615.

Torgesen, J.K. (1996). A model of memory from an information processing perspective. The special case of phonological memory. In G.R. Lyon & N.A. Krasnegor (Eds.), *Attention, memory, and executive function* (pp. 157–184). Baltimore, MD: Brookes.

Torgesen, J.K., Wagner, R.K. & Rashotte, C.A. (1994). Longitudinal studies of phonological processing and reading. *Journal of Learning Disabilities*, 27, 276–286.

Vellutino, F.R., Scanlon, D.M. & Lyon, G.R. (2000). Differentiating between difficult to remediate and readily remediated poor readers: More evidence against the IQ-achievement discrepancy definition of reading disability. *Journal of Learning Disabilities*, 33, 223–238.

Vellutino, F.R., Scanlon, D.M., Sipay, E.R., Small, S.G., Pratt, A., Chen, R. & Denckla, M.B. (1996). Cognitive profiles of difficult to remediate and readily remediated poor readers: Early intervention as a vehicle for distinguishing between cognitive and experiential deficits as basic causes of specific reading disability. *Journal of Educational Psychology*, 88, 601–638.

Wagner, R., Torgesen, J.K., Laughon, P., Simmons, K. & Rashotte, C.A. (1993). Development of young readers' phonological processing abilities. *Journal of Educational Psychology*, 85, 83–103.

Wagner, R.K., Torgesen, J. & Rashotte, C.A. (1994). Development of reading-related phonological processing abilities: New evidence of bi-directional causality from a latent variable longitudinal study. *Developmental Psychology*, 30, 73–87.

Wagner, R.K., Torgesen, J. & Rashotte, C.A. (1999). *Comprehensive Test of Phonological Processing*. Austin, TX: PROED.

Woodcock, R.W., McCrew, K.S. & Mather, N. (2000). *Woodcock-Johnson Psychoeducational Tests of Achievement-III*. Itasca, IL: Riverside.

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