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THE RELATION BETWEEN NAMING AND LITERACY IN CHILDREN WITH WORD-FINDING DIFFICULTIES

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ABSTRACT

Difficulties with picture naming tasks are associated with literacy problems. Children with dyslexia, when given naming tasks, are slower to produce words and have a higher proportion of errors (Wolf and Bowers, 1999). However, little is known about the relation between literacy and naming in other populations. This study investigates this relation in 20 children (aged 6:6 – 7:11) with word-finding difficulties (WFDs). The children in our sample performed very poorly on assessments of naming, but unlike children with dyslexia, were found to have decoding and spelling abilities within the normal range. In addition, their abilities on phonological awareness tasks were at a similar level to their decoding abilities. In contrast, performance on reading comprehension and language comprehension was significantly worse than for decoding, spelling and rhyme awareness. The implications of our findings for models concerned with understanding the relation between naming speed and literacy abilities are discussed.

~~Research on the association between naming and literacy has concentrated on children with dyslexia or typical children. There are many investigations that report a~~ The co-occurrence of naming and literacy deficits in children with ~~dylsexia~~dyslexia is a well established finding (Denckla and Rudel, 1976a; 1976b; Katz, 1986; Murphy, Pollatsek and Well, 1988; Snowling, van Wagtendonk, and Stafford, 1988; Swan and Goswami, 1997; Wolf, 1984; Wolf and Bowers, 1999; Wolf & Goodlass, 1986; Wolf and Obregon, 1992; Wolf and Segal, 1992). ~~Research~~There also are findings from ~~with~~ typically developing children ~~also~~ that provide~~s~~ evidence of a strong association between performance on naming and literacy tasks (Compton, 2003; Denckla and Rudel, 1976a; Denckla and Rudel, 1976b; Walsh, Price, and Gillingham, 1988; Wolf, Bally, and Morris, 1986). These relations between naming and literacy, have led to consideration of the cognitive processes that underpin the two abilities (see Nation and Snowling, 1999; Share, 1995; Swan and Goswami, 1997, and Wolf and Bowers, 1999).

~~The~~Our ~~aim of the present study~~ is to broaden the population base of studies concerned with naming and literacy by considering these processes in a group of children whose disabilities make them an appropriate test case for such an investigation. These are children who have specific problems with naming and are often described as having WFDs (German & Simon, 1991~~),~~. There are still comparatively few studies of children with word finding difficulties. Little is known about the incidence of this condition in the general population or in language impaired populations, although a survey suggests that at least 23% of children with language difficulties have WFDs (Dockrell, Messer George and Wilson, 1998). These children are characterized by problems involving slower naming, more errors in naming and more failures to retrieve words (German and Simon, 1991). In addition, they may also experience a number of secondary behavioral characteristics such as repetitions, circumlocutions (i.e. functional or visual descriptions), word substitutions, and time-fillers (e.g., er, um, well, you know, etc.). There are suggestions that WFDs are caused by impaired or less elaborate semantic

representations that make access to lexical information more difficult (McGregor, 1997; McGregor and Waxman, 1998). The present study will extend our knowledge of these children by investigating whether their naming difficulties are associated with low scores on literacy assessments.

The examination of children with WFDs also is an opportunity to investigate whether explanations about the development of dyslexia can be applied to other populations. One explanation that is particularly relevant to our investigation has been provided by Swan and Goswami (1997). They suggest that children with dyslexia have imprecise phonological representations and this results in decoding difficulties due to problems in grapheme-phoneme conversion, and also difficulties in retrieving words when naming because the appropriate phonological representations are more difficult to identify. This is consistent with the suggestion that the problems of children with WFDs might be phonological in nature (Constable, Stackhouse and Wells, 1997). Thus, if children with WFDs have naming and decoding difficulties, these could be explained by the presence of imprecise phonological representations. Furthermore, the identification of a similar pattern of performance on literacy tasks to children with dyslexia would strengthen the view that the difficulties experienced by children with WFDs are phonological in nature.

Another explanation about dyslexia that is relevant to naming has been put forward by Wolf and Bowers (1999) in their 'double deficit' model. They suggest that there are two separate causes of reading dysfunction and only one of these deficits involves problems with naming. The well-established finding that literacy and phonological difficulties are associated is the basis for the suggestion that dyslexia involves a deficit in phonological abilities. Wolf and Bowers believe that this deficit results in poor performance on some but not all cognitive

processes involved in dyslexia. The areas affected are thought to involve decoding and reading comprehension, both of which could involve phonological processes.

Wolf and Bowers suggest that a second deficit involves slower processing abilities and this results in poor performance in other components of literacy, in this case naming difficulties and also, like the first deficit, to problems in reading comprehension. Their proposals about the second deficit draw on the findings from serial naming tasks such as the RAN (Rapid Automatized Naming; Denckla and Rudel, 1976a; Denckla and Rudel, 1976b). Children with dyslexia have been found to be slower at serial naming in comparison to typical children (often CA controls). In addition, a number of studies have shown that serial naming speed discriminates between good and poor readers (Bowers, Steffy, and Tate, 1988; Wolf *et al*., 1986), even in kindergarten (Wolf *et al*., 1986), when reading age matches are employed (Wolf, 1999) and over time (Compton, 2003). The same pattern of findings also have been reported in languages with more regular orthographies (e.g. German and Dutch), and in these languages naming speed has been found to be a more important predictor of literacy abilities than in English (Van den Bos, 1998; Wimmer, 1993; Wolf *et al*., 1994). These results offer ~~These studies~~ All this support~~s~~ for Wolf and Bowers' proposal that a processing speed deficit results in poor performance on serial naming tasks, reading comprehension and timed reading, but does not involve problems with phonological awareness or decoding.

Thus, Wolf and Bowers suggest that two deficits contribute to literacy difficulties, only one of which is associated with naming problems. Children with WFDs have naming problems, it is a defining characteristic of the disorder (Dockrell, Messer and George, 2001). Thus, it is possible that these children's difficulties are caused by the second of the two deficits identified by Wolf and Bowers, the one that involves speed of processing. If this is the case then one would expect children with WFDs to have difficulties with tasks involving speed of processing

and with reading comprehension, but they would not necessarily be expected to have problems with decoding of written text or with phonological processing.

To summarize, the associations between literacy and naming in typical children and in children with dyslexia suggests that children with WFDs should experience literacy difficulties, consequently the present study provides a test of this general prediction and an opportunity to investigate whether naming and literacy difficulties are inevitably associated together.

The study also provides an opportunity to investigate more recent and more specific explanations used in research on dyslexia about why naming and literacy difficulties co-occur. If naming and literacy difficulties co-occur ~~as a result~~ because of phonological problems, as argued by Swan and Goswami (1997), children with WFDs should experience text decoding problems. In contrast if, as argued by Wolf and Bowers, speed of processing effects naming and comprehension no specific deficits in decoding are predicted for children with WFDS.

A further issue about this topic, is the relation between phonological abilities, speed of naming and literacy. By considering the relations between the performance of the children with WFDs on different measures it is possible to test the prediction of the double deficit model of Wolf and Bowers that both phonological abilities and speed of naming should be independently related to literacy.

The methodology we employed involved assessing the literacy, language and naming abilities of children with WFDs using a range of standardized assessments (e.g. assessing decoding, reading comprehension and phonology), as well as non-standardized but frequently employed assessments (e.g. letter naming, number naming and the RAN). Thus, ~~the current study~~ we aim~~s~~ to establish (i) the nature of the literacy difficulties of children with WFDs, (ii) clarify the

relationship between naming, phonology and literacy, and (iii) consider the extent to which current models of the association between naming, literacy and phonology explain the performance of children with WFDs.

Method

Participants

The sample consisted of 20 children (14 boys and 6 girls), mean age 7:2 (range 6.6–8.0). Language Units and Speech and Language Therapists referred children, under their care, who they believed had WFDs to the research team. Parental consent and school permission was obtained prior to any preliminary testing. Criteria for inclusion involved having a standardized score on the Test of Word-Finding (TWF, German, 1989) below 85, with standardized scores in the typical range on an assessment of non-verbal cognitive ability and on an assessment of articulation.

The Test of Word-Finding (TWF, German, 1989) was used to identify the sample. This test is designed to assess the word finding skills in young children (6:6 to 12:11 years). There are five sub-tests which measure accuracy and speed of: 1) picture naming using nouns; 2) sentence completion naming; 3) description naming; 4) picture naming using verbs, and 5) picture naming using categories. If a child fails to name an item on a test, the item is represented in a multi-choice comprehension assessment at the end of the session. This provides an evaluation of whether the failure is due to a word-finding difficulty or lack of lexical comprehension. To be included in the study children had to score at least one standard deviation below the mean indicating the presence of word-finding difficulties relative to lexical comprehension skills. The children in the sample had a mean pro-rated standardized score of 70.70 (range 70-77; *SD* 1.56). Floor effects in the calculation of these scores resulted in the

constriction of the range and because of this prorated raw scores (mean 33.20; range 21-55; *SD* 9.03) were employed when correlations were calculated. In addition to identifying WFDs the TWF also provides scores on the sub-tests of accuracy, speed and comprehension. All the children were classified as Inaccurate Namers (mean 55.95, range 40-78), that is they gave more inaccurate responses compared with the grade level standard. In addition, 11 children were assessed as Fast Namers and 9 as Slow Namers; 9 children were classified as Average Comprehenders and the other 11 as Low Comprehenders.

Non-verbal cognitive abilities were assessed by the *Ravens Matrices* (1982). Children are presented with a pattern from which a piece is missing and have to choose the correct one from six possibilities. Children who scored below the 20th percentile were excluded from the study. The children had a mean centile of 60.3 (range 25-95; *SD* 26.6).

The children also were screened for articulation problems by using the *Edinburgh Articulation Test* (Anthony, Bogle, Ingram, and McIsaac, 1971). This involves naming the pictures of common nouns thereby eliciting various consonant articulations. Only children performing within the normal range on this test were included (mean 108.1, *SD* 11.0, range 90-122), this ensured that WFDs were not merely the result of articulation difficulties.

Materials

A series of tests were identified to assess the children's performance on naming, literacy, phonology and comprehension. In cases where a test involves timed performance this is noted. Where appropriate the scores for each test and sub-test were converted to standard scores with a mean of 100 and *SD* of 15.

Naming Assessments

Three tests were employed to assess different dimensions of naming: accuracy of naming; speed of object naming, and speed of naming letters and digits (these two, items were deemed to be low in semantic complexity).

British Ability Scales II (BAS) Naming Scale (Elliott, Smith, and McCulloch, 1997). This assesses accuracy in picture naming of nouns. Scores were converted to t-scores with a mean of 50 and *SD* of 10.

Rapid Automatized Naming (RAN) (Denckla and Rudel, 1974). This involves continuous-naming of a set of pictures of common objects and is a measure of serial naming speed. Scores were calculated in terms of overall speed. The mean response times in seconds was 60.6, *SD* 23.9, range 35.3-134.2.

Naming single letters and digits. The children were presented with one of five letters or digits on a computer screen to assess speed and accuracy of discrete naming. The experimenter pressed a button so the computer recorded when the children produced the correct response. The letters and digits were presented in random order and consisted of the upper-case letters - A, B, E, R, S and the numbers 2, 3, 6, 8 and 9. The mean latency to name the letters and the digits was calculated from the children's responses (Digit Naming mean 3.9, *SD* 2.5, range 2.5-13.9, and Letter Naming, mean 4.3, *SD* 1.8, range 2.5-9.0.

Literacy

Children's single word decoding, spelling and comprehension were assessed using the following measures.

BAS II Word Reading Scale (Elliott *et al.*, 1997). This scale is used to assesse the s recognition and oral reading of single words. The principal aim is to test test items involve single word decoding ability using a sample of words ranging from common ones found in children's books to those that are less common.

Weschler Objective Reading Dimensions (WORD) Basic Reading Test (Rust, Golombok, and Trickey, 1993). This scale is used to assesses recognition and oral reading of single words. The test includes a series of pictures and printed words for assessing decoding and word-reading ability. For the early items the child points to the written word, more advanced items require the child to respond orally.

Weschler Objective Reading Dimensions (WORD) Reading Comprehension Test (Rust *et al*., 1993). The child is presented with a series of printed passages and orally presented questions to elicit comprehension of the passages. The child has to respond orally.

BAS II Spelling Scale (Elliott *et al*., 1997). This scale provides Children are presented with a number of phonetically regular and irregular words to assess their child's ability to produce correct spellings. Each item is first presented in isolation, then within the context of a sentence, and finally in isolation. The child has to respond by writing the word.

Phonology

A number of phonological skills were assessed using the *Phonological Assessment Battery (PhAB)* (Frederickson, Reason, and Frith, 1997). The children were assessed on (i) phonological awareness and (ii) fluency. In each test the child responds verbally.

Phonological awareness is scored from performance on involves rhyme and alliteration tests. For the rhyme test children choose two words that rhymed out of a choice of three (one irrelevant word and two that rhyme). The alliteration test is similar with the exception that the chosen words have the same beginning sound.

The *Fluency* tests involve children generating as many words as they can in each of the following areas: 1) semantic - food and animals; 2) alliteration - words beginning with m and b, and 3) rhyme - words that sound like whip and more. Consequently, the two both the alliteration and rhyme fluency tasks appear to assess both phonological and naming abilities.

Language Comprehension

Language comprehension was assessed at the single word level and the sentence level.

The British Picture Vocabulary Scale (BPVS) (Dunn, Dunn, Whetton, and Pintilie, 1982). This ~~test~~is an ~~a~~assessement of~~s~~ receptive vocabulary. The child responds by pointing to the picture that matches the word spoken by the experimenter.

The Test for Reception of Grammar (TROG) (Bishop, 1989). This is a test of receptive grammar. ~~A multi-choice test in which t~~The child responds by ~~has to~~ pointing to the picture that is matches ~~related to~~ the word or sentence spoken by the experimenter.

Procedure

After identification by Speech and Language Therapists the selection tests (TWF, EAT and Ravens) were administered. If a child met the selection criteria, the naming, phonological and comprehension tasks were administered at a second session. The reading and spelling assessments were administered in a third and final session. The tests were administered according to the standardized procedures. Time was spent talking to the child at the beginning of each session to set them at ease. Each session lasted no longer than forty minutes and the children were tested individually. At the end of each session the child was thanked and returned to class. The children completed all these tests within a three-month period.

Results ~~and Discussion~~

The section begins with (i) a presentation of the standardized scores from the assessments, this allows an identification of the strengths and weaknesses in the performance of children with WFDs. Next the relations between key dimensions of the children's performance are considered in three sections: (ii) Relations between Naming, Comprehension, Phonology and

Literacy; (iii) Relations between Literacy, Naming and other Language measures and (iv) a Multiple Regression Analyses involving Naming, Phonology and Literacy.

Performance on Language and Literacy Assessments

Unexpectedly, the children with WFDs showed relative strengths in reading, spelling and phonological awareness (see Table 1). The mean scores on reading and spelling (BAS Word Recognition, WORD Basic Reading and BAS Spelling) were all within one standard deviation of the mean. Furthermore, 60% of the children were performing within the normal range on BAS Word Recognition and BAS Spelling, although less than half (45%) were within the average range on the WORD Basic Reading assessment. On the two assessments of phonological awareness, the sample had mean scores within the normal range. On the rhyme task, 60% of the children were performing at or above the average for their age, whereas the same figure for the alliteration tasks was 45%.

Please insert Table 1 about here

Comparisons were made between the standardized scores using the Wilcoxon signed ranks test. Table 2 shows that there were no significant differences between the scores for reading and spelling in relation to the rhyme awareness which had the lowest standardized scores of these four assessments (BAS Reading, WORD Reading, BAS Spelling and Rhyme Awareness). This might be expected given the close relation between these abilities in other samples (Bradley and Bryant, 1983; Snowling, 1999). In addition, the standardized scores for reading, spelling and rhyme awareness (but not WORD Basic Reading) were significantly higher than those for alliteration awareness. Thus, rhyme awareness was an area of relative strength comparable to the children's strengths in decoding and spelling, while the scores for alliteration awareness were depressed relative to both decoding, spelling and rhyme awareness.

Please insert Table 2 about here

The standardized scores from the three measures of comprehension (TROG, BPVS and WORD Reading Comprehension) were below 1 S.D. from the mean and were remarkably similar (see Table 1). These scores were, on average, 10 points lower than the scores for reading, spelling and rhyme awareness. Table 3 shows that the gap involved significant differences between scores for phonological awareness and comprehension (except for one comparison). This indicates that children's performance on a range of comprehension tasks, involving receptive grammar, picture vocabulary and reading, was depressed relative to their abilities involving phonological awareness.

Please insert Table 3 about here

The assessments of naming resulted in the lowest standardized scores. All three fluency measures were more than 1 *SD* below the expected mean with performance on the semantic and alliteration fluency tests being particularly impaired. These three tasks involved producing as many words as possible in a restricted time and this suggests the children had a general problem in generating words even when this was not in response to a picture. The children had the highest standardized scores on the assessment of rhyme fluency and this was found to have significantly higher standardized scores than the other two fluency tests (rhyme with alliteration, z=-1.993, p=.046; rhyme with semantics, z=-.3551, p<.001). These significant differences suggests that the children's lexicon is better structured to retrieve words which rhyme, than to retrieve the initial sound of a word or its semantic class. Further comparisons were made between the standardized scores for comprehension and fluency (see Table 4). ~~These comparisons revealed that~~ there was no significant difference between the assessments

of comprehension and rhyme fluency, confirming the relative strength of performance on the latter. In contrast, in most cases, assessments of comprehension were significantly higher than the results for alliteration and semantic fluency, confirming the children's weakness in these two areas.

Please insert Table 4 about here

The *a priori* defining feature of this population was their poor performance on the Test of Word Finding. The mean score for the TWF was even lower than those of fluency and was below 2 *SD* from the mean. The low level of performance on the Test of Word Finding is reflected by two of the fluency measures having significantly higher standardized scores than those from the Test of Word Finding (semantic fluency, z=-3.614, p=.539; rhyme fluency, z=-3.899, p<.001; alliteration fluency, z=-3.080, p=.002). These statistical comparisons confirm that the children had particular problems with naming.

Thus, the children in this sample, despite their lexical difficulties, do not appear to have marked reading difficulties in relation to word decoding or difficulties with the discrimination of rhymes, but they show problems with reading comprehension, language comprehension and measures of fluency~~other aspects of language~~. The children's performance on tasks involving naming was further below those involving comprehension, confirming that naming is an area of particular difficulty. This pattern of performance also supports the view that the children had a specific vulnerability with semantics that compromises their written and oral comprehension. Phonological awareness skills were not similarly affected and consequently, the results do not support a phonological explanation of the children's naming difficulties.

Relations between Naming, Comprehension, Phonology and Literacy

The first part of this section examines the intra- and inter-correlations between naming and literacy (see Table 5; Spearman Correlations). Negative correlations are predicted between measures of latency and accuracy in that slower naming is likely to be associated with lower accuracy. As one would expect, the correlations among most of the naming measures (TWF, BAS Naming, and Speed of Letter and Digit Naming) were high, indicating commonality between these assessments. The exceptions were that performance on the RAN did not significantly correlate with performance on any of the other naming measures and performance on digit naming did not correlate significantly with performance on BAS Naming. There were very high correlations among all 4 of the literacy measures (all above .79; see bottom right of Table 5) and this suggests that performance on these tasks was assessing either the same ability or an underlying ability associated with these tasks.

Please insert Table 5 about here

The inter-correlations between performance on the naming and literacy tasks are relevant to the predictions from the double deficit model of Wolf and Bowers that naming speed and literacy abilities should be related. Most of the literacy measures (single word reading, reading comprehension and spelling) significantly correlated with the measures of naming (TWF, BAS Naming, letter and digit naming). The exceptions were that the RAN did not significantly correlate with any of scores on the literacy tests, and that the Naming and the Spelling sub-tests of the BAS were not significantly correlated. The large number of significant correlations indicate that although children with WFDs were significantly worse at naming than reading (see previous section), these two sets of scores were related, so that those children who had more accurate and faster naming scores also tended to have higher literacy scores. These findings are consistent with the view that processing speed influences naming and literacy performance, but also suggest that additional factors result in impaired naming.

Relations between literacy, naming and other language measures

The correlations between the measures of phonology and fluency are given in Table 6. As might be expected there was a significant relation between performance on the two phonological awareness tasks involving rhyme and alliteration (r=.48, *p*=.032)**.** Two of the fluency tasks were significantly correlated (semantics and alliteration, r=.46, *p*=.039), but rhyme fluency was not significantly correlated with the other two. These findings confirm that assessments of phonological awareness and phonological fluency ~~assess~~ involve different aspects of performance as there were both differences and a lack of correlations between these two sets of assessments. ~~Moreover there is an indication that, for children with WFDS, tasks which involve alliteration are harder than those that involve rhyme.~~

Please i~~I~~nsert Table 6 about here

Table 6 also shows correlations of the phonological tasks with the naming and the literacy tasks. The high correlations (correlations of between .58 and .80) between the tasks involving phonological awareness (i.e. rhyme and alliteration) and literacy would be expected from previous research on these dimensions. The slightly lower and less consistent correlations between performance on these two phonological awareness tasks and naming indicate that there may only be a partial sharing of component processes between the two dimensions.

There was a different pattern of correlations for the fluency tasks. Rhyme fluency was highly correlated with the literacy measures, and this again indicates the importance of this dimension for literacy abilities. The other fluency measures of alliteration and semantics were not significantly correlated with literacy, and thus they may involve a different dimension of

cognitive processing. Somewhat surprisingly, the three fluency measures which involve the production of words had low non-significant correlations with the naming tasks.

The findings suggest that not only were phonological abilities and literacy abilities areas of relative strength for these children, but the two sets of abilities were highly correlated. In addition, although naming was found to be an area of weakness in these children, there were correlations between some phonological abilities and naming. It would appear that phonological processes are involved in naming, but that despite the children having reasonable phonological awareness, additional factors result in the low level of naming performance.

Multiple Regression Analyses involving Naming, Phonology and Literacy

We have seen that both naming and phonological scores were significantly correlated with literacy. This is consistent with the double deficit model of Wolf and Bowers, however, this model also predicts that naming speed and phonology will make separate contributions to the variance in literacy abilities. To test this prediction a multiple regression analysis was conducted. The BAS Reading assessment was chosen as the dependent variable because it had the highest correlation with the other assessments of literacy. Two independent variables were chosen to represent naming and phonological abilities. In t~~T~~he previous set of correlations, ~~had revealed that~~ letter naming was the timed assessment that best predicted literacy abilities and rhyme awareness was the assessment of phonology that best predicted literacy abilities, consequently, these two variables were entered into an exploratory multiple regression. To control for the effects of general ability, chronological age and the raw scores from the Raven's test were also entered into the regression. The multiple regression revealed two significant models. Model A included only the rhyme raw score ($F_{1.18}$=17.45, p<.001, adjusted R square .46), while model B included the rhyme score and letter naming ($F_{2,17}$=13.53, p<.001, adjusted R square .57). Thus, a significant proportion of the variance in

the scores of BAS Reading were accounted for by phonology and speed of letter naming, and these two variables independently contributed to the model.

~~Conclusion~~Discussion

~~The analyses on this sample have revealed that~~M~~ m~~any children with WFDs had mean standardized scores in the normal range on two assessments that are known to be closely related, that is single word decoding ~~literacy~~ and phonological awareness. They had lower levels of performance on comprehension assessments (lexical comprehension, syntactic comprehension and reading comprehension). Their performance was lowest on tasks involving some form of naming, the two fluency tasks, BAS Naming and the Test Word Finding. Thus, the areas of assessment in which the children with WFDs performed less well involved aspects of the semantic system and naming. The semantic system probably is implicated in the children's naming difficulties~~This supports recent suggestions that this locus gives rise to the children's difficulties~~ (Dockrell, et al. 2001; McGregor and Waxman, 1998; McGregor, 1997).

It has been found in p~~P~~revious research on children with dyslexia, ~~has usually found~~ that impairments involving ~~-~~naming, phonological awareness, decoding and spelling tend to co-occur. ~~The finding that m~~M~~any~~ children with WFDs had decoding, spelling and phonological scores within the normal range ~~reinforces~~is consistent with ~~the idea that~~ these abilities being ~~are~~ closely inter-related. However, the findings also demonstrate that at the naming abilities of children with WFDs were significantly below their phonological and literacy abilities. Thus, ~~the findings indicate that~~ naming difficulties are not inevitably associated with low scores on assessments of literacy, and that at the level of performance there can be a dissociation between naming and literacy abilities.

~~The correlations between the standardized scores revealed that most of~~Significant correlations were found between the standardized scores for phonological awareness and literacy abilities, and for naming and literacy abilities. ~~the assessments involving naming and all the assessments involving phonological awareness were significantly correlated with literacy abilities.~~ A multiple regression analysis indicated ~~revealed~~ that both naming speed and phonological awareness made independent contributions to the prediction of literacy abilities. Thus, there were both significant differences and significant correlations between these children's scores on literacy and naming. ~~The findings of significant relations between literacy and naming was accompanied by significant differences between the two sets of variables.~~ This suggests that there are shared cognitive processes which involve both the literacy and naming systems, but that additional factors interfere with the naming performance in children with WFDs. A likely candidate is that an impaired semantic system reduces naming performance.

In discussing these findings about the children's profile of abilities it is worth bearing in mind that the pattern of results could have been influenced by developmental level of the children. For example, Wolf *et al*. (1986) report that in kindergarten children, a number of different assessments of naming speed predicted later reading, but by the end of grade 2 these relations were far more specific, so that the speed of naming letters and numbers predicted reading and in particular, decoding. This might account for the failure, in this study, to detect significant correlations between the RAN and the other variables. Another reason for the lack of correlations might be that the version of the RAN that was administered involved object naming, and as just mentioned, digit or letter naming have been found to have higher correlations with literacy assessments around this age.

We now turn to the cognitive mechanisms that could result in associations between naming, literacy and phonology, and explore the extent to which similar mechanisms to those used to explain dyslexia might also apply to children with WFDs. Swan and Goswami (1997) have argued that in children with dyslexia, imprecise phonological representations can account for both their naming difficulties and literacy difficulties. However, it is difficult to use this suggestion to explain the profile of children with WFDs, these children had naming difficulties, but unlike children with dyslexia their literacy and phonological awareness abilities were largely unimpaired. Thus, imprecise phonological representations are unlikely to be the sole cause of WFDs. Furthermore, the relatively high scores of these children on assessments of phonological awareness tend to cast doubt on suggestions that problems involving phonology alone give rise to WFDs (Constable *et al*., 1997).

Another explanation of the relation between naming difficulties, literacy and phonology has been made by Wolf and Bowers (1999). Interestingly, the children with WFDs appear to fit one of the profiles that they identify. Children with WFDs had no marked deficit on phonological awareness, no marked deficit on decoding tasks (BAS Word Recognition; WORD Reading), but their performance was below the normal range on reading comprehension (and on language comprehension). In addition, these children had slower naming latency than language age controls (Dockrell *et al*., 2001) and the suspicion must be that these children's scores were below the normal range on the RAN, but because norms do not appear to be available for this assessment this must remain uncertain. Consequently, children with WFDs appear to be similar to the profile identified by Wolf and Bowers that involves deficits in naming and in reading comprehension, but not in phonology and decoding.

Furthermore, ~~the finding from a multiple regression analysis of~~ it was found in a multiple-regression analysis that there were separate significant relations between phonology and

literacy abilities, and between naming speed and literacy abilities. These findings are consistent with ~~also supports~~ the double deficit model; both phonology and naming speed independently predicted literacy skills and abilities. Thus, our findings from a population who have WFDs, can be considered as providing support for the recent proposals of Wolf and Bowers. It also is worth noting the similarity between the results from our regression analyses and those conducted by Catts, Gillispie, Leonard, Kail, and Miller (2002) on poor readers with both average and poor IQs. Catts *et al*. report that speed of response accounted for a significant proportion of the variance in reading comprehension and word recognition independently of phonological awareness and IQ. They interpret these findings as suggesting that speed of response is an extraphonological factor in some reading disabilities.

It also is useful to compare our findings with those of Snowling, Nation and their colleagues about a group of children who they term 'poor comprehenders' (Nation & Snowling, 1999; Nation, Marshall and Snowling, 2001). These children are identified by having decoding and phonological skills in the typical range, but they have below average reading comprehension skills and they have naming difficulties. In many respects, the poor comprehenders appear to have a similar profile to children with WFDs. Given the different selection criteria employed to identify these two groups of children the similarities in their profiles are surprising. This increases confidence that the constellation of abilities that have been observed in these two groups is the result of similar underlying cognitive problems that give rise to a coherent pattern of disabilities. ~~In addition, these findings~~ It also provides further support for explanations of naming difficulties being due to problems with the semantic system.

To summarize, an important aspect of these findings is that children with WFDs have naming difficulties that are not accompanied by marked problems in assessments of decoding, spelling or phonological awareness. The finding was unexpected because of previous research on

children with dyslexia who appear to have both reading and naming difficulties. However, more recent discussions by Wolf and Bowers of the abilities of children with dyslexia suggest that there are two separate deficits that contribute to severe literacy problems. The performance of children with WFDs corresponds to one of these profiles, thereby providing support for this explanation of dyslexia and suggesting that the model has a wider relevance that encompasses children who have language difficulties. In addition, children with WFDs appear to have a profile of abilities similar to the 'poor comprehenders' identified by Nation and Snowling (2000). Taken together our findings suggest that most children with WFDs, at this point in development, do not have severe difficulties with single word reading or with phonology, but have greater difficulties in comprehending language and in retrieving words from their lexicon.

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Table 1. Sample Characteristics: Standardized Scores and other Assessments of children with WFDs.

Measure	Mean	*SD*	Range
Reading and Spelling			
BAS Spelling	94.50	21.82	55-145
BAS Word Reading	94.30	17.71	55-137
WORD Reading	90.70	14.46	71-133
Phonological Awareness			
Phonological Awareness: Rhyme	92.00	11.81	69-113
Phonological Awareness: Alliteration	86.15	10.54	69-104
Comprehension			
Test of Reception of Grammar	82.15	8.21	55-69
WORD Comprehension	81.15	9.79	68-100
British Picture Vocabulary Scale	81.05	12.57	50-97
Assessments of Fluency			
Fluency: Rhyme	82.65	11.38	69-107
Fluency: Alliteration	77.65	8.57	69-100
Fluency: Semantic	73.80	8.10	69-96
Naming			
BAS Naming Scale	79*	9.28*	62-108
German Test of Word Finding (Prorated)	70.70	1.56	70-77

*Mean and Range are standard scores transformed from T scores.

Table 2. Comparisons between Performance on Literacy and Phonological Awareness Assessments.

Comparisons Between Standardized Scores of Literacy and Phonological Awareness			
Literacy Assessment	Phonological Assessments	*Z* score	Significance
Word Basic Reading	Rhyme Awareness	-0.564	n.s.
BAS Word Reading		-0.524	n.s.
BAS Spelling		-0.558	n.s.
Word Basic Reading	Alliteration Awareness	-1.608	n.s.
BAS Word Reading		-2.274	.023
BAS Spelling		-2.016	.044
Rhyme Awareness		-3.724	.000

Table 3. Comparisons between Performance on Phonological Awareness and Comprehension Assessments.

Comparisons Between Standardized Scores of Phonological Awareness and Comprehension			
Phonological Assessments	Comprehension	*Z* score	Significance
Rhyme Awareness	TROG	-2.931	.003
	WORD Comprehension	-3.550	.000
	BPVS	-3.286	.001
Alliteration Awareness	TROG	-1.228	n.s.
	WORD Comprehension	-2.242	.025
	BPVS	-2.015	.044

Table 4. Comparisons between Performance on Comprehension Assessments and Fluency.

Comparisons Between Standardized Scores of Comprehension and Fluency			
Comprehension	Fluency	*Z* score	Significance
BPVS	Rhyme Fluency	-0.463	n.s.
WORD Comprehension		-0.242	n.s.
TROG		-0.022	n.s.
BPVS	Alliteration Fluency	-1.215	.n.s.
WORD Comprehension		-1.417	.157
TROG		-1.990	.047
BPVS	Semantic Fluency	-2.093	.036
WORD Comprehension		-2.655	.008
TROG		-2.780	.005

Table 5. Correlations between Naming and Literacy

	Naming Assessments					Reading Assessments			
	TWF	BAS Naming	Speed of Letter Naming	Speed of Digit Naming	RAN	BAS Reading	Word Reading	Word Comp	BAS Spell
Naming Assessments									
BAS Naming	**.65***	-							
Speed of Letter Naming	**-.70****	**-.56****	-						
Speed of Digit Naming	**-.49***	-.36	**-.60****	-					
RAN	-.07	-.10	.30	-.12	-				
Reading Assessments									
BAS Reading	**.58****	**.49***	**-.66****	**-.62****	-.34	-			
WORD Reading	**.57****	**.64****	**-.60****	**-.50***	-.37	**.93****	-		
WORD Compreh	**.46***	**.49***	**-.65****	**-.53***	-.36	**.87****	**.86****	-	
BAS Spelling	**.48***	.41	**-.66****	**-.59****	-.30	**.91****	**.83****	**.79****	-

Significant Correlations given in bold, * p<.05 ** p<.01 (for correlations >.59, p is equal or less than .005 and for correlations >.66, p is equal or less than .001)

Table 6. Correlations between Scores from Phonological, Literacy and Naming Assessments

	Sub-scales of the PhAB				
	Rhyme Aware	Alliteration Aware	Fluency Rhyme	Fluency Alliteration	Fluency Semantic
Sub-scales of the PhAB					
Alliteration Awareness	**.48***				
Fluency Rhyme	.41	.23			
Fluency Alliteration	.37	.23	.31	-	
Fluency Semantic	.25	.26	.15	**.46***	-
Literacy Assessments					
BAS Reading	**.76****	**.60****	**.53***	.34	.16
WORD Reading	**.71****	**.58****	**.58****	.42	.24
WORD Comprehension	**.67****	**.65****	**.48***	.42	.24
BAS Spelling	**.80****	**.60****	**.59****	.32	.16
Naming Assessments					
TWF	**.65****	.30	.11	.00	.14
BAS Naming	.38	.34	.20	-.04	.07
Speed of Naming Letters	**-.64****	**-.65****	-.04	.14	.08
Speed of Naming Digits	**-.63****	**-.66***	-.04	-.20	-.04
RAN	-.04	-.38	.03	-.12	-.27

Significant Correlations given in bold, * p<.05 ** p<.01 (for correlations greater than .59, p is equal to or less than .005 and for correlations greater than .66, p is equal to or less than .001)