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RELATIONSHIPS BETWEEN SPEECH PERCEPTION, PHONOLOGICAL AWARENESS AND LANGUAGE IN THE DEVELOPMENT OF LITERACY

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SEPTEMBER 2007

Submitted in partial fulfilment of the MSc in Speech and Language Sciences

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ACKNOWLEDGEMENTS

Firstly, I would like to thank Jana Dankovicova for agreeing to take over as my supervisor following Maggie Vance's departure from the department. Thank you so much for your advice and suggestions. Thank you to Maggie for organising the school visits that enabled my colleagues and I to collect data, for providing us with a place to stay while we did so, and for being available to help with specific queries over the last few months. Many thanks also to Chris Donlan for his patience in assisting me with the statistical analysis involved in this project.

I would also like to thank the teachers at the various schools visited for their co-operation and patience, and the parents and pupils involved for so readily agreeing to participate in this research.

Finally, I would like to thank my colleagues, Alix Dudman and Helen Raby, for their contributions to the data collection, and for all their help and support over the last year.

ABSTRACT

It is widely accepted that literacy development is associated with phonological awareness, speech perception and language skills. The extent to which speech perception and language contribute to literacy, directly or indirectly via phonological awareness, is however unclear. This study aimed to achieve a more holistic understanding by investigating the contribution of all variables to literacy, simultaneously. Consistent with the Comprehensive Language Approach, it was hypothesised that, along with language and phonological awareness, speech perception would also contribute uniquely to literacy, and that mutually-reinforcing relationships between all variables would be found, such that the pattern of contributions to literacy from all variables would differ as a function of literacy skill. A task battery assessing speech perception, language, phonological awareness and literacy was administered to a sample of fifty-four 6-year old children. Multiple regression analyses revealed only phonological awareness and speech perception to contribute uniquely to the full range of literacy scores, explaining 8% and 20% of the variance respectively. A mean split of literacy scores was used to compute upper and lower halves of the range. No significant contributions were found to either shared or unique variability in the upper half of the literacy range, likely due to restricted sensitivity in measures. In the lower half of the literacy range, unique contributions to literacy were found only for speech perception and language. Results appear to reflect greater stability in the relationship between speech perception and literacy than in relationships between language and literacy and phonological awareness and literacy, where level of literacy skill and experience may be implicated. Clinical implications for instruction and remediation are discussed, as is the need for further research to determine whether mutually-reinforcing relationships may assume different patterns, associated with different developmental stages.

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1. INTRODUCTION

1.1. A Central Role for Phonological Awareness

Phonological awareness is a metalinguistic skill that involves the ability to reflect on and manipulate the sounds of words (Stackhouse & Wells, 1997). It has been argued that this skill involves a developmental progression through the pre-school and early school years from awareness of syllables to awareness of onsets (the initial consonants in a syllable e.g. /tr/ is the onset of 'train') and rimes (the vowel and final consonants of a syllable e.g. /eɪn/ is the rhyme of 'train') to awareness of phonemes (the smallest sound units that signal meaning differences) (Goswami & Bryant, 1990). Much well-established evidence now exists that children's phonological awareness skills play an important role in early reading ability. Those children who are better able to detect syllables (Mann & Lieberman, 1984), rhymes (Lundberg, Olofsson & Wall, 1980; Bradley & Bryant, 1983; Bryant, MacLean, Bradley & Crossland, 1990) or phonemes (Bryant, MacLean, Bradley & Crossland, 1990; Nation & Hulme, 1997) progress more successfully in their reading development than their peers who have difficulty with such tasks.

A significant amount of research and debate has been dedicated to identifying which aspects of phonological awareness are most influential, particularly whether 'large' or 'small' phonological units are better predictors of differences in reading skill. In this respect, phoneme awareness – the ability to detect and manipulate individual phonemes in words - is the most widely supported correlate of literacy skill. This has been attributed to the extent to which phoneme awareness relies on the existence of well-specified phonemically structured phonological representations that support mappings between orthography and phonology (Hulme, Hatcher, Nation, Brown, Adams & Stewart, 2002). It is now widely accepted that while phonological awareness at syllable-and onset-rime level are precursors to literacy, the relationship between literacy and phoneme-level phonological awareness is reciprocal, developing, partly, as a consequence of learning to read (Goswami & Bryant, 1990; Morais, 1991).

Training studies provide a useful means of further investigating the causal connection between children's phonological awareness and their literacy development. A range of such studies have shown that training children at tasks designed to improve their phonological awareness has improved their reading achievement. This has been found for children in the very early stages of learning to read (McGuiness, McGuiness & Donohue, 1995), for pre-schoolers for whom formal reading instruction has not yet begun (Lundberg, Frost & Peterson, 1988; Bryne & Fielding-Barnsley, 1991), and in young children at risk of failure to learn to read (Borstom & Elbro, 1997). In line with the 'phonological linkage hypothesis' (Hatcher, Hulme & Ellis, 1994), the effects of phonological awareness training on reading appear to be strongest when the links between phonemes and printed letters/graphemes are made explicit (e.g. McGuiness et al, 1995 and Borstrom & Elbro, 1997). However, significant effects have also been reported for training studies where graphemes have not been used, particularly with pre-school children who have not yet been formally exposed to letters and reading practice. Thus, Lundberg et al (1988) employed a reading-independent training programme comprising metalinguistic games and exercises in their study of Danish pre-schoolers, while Byrne & Fielding-Barnsley (1991) emphasised only sounds in words, using large pictured objects of words beginning and ending with target sounds to support understanding. Interestingly, Byrne & Fielding-Barnsley's (1991) training programme resulted in improved post-training measures of phonemic awareness for both trained and untrained sounds, indicating that training programmes need not target all phonemes in a language to have a beneficial effect.

1.2. The Mediating Role of Phonological Awareness

The importance of phonological awareness to reading acquisition has led to various attempts to clarify factors that may underlie deficits in this skill. One area of investigation has involved children with dyslexia. Such children have specific difficulties with learning to recognize printed words, pronouncing nonsense words and spelling. Their difficulties have been explained in terms of the phonological deficit hypothesis (Rack, Snowling & Olson, 1992; Rack, 1994) as the result of specific deficits in the use of phonological information, leading to deficits in sound segmentation, categorisation, and blending, all of which limit the ability to make the letter-sound correspondences necessary to learn to read. Studies that have investigated the reading abilities of both reading-impaired children and children with a specific diagnosis of dyslexia have, however, suggested that deficits in phonological skill associated with their reading difficulties may have their roots in a more basic perceptual deficit. Early research by Tallal (1980) investigated the performance of 8- to12- year old reading-impaired and control children on a battery of *nonverbal* auditory perceptual tests involving discrimination and perception of temporal order. Reading-impaired children made significantly more errors than controls in responding to rapidly-presented nonverbal auditory stimuli. Their ability on this task was also significantly correlated with their performance on a non-word reading test that assessed ability to make phoneme-grapheme correspondences. From this, Tallal (1980) concluded that reading difficulties might be explained in terms of a primary perceptual deficit affecting the rate at which perceptual information is processed, with implications for efficient phonetic code analysis required to learn to read.

While Tallal's (1980) investigation focused on perception of nonverbal acoustic stimuli, other research has looked more specifically at dyslexic children's perception of speech information. A major experimental paradigm used to investigate this is categorical perception of stop consonants such as /p/, /b/, /d/, and /g/. Despite the fact that, in the paradigm, the consonants /p/ and /b/ are placed along a continuum of voice onset time (VOT) and are continuous in speech, individuals tend to perceive them as discontinuous and can differ in the timing at which they demonstrate the perceptual boundary between phonemes. Manis, McBride-Chang, Seidenberg, Keating, Doi, Munson & Petersen (1997) used such a paradigm when they administered phonological awareness (phoneme level) and phoneme identification tasks to children with dyslexia. They found that those dyslexic children with poor phonological awareness skills showed greater difficulties with speech discrimination tasks (i.e. identifying instances of 'path' and 'bath') than chronological-age and reading-level control groups as well as those dyslexic children with better developed phonological awareness. Interestingly, Manis et al's (1997) discovery that not all of the dyslexic children in their study exhibited a speech perception deficit, prompted them to conclude that these deficits in dyslexia may be quite individualised.

Similar speech perception difficulties have emerged from investigations comparing skilled and less skilled readers, not necessarily classified as having dyslexia. Further, whereas research such as that by Manis et al (1997) above has indicated an *association* between speech perception and phonological awareness, other research attempts to show direction of causality between these variables. Thus, Chiappe, Chiappe & Siegal (2001) examined categorical speech perception along the /b/ - /p/ continuum of 6-year old good and poor readers, defined by their score on the Wide Range Achievement Test – 3 (WRAT – 3; Wilkinson, 1995). Results showed that poor readers had shallower phoneme identification slopes, indicating less clearly defined categorical perception than good readers. Their difficulties were not only apparent at the perceptual boundary between /p/ and /b/, but also at either end of the continuum, i.e. poor readers had difficulty identifying even clear instances of these two phonemes. In addition, however, reading group differences in phonological awareness were eliminated when they were statistically corrected in line with the children's phoneme identification slopes, i.e. differences between good and poor readers on phonological awareness measures could be explained by individual differences in speech perception, but phonological awareness measures did not explain reading group differences in speech perception. Thus, Chiappe et al (2001) argue that their results suggest a causal role for impaired speech perception in the phonological awareness deficits associated with reading difficulty.

A similar causal role for impaired speech perception in phonological awareness deficits has been proposed for children with Specific Language Impairment (SLI). Despite having normal hearing, intelligence and opportunities to learn language, these children exhibit difficulties with several aspects of language, including phonology, syntax and morphology, especially function morphemes (e.g. 'the', 'a', and 'is') and tense and plural markers. From the perspective of perceptual accounts of SLI, these children learn language incorrectly because they misperceive speech (Joanisse & Seidenberg, 1998). Indeed, they show a range of subtle impairments in speech perception, including failure to discriminate consonant voicing (/ba/ vs /pa/) and place of articulation (/ba/ vs /ga/) (Elliott, Hammer & Scholl, 1990), and difficulty identifying steady-state vowels (Stark & Heinz, 1996). Perceiving speech in noise is particularly challenging among children with language and learning difficulties (Bradlow, Krause & Hayes, 2003) and children with SLI have been found to show significant speech perception deficits under conditions of both stationary and fluctuating noise (Ziegler, Pech-Georgel, George, Alario & Lorenzi, 2005). Furthermore, research has shown that children with SLI are more likely than their normally-developing counterparts to experience literacy difficulties that are present both before entering school and even well after school entry (Bishop & Adams, 1990; Tallal, Allard, Miller & Curtiss, 1997; Snowling, Bishop & Stothard, 2000). Tallal et al (1997) propose a developmental continuum between language disorders such as SLI and reading disorders, such that both are related to a basic processing constraint that disrupts the development of normal phonological processes with different effects across the age range, i.e. impaired phonological processing affects oral language in the early years, and subsequent reading development at school.

Studies such as those reviewed above allow for the possibility that speech perception may affect reading via its effect on phonological awareness skills, i.e. the impact of speech perception skills on reading ability may be mediated by phonological awareness. Indeed, consistent with this view, Stackhouse & Wells (1997) argue that phonological awareness is dependent on the integrity of the underlying speech processing system. Within their psycholinguistic framework (1997, see Appendix 1.), the speech processing system comprises input systems for receiving spoken information, output systems for producing spoken words and sentences, and lexical representations or stores of word knowledge. From the perspective of this model, children who fail to perceive clear distinctions between phonemes (input) will be unable to form readily accessible representations of these phonemes. Consequently, their ability to manipulate and segment phonemes and to learn phoneme-grapheme correspondences will be impaired, with obvious implications for reading development. Indeed, research supports this theoretical viewpoint. Attempting to specify the nature of the relationship between speech perception, phonological awareness and literacy, McBride-Chang (1996) tested five different structural models of word reading among 8-to 10–year old children. The three models of particular relevance to the present study proposed that speech perception affects reading 1) indirectly, only through its association with phonological awareness (Indirect Model), 2) indirectly and directly, (Direct Model) and 3) directly but without the association with phonological awareness (Direct – No Phonological Awareness Model). Using structural equation modelling, the best fitting model was found to be the Indirect Model in which the relationship between speech perception and reading was mediated by phonological awareness.

Another skill area underlying phonological awareness which has attracted interest is language ability. Research has revealed relationships between language skills generally (and vocabulary size in particular) and phonological awareness. In a longitudinal study of Finnish children for example, Silven, Nieme & Voeten (2002) found receptive and expressive vocabulary at 2 years of age, as measured from videotaped mother-child interaction sessions, to predict onset-rime sensitivity at 4 years. Similarly, Cooper, Roth, Speece & Schatschneider (2002), for example, found that general language ability (receptive and expressive semantics, syntax and morphology) measured in kindergarten was able to predict a significant amount of unique variance in phonological awareness from kindergarten through to second grade, even when controlling for the reciprocal influence of reading on phonological awareness, i.e. language skill predicted phonological awareness uncontaminated by reading ability. Hence, associations between early language and phonological awareness appear to continue even into the school years.

The extent to which changes in lexical knowledge/vocabulary growth, in particular, act as a precursor to the phonological awareness skills implicated in early reading has been proposed within the Lexical Restructuring Model (Metsala & Walley, 1998). By this model, the growth of children's vocabularies as they progress through infancy to middle childhood prompts the development of word representations within their mental lexicons from those that are holistic/global in nature to those that are more fine-grained and segmental. Thus the more course-grained syllabic and prosodic information in spoken words that would be sufficient to distinguish between the words 'mommy' and 'cat' in a small lexicon with few overlapping items would not be sufficiently useful for a child with a larger lexicon, who may also have acquired the words 'can', 'cap', 'bat', 'fat', 'cot' and 'cut'. The more fine-grained representations that enable such discriminations are better able to support the mapping process between sounds and letters that is essential to learning to read. In support of this theoretical viewpoint, a series of experiments carried out by Metsala (1999) revealed strong positive correlations between receptive vocabulary size and performance on phonological awareness tasks in 4-, 5- and 6-year old children. In addition, however, Metsala (1999) also found that psychological characteristics of word items such as word status (word/non-word), age of acquisition (earlier/later) and neighbourhood density (involving phonological similarity relationships between lexical items) were correlated with phonological awareness. Thus, children demonstrated better phonological awareness for real words (for which they possessed phonological representations), that were acquired earlier in life (for which they had had time to develop more segmented 'adult-like' representations), and that had many similar sounding neighbours (necessitating more finely-tuned representations).

Studies illustrating a relationship between language and phonological awareness allow for the possibility that, just as phonological awareness may mediate the relationship between speech perception and literacy, so too may it mediate the relationship between language and literacy. Associations have certainly been shown between all three variables. Early research by Scarborough (1990) investigated the language processing abilities of children from 'dyslexic families', some of whom later went on to develop dyslexia and some of whom became normal readers. Children's language skills were assessed at 2, 3- and 5-years of age, and their reading ability assessed at the age of 8 years. A range of language deficits were found to exist for those children who went on to become dyslexic, including more limited use of syntax in conversation with their mothers at 2 years of age and poorer vocabulary and object-naming abilities at 3 and 5 years of age. At 5 years, poorer phonological awareness and letter-sound knowledge were also apparent. None of these deficits were found in those children who developed normal reading skills. More specific evidence to support the mediating role that phonological awareness may have in the relationship between language and literacy has been found for typically developing children. In an attempt to identify the factors most crucial to literacy development, Chaney (1994) investigated the inter-relationships among socio-economic factors, language development, metalinguistic awareness (including measures of phonological awareness, word awareness and structural awareness), print awareness and family literacy in 3-year olds. She found that a measure of general structural language, encompassing semantics, morphology and syntax, was the best predictor of metalinguistic skill, itself associated with literacy. An even clearer demonstration of this relationship was provided by Olofsson & Niedersoe (1999). Their path analysis showed significant relationships between pre-school language measures (including vocabulary, sentence construction, repetition and completion, speech comprehension, and morphology) and reading ability in school. Interestingly, this included both a significant indirect path between early language abilities and school reading ability via phonological awareness, but also a significant *direct* path between early language abilities and school reading.

1.3. Independent Predictors of Literacy

The evidence reviewed above has suggested that the roles of both speech perception and language in literacy development may be indirect, i.e. mediated by phonological awareness. However, the extent to which speech perception and language make only indirect contributions to the development of literacy is questioned by research which has found independent effects of these variables, over and above those of phonological awareness. In this respect, del Rasario, Gonzalez, Garcia Espinel & Rosquete (2002) found evidence to suggest that speech perception contributes directly to reading when they examined two types of phonological training in 9- to 11-year old children with reading difficulties. One programme trained children in speech discrimination, letter-sound correspondence and phonemic awareness while the other trained children only in letter-sound correspondence and phonemic awareness. While both experimental groups improved in phonemic awareness compared to the control group, only the group who underwent speech perception training scored higher than the control group on reading measures. A similar independent role for speech perception was found by Chiappe, Glaeser & Ferko (2007) in their investigation of the roles of speech perception and phonological processing in reading and spelling acquisition over a one year period for 6-year old native and non-native English speakers. Their results showed that while speech perception and phonological awareness measures explained shared variance in predicting growth in word reading performance, speech perception also explained significant unique variance in reading for both groups of children.

Likewise, independent contributions to literacy from language and phonological awareness have been revealed in several longitudinal studies. The direct relationship between a range of language measures and literacy has already been alluded to in review of a path analysis carried out by Oloffson & Niedersoe (1999). Similarly, Chaney (1998), in a longitudinal follow-up of her 1994 research, investigated the relationship between metalinguisitic and language abilities measured at the age of 3 years and reading progression at 7 years. Hierarchical regression analyses showed independent contributions to literacy from both these skills with metalinguistic skills contributing over and above the contribution made by language measures. In another longitudinal investigation, Catts, Few, Zhang & Tomblin (1999) found that phonological awareness and a composite of language measures (including expressive and receptive vocabulary and grammar) at kindergarten were *both* significant predictors of literacy in the second grade, although in contrast to Chaney (1998), their composite language measure contributed more unique variance to literacy than phonological awareness.

Direct relationships between language, phonological awareness and literacy appear to exist even among children who have not yet been exposed to formal reading instruction. In a concurrent investigation, Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe (2003) studied the relationship between phonological awareness and language (receptive vocabulary) in a low-income population of 4-year olds. Hierarchical regression analysis revealed both phonological awareness and language to be equally significant predictors of print knowledge, as measured by performance on emergent literacy tasks, i.e. the ability to 'read' environmental print (e.g. identifying 'Macdonalds' from the logo), familiarity with printed language, letter knowledge and early writing. In interpreting their results, Dickinson et al (2003) refer to the distinction between the Phonological Sensitivity Approach (PSA) and the Comprehensive Language Approach (CLA) to literacy. From the perspective of the PSA, phonological sensitivity is the key language ability supporting reading development, while the CLA affords literacy development to the *interaction* between varied language skills so that phonological awareness is but one element that supports early and later reading, along with discourse, syntax and vocabulary. Dickinson et al (2003) argue their findings to support the CLA – thus, not only did they find independent contributions to print knowledge for language and phonological awareness, but also that all three abilities were significantly correlated. Indeed, these inter-relationships were influenced by level of proficiency at each skill so that language was a stronger predictor of literacy growth among children with normal phonological awareness than it was among children with poorer phonological awareness, while phonological awareness was a stronger predictor of literacy among children with normal language skills than among children with poorer language skills. Dickinson et al (2003) argue this pattern of findings to indicate the extent to which the relationships between language, phonological awareness and literacy/print knowledge are mutually-reinforcing.

It is notable from the review of relevant data presented here that studies attempting to address the relationships between speech perception, language, phonological awareness and literacy have tended to investigate different combinations of these variables: either speech perception, phonological awareness and literacy OR language, phonological awareness and literacy. Thus, it is difficult to gain a complete holistic picture of the influences and interactions between all variables. One study has addressed all variables simultaneously. Metsala (1997) compared spoken word recognition between 9-year old impaired and normally-developing readers using a speech-gating task, in which children heard increasingly longer segments of speech input presented from word onset, and used this to guess the identify of the target word. Results showed that among the youngest children, speech perception measured with this task contributed to word and non-word reading even after variance due to phonological awareness and receptive language (vocabulary) had been accounted for.

While Metsala's (1997) study is certainly useful in showing independent contributions from speech perception to literacy in the context of language and phonological awareness, it is ultimately limited as a simultaneous investigation of all variables: it did not identify whether language and phonological awareness themselves each made unique contributions to literacy, nor the extent to which speech perception maintained its unique contributions to literacy in this case. The present study aims to do both, investigating speech perception, phonological awareness and language simultaneously in an attempt to achieve a more comprehensive picture of the role of *all* variables in the development of literacy. In light of Metsala's (1997) findings and the CLA (Dickinson, 2003), the following hypotheses are proposed:

1. Speech perception, language and phonological awareness will each contribute uniquely to variance in literacy scores. This expected pattern of results is hypothesised to reflect the extent to which speech perception may also have a place among the range of 'language' abilities that support literacy, proposed within the CLA.
2. There will be significant correlations between all variables studied, i.e. speech perception, language, phonological awareness and literacy.
3. The pattern of relative contributions made to literacy by speech perception, language and phonological awareness will differ as a function of reading skill. Thus, whereas Dickinson et al (2003) found that phonological awareness was less predictive of literacy among children with poorer language skills and language skills less predictive of literacy among children with poorer phonological awareness, it is hypothesised here that the full range of variables will contribute less to literacy among those children with more poorly developed reading skills than they will to children with more highly developed reading skills, thus providing more support for the mutually-reinforcing nature of the relationship between these variables.

2. METHOD

2.1. Design

The study employed a correlational design, with literacy as the dependent variable and speech perception, language and phonological awareness as the independent variables.

2.2. Participants

Fifty-four children (thirty males twenty-four females) from four primary schools in the south east of England participated in this study. Parent information letters and consent forms were sent to parents of all children who had participated in an earlier phase of research and all children for whom consent was received were tested in the January of their Year 1 year. The average age of the children was 6 years 8 months.

2.3. Materials

Each child was assessed on a battery of language, reading, speech perception and phonological awareness measures. The assessments used included:

2.3.1. Speech perception

Speech perception skills were assessed using the XAB Non-word Discrimination task from Vance, Rosen & Coleman's (2005) Speech Input Processing in Children programme (SIPc). The programme is computer-based and is presented as a game involving aliens in spaceships. In this instance it was presented on a laptop with an external mouse. The programme assesses children's ability to discriminate between stimulus sets of non-words differing by one phoneme. Via headphones, children hear one alien produce the non-word X (e.g. 'spish') and then two further aliens producing the non-words A and B (e.g. 'spish' and 'stish'. See Appendix 2). Children must identify which of these non-word stimuli matches the first stimulus. In addition to assessing speech perception in quiet conditions, children's abilities under noise conditions were also investigated since this represents a more sensitive measure of speech perception ability (e.g. Bradlow, Krause & Hayes, 2003).

2.3.2. Receptive language

The Sentence Structure subtest of the CELF-R (Semel, Wiig & Secord, 1987) was used to assess the children's understanding of a range of sentence structures including negatives, passives, relative clauses, subordinate clauses, infinitives, prepositional phrases, indirect objects and Wh-interrogatives. This subtest includes twenty-six items and children are required to select from an array of four pictures the one that matches a spoken sentence.

2.3.3. Phonological Awareness

Two subsections of the PIPA (Dodd, Crosbie, McIntosh, Teitzel, & Ozanne, 2000) were used to assess phonological awareness skills. These were the Rhyme Awareness subtest which assesses ability to identify from a list of four pictured words the one that does not rhyme (e.g. 'rake, snake, cake, corn') and the Phoneme Isolation subtest which requires identification of the first sound of a word (e.g. the first sound in 'fish').

2.3.4. Reading

Children's reading skills were assessed using the Word Identification subtest of the Woodcock Reading Mastery Tests - Revised (Woodcock, 1987) which required children to read aloud isolated words increasing in difficulty.

2.4. Procedure

Children were invited to leave the classroom one by one and were tested on the entire assessment battery individually in a quiet room. It took about thirty minutes to administer the battery to each child.

The order of assessment tasks was varied for each child to preclude order effects. The receptive language, phonological awareness and reading assessments included in the battery were administered in accordance with instructions from the relevant test manuals. Practice items were included for all tests.

Prior to both the speech perception assessment in quiet and noise, each child was given the opportunity to practise the task first using the practice blocks included in the programme. The practice block for each condition included fifteen items, allowing the child to learn how to do the task and ensuring that they were comfortable using the mouse to make their responses. For each item, the XAB format was adopted: a large spaceship was presented in the upper half of the screen, with two smaller spaceships in the lower half. The presentation of the first non-word (X) was accompanied by the appearance of an alien in the large spaceship. Two further aliens appeared in the smaller spaceships at the bottom of the screen to accompany presentation of two further non-words (A and B), one of which matched the non-word presented previously. In the quiet condition, the following explanation of the task was given to each child to accompany the display on the screen, before beginning the practice block: *'We're going to play a game about aliens. Here's a big alien in his spaceship. He's going to say a word. Then two little aliens will arrive. Each one of them will also say a word. Now, you have to listen really carefully and click on the little alien that copies what the big one said'.* A similar explanation preceded the practice block in noise. Each child was told that this time when they listened to the aliens, there would be some noisy children talking too and they would have to listen very carefully. The task was self-paced so that the experimenter initiated each item when the child was ready to attend. For the first five practice items, visual prompts appeared above each alien to support the auditory matching involved in the task, but the child's attention was not drawn to these. For each correct response, the aliens disappeared, the child heard 'well done' and a coloured balloon was added to a space on the left hand side of the screen. For an incorrect response, the aliens remained on screen and the child heard 'try again'. This feedback and repetition of stimuli were repeated until the child made the correct response. If the child's responses indicated that he/she understood the task, the programme then proceeded to the test block. If the child produced incorrect responses for more than four or five of the items, they were given the opportunity to redo the practice block. The test blocks proceeded exactly as the practice block but without visual prompts above the aliens and without instruction or feedback. Four test blocks were administered to each child (two in quiet and two in noise) but they did not always follow on from each other consecutively because of the varied presentation order of each individual assessment task. Similarly to the practice blocks, each of the test blocks consisted of fifteen items.

Once each child had completed the test battery, they were invited to choose a sticker as a reward for their participation.

3. RESULTS

3.1. Descriptive Statistics

For each child a set of raw scores for literacy, language, phonological awareness, speech perception in quiet and speech perception in noise was calculated. On the literacy assessment, scores were those achieved before making six consecutive errors. The maximum score on the language assessment was 26. Since two subtests of the PIPA had been used to assess phonological awareness, scores from these subtests were summed to produce a total phonological awareness score out of 24 for each child. Scores from the test blocks testing speech perception in quiet (two blocks) and in noise (two blocks) were summed to produce a total score out of 30 for each condition.

Inspection of the data showed only literacy and phonological awareness scores to be roughly normally distributed. It should be noted that literacy scores were not symmetrical about the mean. Speech perception in quiet data showed clear ceiling effects and was therefore not included in further analysis[1] (see Figure 1 and 2). Significant skew was also evident in language and speech perception in noise data but no adjustments were made to these since literacy, as the dependent variable, was normally distributed. Descriptive statistics of the scores for each variable are provided in Table 1.

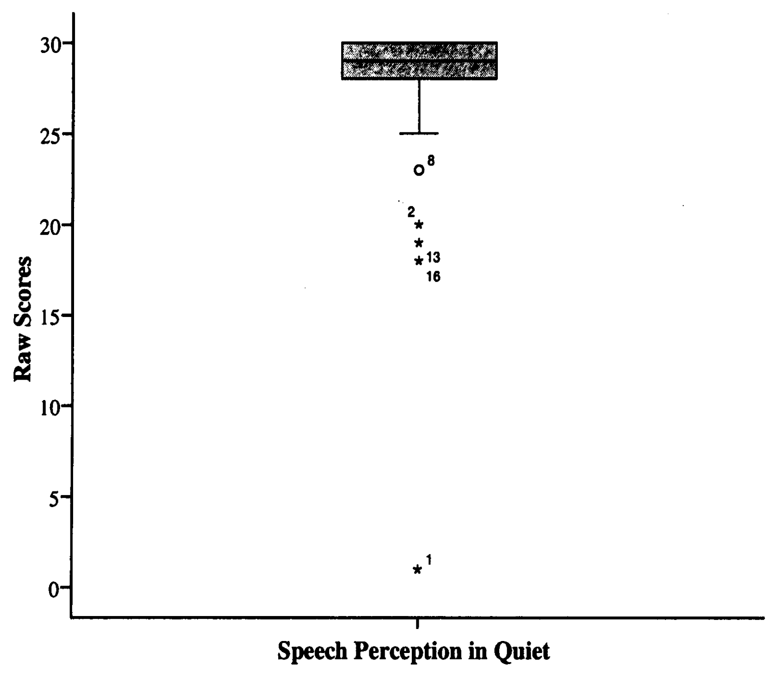

Figure 1. Box plot of scores in speech perception in quiet.

[1] Subsequent references made to 'speech perception' will be referring to speech perception in noise unless otherwise clarified.

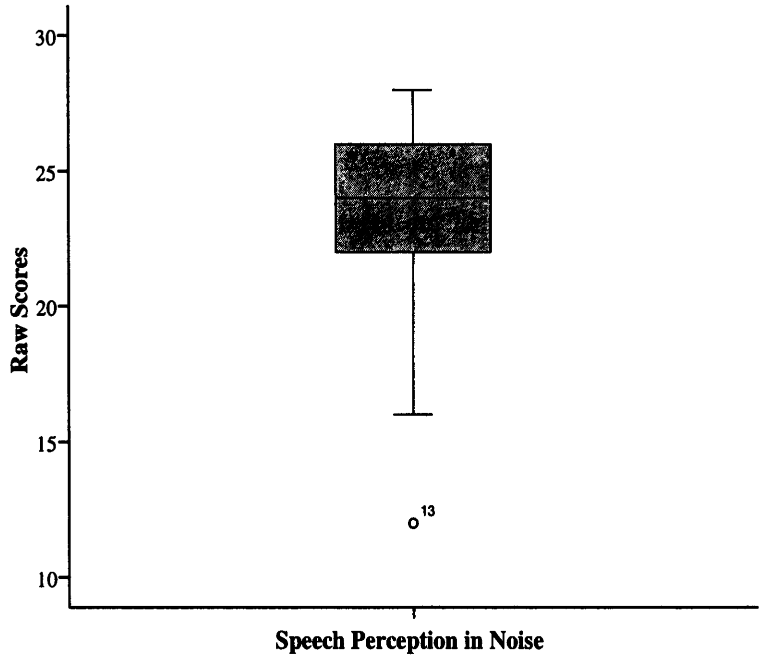

Figure 2. Box plot of scores in speech perception in noise.

Variable	Mean	Standard Deviation	Median	Interquartile Range
Literacy	41.2	17.1		
Phonological Awareness	19.8	2.8		
Language	22.1	3.3	23.0	3.0
Speech Perception	23.8	3.1	24.0	4.0

Table 1. Means and standard deviations for variables tested. Medians and interquartile ranges are also provided for non-normally distributed language and speech perception data.

In order to conduct investigations between better and poorer readers, a mean split of literacy scores was carried out to divide the range of scores into upper and lower halves. Previous research has used scores below the 25th percentile to identify poorer readers. However, this cut-off point is typically used with larger samples. Since the number of children with literacy scores below the 25th percentile in this sample was anticipated to be too small for further multiple regression analysis to be valid, a mean split was felt to be a more appropriate, if somewhat less sensitive, approach to facilitate further investigation. Descriptive statistics for the split scores of each variable are provided in Table 2. As with data relating to the sample as a whole, among both split samples, only literacy and phonological awareness were roughly normally distributed. Significant skew was observed in language and speech perception data, but again, no adjustments were made for this due to the roughly normal distribution of literacy, the dependent variable in both groups of split data.

Variable	Mean	Standard Deviation	Median	Interquartile Range
Upper Half of Literacy Range				
Literacy	54.5	5.9		
Phonological Awareness	20.9	2.6		
Language	22.6	3.0	23.0	3.0
Speech Perception	25.1	2.0	25.5	3.0
Lower Half of Literacy Range				
Literacy	24.6	10.5		
Phonological Awareness	18.3	2.2		
Language	21.5	3.5	22.5	3.0
Speech Perception	22.1	3.5	23.5	3.8

Table 2. Means and standard deviations for variables split in line with the mean split of literacy scores. Medians and interquartile ranges are also provided for the non-normally distributed language and speech perception data.

Relationships between the full range of literacy scores and speech perception, language and phonological awareness are shown in Figures 3, 4 and 5 respectively. The literacy mean-split line (mean = 41.2) is plotted to indicate the spread of scores between variables in each of the upper and lower halves of the range of literacy scores. It can clearly be seen that literacy scores in the upper half of the range are associated with a fairly narrow range of speech perception (Figure 3) and phonological awareness scores (Figure 5), while a relatively wider range for both variables is associated with scores in the lower half of the literacy range. This relationship is not clearly demonstrated between literacy and language (Figure 4).

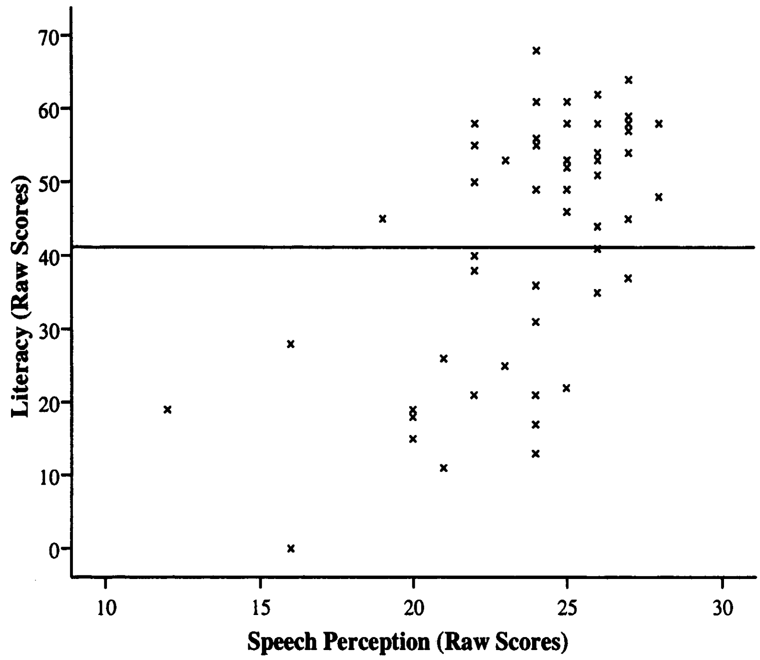

Figure 3. Scatter plot of the relationship between the full range of literacy scores and speech perception scores with the literacy mean-split line plotted.

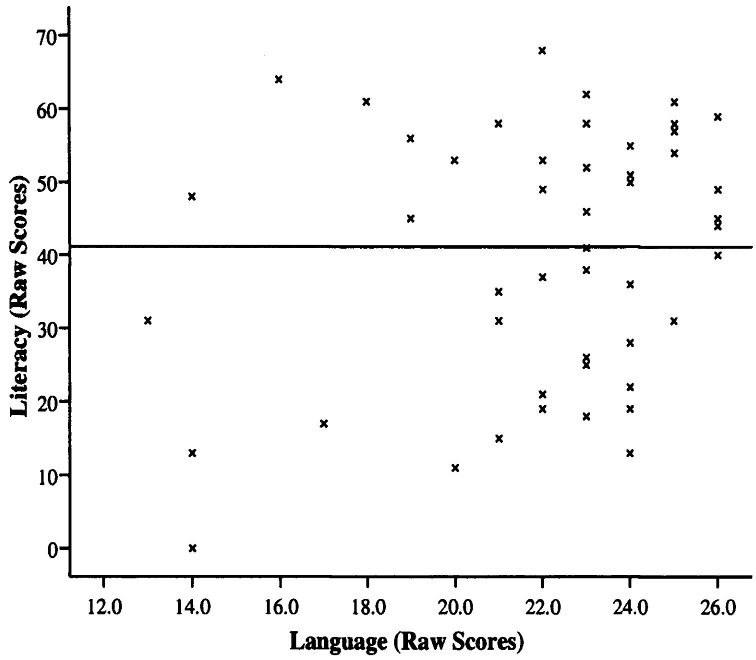

Figure 4. Scatter plot of the relationship between the full range of literacy scores and language scores with the literacy mean-split line plotted.

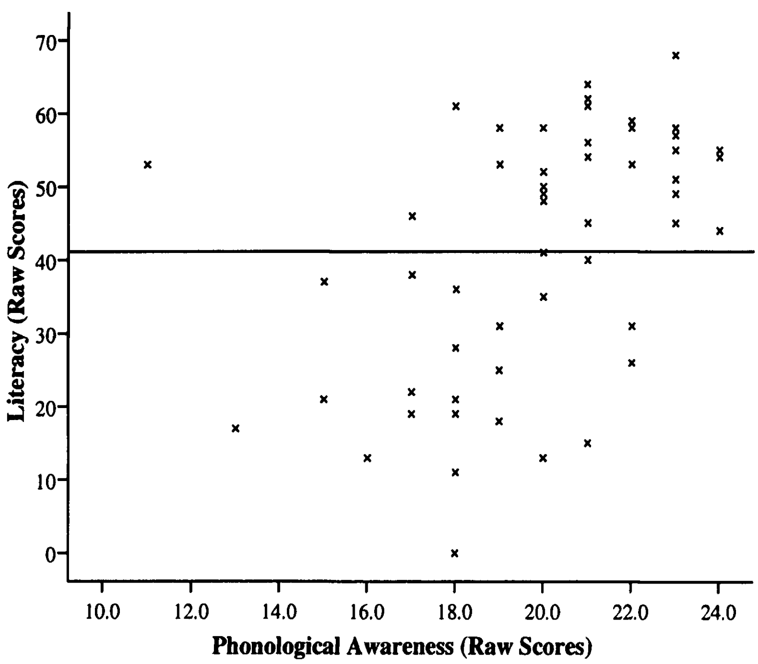

Figure 5. Scatter plot of the relationship between the full range of literacy scores and phonological awareness scores with the literacy mean-split line plotted.

3.2. Inferential Statistics

In order to test the hypothesis of significant correlations between all variables studied, Spearman's correlation coefficients were calculated (this non-parametric statistic was calculated since not all variables were normally distributed - see Table 3). The expected pattern of inter-relationships between all variables was not found. Significant correlations were found to exist between phonological awareness and speech perception (r_s = .32, $p < 0.05$), between phonological awareness and literacy (r_s = .51, $p < 0.01$) and between speech perception and literacy (r_s = .54, $p < 0.01$). Language showed less of a relationship with these variables, failing to correlate with either speech perception (r_s = .16, n.s) or literacy (r_s = .20, n.s). Indeed, phonological awareness was the only variable with which language was found to have a relationship (r_s = .36, $p < 0.01$).

	Language	Phonological Awareness	Speech Perception	Literacy
1. Language		.36**	.16	.20
2. Phonological Awareness			.32*	.51**
3. Speech Perception				.54**
4. Literacy				

* p < 0.05; ** p < 0.01

Table 3. Correlations between language, speech perception, phonological awareness and the full range of literacy scores.

To test the hypothesis of a unique contribution to literacy from speech perception, language and phonological awareness, a standard multiple regression was conducted. Results showed the model to be significant such that overall, language, phonological awareness and speech perception accounted for 44% ($R^2 = 0.44$) of the variance in literacy scores ($F = 13.32$, df = 3, 50, $p < 0.001$). Inspection of the coefficients (Table 4) however, revealed only phonological awareness (beta = .3; t =

2.68, $p < 0.01$) and speech perception (beta = .47, t = 4.31, $p < 0.001$) to make significant unique contributions to the total variance in literacy, accounting for 8% and 20% respectively. Because of the relatively large proportion of variance in literacy scores accounted for by speech perception, there was a possibility that this variable may have obscured any small contribution from language that might have overlapped with that of speech perception. It was therefore decided to run another regression analysis in which only phonological awareness and language were entered in order to investigate whether any language contribution emerged with only these predictors. Results showed the model to account for a significant 24% of the variance in literacy skills (F = 7.92, df = 2, 51, p = 0.001). Inspection of the coefficients however (Table 5), revealed that while phonological awareness made a significant unique contribution to literacy variance (beta = .43, t = 3.35, $p < 0.01$), language continued to make no unique contribution (beta = .15, t = 1.15, n.s.). Inspection of the data in both analyses revealed no multivariate outliers and a roughly normal distribution of residuals.

	B	Std. Error B	ß
Constant	-72.3	18.91	
Language	0.67	0.58	.13
Phonological Awareness	1.88	0.7	.3**
Speech Perception	2.59	0.6	.47***

$R^2 = 0.44$;

** $p < 0.01$; *** $p < 0.001$

Table 4. Prediction of literacy scores from language, phonological awareness and speech perception.

	B	Std. Error B	β
Constant	-28.21	18.46	
Language	0.77	0.67	.15
Phonological Awareness	2.64	0.79	.43**

$R^2 = 0.24$; ** $p < 0.01$

Table 5. Prediction of literacy scores from language and phonological awareness.

To investigate whether or not the pattern of relative contributions made to literacy by speech perception, phonological awareness and language would differ as a function of reading skill, a mean split of literacy scores was carried out to divide the range of scores into upper and lower halves. On the basis of this mean division, thirty cases were found to be in the upper half of the range of literacy scores and twenty-four in the lower half. Again, Spearman's correlation coefficients amongst the variables in each of the reading groups were calculated (see Table 6). Amongst readers in the upper half of the range, the only significant correlation found was between language and phonological awareness ($r_s = .55$, $p < 0.01$), while amongst readers in the lower half of the range, only speech perception and literacy ($r_s = .46$, $p < 0.05$) showed a significant relationship.

Readers in Upper Half of Range	Language	Phonological Awareness	Speech Perception	Literacy
1. Language		.55**	.14	-.14
2. Phonological Awareness			.12	-.03
3. Speech Perception				.09
4. Literacy				

Readers in Lower Half of Range	Language	Phonological Awareness	Speech Perception	Literacy
1. Language		-.03	.03	.39
2. Phonological Awareness			-.03	.23
3. Speech Perception				.46*
4. Literacy				

* $p < 0.05$; ** $p < 0.01$

Table 6. Correlations between language, speech perception, phonological awareness and literacy amongst scores in the upper and lower half of the literacy range.

Amongst readers in the upper half of the range, results of the standard multiple regression analysis investigating the relative contributions made to literacy from speech perception, phonological awareness and language revealed the model to be non-significant ($R^2 = 0.04$; $F = 0.37$, df = 3, 26, n.s.). Thus speech perception, phonological awareness and language failed to account for a significant amount of variance in literacy scores amongst these better readers (see Table 7). Amongst readers in the lower half of the range, standard multiple regression revealed a different pattern of results. In this group of readers, the model was found to be significant, accounting for 45% of the variance in literacy scores ($R^2 = 0.45$; $F = 5.42$, $df = 3; 20$, $p < 0.01$). Inspection of the coefficients (Table 7), however, revealed only speech perception (beta = .46; $t = 2.75$, $p < 0.05$) and language (beta = .43, $t = 2.56$, $p < 0.05$) to make significant unique contributions to the total variance in literacy, accounting for 21% and 18% respectively. Inspection of the data revealed no multivariate outliers and a roughly normal distribution of residuals.

Readers in Upper Half of Range			
	B	Std. Error B	ß
Constant	48.02	16.8	
Language	-0.29	0.41	- .15
Phonological Awareness	0.13	0.47	.06
Speech Perception	0.42	0.57	.14
$R^2 = 0.04$			

Readers in Lower Half of Range			
	B	Std Error B	ß
Constant	-49.7	20.6	
Language	1.28	0.5	.43*
Phonological Awareness	0.91	0.79	.19
Speech Perception	1.37	0.5	.46*
$R^2 = 0.45$; *$p < 0.05$			

Table 7. Prediction of literacy scores from language, phonological awareness and speech perception amongst readers in the upper and lower half of the range.

4. DISCUSSION

The aims of this study were two-fold: firstly, it aimed to achieve a more complete picture of the role of speech perception in literacy development by considering this skill alongside language and phonological awareness. To this end, it was hypothesised that, along with language and phonological awareness, speech perception would make a unique contribution to literacy. Consequently, it might then also be considered, within the context of the

Comprehensive Language Approach (CLA; Dickinson et al, 2003), as one of the 'language' skills that support literacy. Secondly, the study aimed to further support and extend Dickinson et al's (2003) proposal of mutually-reinforcing relationships between literacy and 'language' variables. Hence it was hypothesised that significant correlations would exist between speech perception, language, phonological awareness and literacy, and that the pattern of relative contributions made to literacy from all variables would differ as a function of reading skill. In particular, speech perception, language and phonological awareness were predicted to contribute less to literacy among poorer readers than they would among better readers.

A battery of tasks assessing speech perception, language, phonological awareness and literacy were administered to a sample of 6-year old children. Results of multiple regression analyses showed that although phonological awareness, speech perception and language accounted for a significant 44% of variance in the full range of literacy scores, only phonological awareness and speech perception made significant unique contributions, accounting for 8% and 20% of variance in literacy scores respectively. Language failed to make a unique contribution. Even when a separate regression model was calculated, entering only language and phonological awareness to avoid any potentially obscuring effect from the large contribution made by speech perception, language continued to make no unique contribution to literacy over that contributed by phonological awareness.

Unique contributions to literacy from speech perception and phonological awareness found in this study sit well with previous research investigating relationships between these three variables (e.g. del Rasario et al, 2002; Chiappe et al, 2007). The lack of a unique contribution from language, however, is inconsistent with research that *has* found language to make a unique contribution, over that made by phonological awareness, to literacy/print awareness in both school-age children (Catts et al, 1999) and children not yet exposed to formal reading instruction (Dickinson et al, 2003). Rather, the pattern of results found here could be taken to suggest more of a mediating role for phonological awareness in the relationship between language and literacy. Thus, in the present investigation, when only language and phonological awareness were entered into a regression model, phonological awareness, but not language, continued to contribute uniquely to literacy, despite the contribution of language to the significant shared variance accounted for in the full range of literacy scores. Such an interpretation is consistent with Oloffson & Niedersoe's (1999) path analysis in which language was found to have an indirect influence on literacy via phonological awareness. Hence from the perspective of the Comprehensive Language Approach (Dickinson et al, 2003), the pattern of results in this study relating to the full range of literacy skills fails to provide support for a) language and phonological awareness as unique predictors of literacy, and b) the hypothesis that all three variables - language, phonological awareness AND speech perception - would each contribute uniquely to literacy when considered in a simultaneous investigation.

Why might the relationship between language and literacy be mediated by phonological awareness in the present sample, when past research, such as that by Dickinson et al (2003), has shown these variables to be independent predictors? It has been suggested that different emergent literacy skills may contribute most significantly to literacy at different stages in development (Whitehurst & Lonigan, 1998). From this perspective, the relationship between language and literacy is not necessarily uniform. Thus, Storch & Whitehurst (2002) for example, carried out a six year longitudinal study in which they found that the impact of language skills on literacy was most apparent in pre-school, aged 4 years, and again in the third and fourth grades, aged 8 – 9 years. In the first and second grades, aged 6 - 7 years, with up to two years of formal reading instruction, language had only an indirect impact on literacy, mediated by phonological processing. Such findings may be particularly relevant in helping to account for the different pattern of results observed for language between the present study and that of Dickinson et al (2003), for example. Children in the present study, with an average age of 6; 8 years, were considerably older than the 4-year olds studied by Dickinson et al (2003) and may therefore have been at the stage in the literacy development process at which language contributes, but only indirectly.

Interpreting the apparent lack of unique contribution to the full range of literacy scores from language in the present study is made somewhat more difficult, however, by the lack of consistency in the language measures used across the range of research presented here. Thus, where research has found a unique contribution to literacy from language, e.g. Dickinson et al (2003), measures of single-word receptive vocabulary, such as the Peabody Picture Vocabulary Test (Dunn & Dunn, 1981), were used. In contrast, the present study used the Sentence Structure subtest of the CELF-R (Semel et al, 1987) in which participants listened to a verbally-presented sentence and retained it in memory while scanning through four pictures to decide which matched the given sentence. Thus, it may be that additional memory demands introduced in this task influenced the extent to which it was predictive of literacy skill in a way that single-word vocabulary tasks, with fewer memory demands, did not. Alternatively, the limited scope of language assessed in the present study might also help to account for the lack of a unique contribution to literacy skill found in this sample. Thus, in this study, the measure of language used related to a specific aspect of grammar, i.e. comprehension of syntax. In contrast, Catts et al's (1999) finding of unique contributions to literacy from language incorporated a battery of language tests, including the Picture Vocabulary, Oral Vocabulary, Grammatical Understanding, Sentence Imitation and Grammatical Completion subtests of the Test of Language Development 2:P (Newcomber & Hammill, 1988) and a narrative story task. Children's performance on such a range of both receptive and expressive vocabulary and grammar tasks could be considered to provide a more representative indication of their general language ability, from which any predictive relationships that exist are perhaps more likely to be revealed.

Dickinson et al's (2003) proposal of mutually-reinforcing relationships between literacy and predictor variables, in line with the CLA, has also failed to be supported by the results of this study. In contrast to the strong pattern of inter-relationships between language measures, phonological awareness and literacy in their study, the hypothesised pattern of inter-correlations between all variables studied was not found here. Hence, although phonological awareness, speech perception and the full range of literacy scores all correlated significantly with each other, language only correlated with phonological awareness and showed no significant relationship with literacy or speech perception. When literacy scores were divided into upper and lower halves of the range, a similar lack of inter-relationships existed in both halves, the only significant correlations being those between language and phonological awareness in the upper half and between speech perception and literacy in the lower half. Similarly, the hypothesis put forward at the outset of different patterns of contribution from predictor variables to literacy as a function of reading skill appears not to have been supported. Thus, whereas less contribution to literacy from speech perception, language and phonological awareness for poorer readers than better readers was anticipated, the opposite appears to have been found: none of the variables studied contributed significantly to either shared or unique variability in the upper half of the range of literacy scores, while a significant 45% of variability in literacy scores could be accounted for by all variables in the lower half of the range, although only two of these made unique contributions - speech perception, accounting for 21%, and language for 18% of the variance.

Certainly what seems most unexpected about these results is the lack of any correlations or contributions from predictor variables to the upper half of literacy scores. That speech perception, language and phonological awareness have no role to play in the literacy skills of better readers seems an altogether unlikely interpretation of these findings in light of the vast amount of previous evidence that has shown relationships between these variables. Closer inspection of the visual representations of the relationships between the variables displayed in the scatter plots does, however, help to provide a more feasible explanation for the present findings. It should, however, be remembered that while the scatter plots *assist* understanding of the current findings, they represent only univariate relationships between variables, unlike the regression analyses which provide simultaneous models of the predictive value of all predictor variables.

What becomes apparent upon inspection of the scatter plots, notably those illustrating the relationships between speech perception and literacy, and phonological awareness and literacy, is that the division of literacy scores into upper and lower halves has effectively resulted in the selection of two clusters of scores: a relatively densely packed cluster in the upper half of the literacy range, and a relatively sparsely packed cluster in the lower half. Predictive relationships are less likely among densely packed scores, however, so that a pattern of contributions to literacy from predictor variables was not found in the upper half of the literacy range. The dense clustering of scores may well reflect a methodological flaw in this study. Hence, it may be that the speech perception and phonological awareness measurement tools used lacked sufficient sensitivity for those children with higher ability levels so that children in this group all scored within a few points of the maximum. With regard to phonological awareness, for example, the composite score used in the present study, comprising only one test of each of rhyme and phoneme awareness, might have been made more sensitive by incorporating a variety of tasks, e.g., a rhyme recognition *and* production task to tap into rhyme awareness, and a phoneme judgement, deletion and substitution task to tap into phoneme awareness (e.g. Foy & Mann, 2001). Note that there was no set maximum score on the measure of literacy, since children were free to continue until such time as they made six consecutive errors.

It is, however, the position of the densely clustered scores in the upper half of the range of literacy scores that is important in fully understanding the pattern of results found in this group, particularly with regard to speech perception and phonological awareness, and in suggesting the extent to which these findings are still potentially meaningful. Hence, despite the lack of predictive relationships between predictor variables and the upper half of the literacy scores, scatter plots show that the densely packed clusters of scores in the upper literacy range nevertheless conform to the general trend shown in the full range of literacy scores. From this perspective, any restricted sensitivity in the speech perception and phonological awareness measures used to assess children in the upper half of the range of literacy skills may well have obscured the linear relationship that is evident when the full range of literacy skills is considered. This is important because it raises the possibility that a pattern of relationships between variables may also have been found in the upper half of the literacy range, as it was in the lower half, had a more sensitive battery of measurements been used, that allowed for a greater spread of scores in the upper literacy range.

A somewhat different explanation for the lack of contribution made from language to the upper half of literacy scores is proposed. The scatter plot of this relationship reveals that instead of a cluster of scores in the upper right hand corner of the plot, a rather narrow band of scores clustered along the full range of language scores is evident. Hence, it appears that, although most children in the upper literacy range scored within a fairly narrow range of literacy scores, a greater range of language abilities was detected by the language measures, unlike those of speech perception and phonological awareness. Furthermore, due to this spread of language scores in the upper half of the range of literacy scores, there is no general linear trend in the full range of literacy scores with which scores in the upper half can conform. The implication is that the lack of a relationship between language and the upper literacy scores represents more of a real effect, as opposed to an effect of restricted range, apparently the case for speech perception and phonological awareness. The developmental progression proposed to explain the lack of effect for language in the full range of literacy scores is therefore also applicable here.

In terms of the pattern of contributions from predictor variables to literacy that *was* found in the lower half of the literacy range, a contribution from speech perception was expected and is consistent with aforementioned research (e.g. del Rasario et al, 2002; Chiappe et al, 2007). The unique contribution from language, however, although expected, is interesting in light of the lack of a unique contribution from this variable to both the full and upper range of literacy scores. Such a pattern of findings, however, may actually be consistent with the developmental explanation proposed earlier to account for the lack of a contribution from language to the full range of literacy scores. From this perspective, despite being the same age as better readers, these poorer readers might be considered to be at a relatively earlier stage of reading development, so that language has a direct relationship with literacy in these readers in much the same way as it does among younger less experienced readers, according to findings such as those by Storch & Whitehurst (2002). Indeed, there is no unique contribution to literacy from phonological awareness in the lower half of the range of literacy skills. Thus, phonological awareness cannot be mediating any relationship between language and literacy, as is argued when the full sample is considered.

Failure to find a contribution from phonological awareness to literacy scores in the lower half of the range is another unexpected finding from the present results, particularly since such an affect was found in the full range of literacy scores. What the current findings may reflect is evidence of an effect described by de Jong & van der Leij (1999), in which they propose that the effect of phonological awareness on literacy '. . . *is dependent on the level of reading achievement (or amount of reading-related knowledge) and on the level of phonological awareness in a particular sample. When these levels are either too low . . . or too high, effects on reading acquisition will not be observed*' (pp. 469). Indeed, de Jong & van der Leij (1999) found that, in their study of Dutch 4- to 7-year olds, phonological awareness was only important to reading acquisition during the first year of reading instruction, beginning at 6 years of age. No effects for phonological awareness were found either before sufficient reading instruction/experience had taken place, or after the period at which reading began to stabilise. Thus, phase of reading acquisition might help to account for the present findings in much the same way as it helped to account for the findings regarding the effect of language. From this perspective, in the lower half of the range of literacy scores, failure to find a contribution from phonological awareness may have occurred because the levels of reading achievement and phonological awareness were too low. This was not the case when the whole sample of literacy scores was considered. Poorer readers in the lower half of the literacy range may have been at an earlier stage of reading development, such that they may not yet have possessed sufficient reading knowledge or phonological awareness for the reciprocal relationship (Goswami & Bryant, 1990; Morais, 1991) between these variables to have developed. The restricted range of phonological awareness measures referred to in explanation of the findings among the upper half of the range of literacy scores is also consistent with de Jong & van der Leij's proposal: levels of phonological awareness may have been too high in this group as a result of the insufficiently sensitive measures.

Interestingly, De Jong & van der Leij (1999) argue that their pattern of findings relates to learning to read Dutch, a consistent orthography, and that inconsistent orthographies such as English are likely to show a longer period of relationship between phonological awareness and literacy – hence the contribution made by phonological awareness to the full range of literacy scores, despite the fact that children in this study had been exposed to at least two years of reading instruction. By the same reasoning, however, what these results may show is the extent to which, when learning an inconsistent orthography, it may also take longer for the relationship between these variables to begin, particularly among poorer or less experienced readers.

Despite failing to support the hypotheses proposed at the outset, interesting observations can be made from the present results. While the restricted range of measures prevented the study from showing any real differences between the pattern of contributions from predictors to the upper and lower halves of the literacy range, it did demonstrate differences between the full and lower range of literacy scores with regard to the contributions from phonological awareness and language. Indeed, the results appear to have highlighted the extent to which the relationships between these two variables, in particular, and literacy may not necessarily be uniform or static throughout development, but rather may have different degrees of influence depending on stage of acquisition or amount of reading experience. At the same time, the results also appear to suggest the existence of a greater degree of uniformity in the relationship between speech perception and literacy. Indeed, speech perception accounted for very similar percentages of unique variance in literacy in both the full and lower half of the range of literacy skills, and may well have contributed to the upper literacy range had a more sensitive measure been used.

These observations have implications for both research and clinical practice. From a research perspective, the pattern of findings here does only relate to a sample of 6-year olds. Future longitudinal research might attempt to determine more comprehensively the existence of any developmental pattern in the contributions made to literacy in the same sample of children over a period of several years, spanning from pre-school to 8 or 9 years of age. Indeed, within the context of the Comprehensive Language Approach to literacy, it may be that there are indeed mutually-reinforcing relationships between language, phonological awareness, speech perception and literacy, and unique contributions to literacy from these variables, but that they are only apparent at certain stages in development, and not others, or that only a subset of variables are related at any one time, with variables either adding or losing their influence, dependent on age and reading experience. An understanding of any such relationships may have implications for literacy instruction and remediation.

In terms of clinical implications, the large amount of variance accounted for uniquely by speech perception in the context of all predictors studied in both the full and lower half of the range of literacy scores, suggests that it is speech perception skills, rather than phonological awareness, that have more of a central, and indeed static role to play in literacy development, and are thus worthy of attention in remediation and instruction programmes. Consequently, these results have particular implications for the later reading ability of children with phonological speech difficulties, many of whom, in addition to their speech output difficulties, also have input difficulties. Bishop & Adams (1990) proposed that in children with speech difficulties, reading and spelling development should progress normally if the speech difficulty has resolved by around 5;6 years. The present findings showing the significance of the role for speech perception at the age of 6-7 years, helps to suggest why. They also suggest that there may need to be a focus on different skills during instruction or remediation, dependent on whether a child appears to be developing normally or either is, or is at risk of becoming, a poor reader at the age of 6 years. Thus, in addition to speech perception skills, an emphasis on language skills rather than phonological awareness may be more beneficial for children who are experiencing difficulties than for those who are progressing normally, among whom, at this age, there should be more focus on phonological awareness. Indeed, in children of this age experiencing difficulties with literacy, such a focus on language may allow for lexical restructuring (Metsala & Walley, 1998) to develop phonological awareness and support later literacy.

5. CONCLUSION

The present study has attempted to achieve a more comprehensive understanding of the roles of speech perception, phonological awareness and language in literacy development, in a simultaneous investigation of all variables. It was expected that, from the perspective of the Comprehensive Language Approach to literacy (Dickinson et al, 2003), speech perception, along with language and phonological awareness, would contribute independently to literacy, raising the possibility that it be considered as one of the range of 'language' variables implicated within the CLA. The pattern of contributions from all variables was also expected to differ as a function of reading skill, thus supporting and extending proposals of mutually-reinforcing relationships between these skills. Neither expectation found support in the present sample. Results did, however, reflect more stability in the relationship between speech perception and literacy than in the relationships between language and literacy, and phonological awareness and literacy. Further, this lack of stability in the latter relationships appeared to be well accounted for in terms of differences in age and reading experience, thereby supporting proposals that different skills contribute most significantly to literacy at different stages in development. Indeed, it was further proposed that different patterns of mutually-reinforcing relationships may be present in the process of learning to read. Further research is, however, needed to obtain a comprehensive understanding of these as they are likely to have important implications for reading instruction and remediation.

Word Count: 9 988

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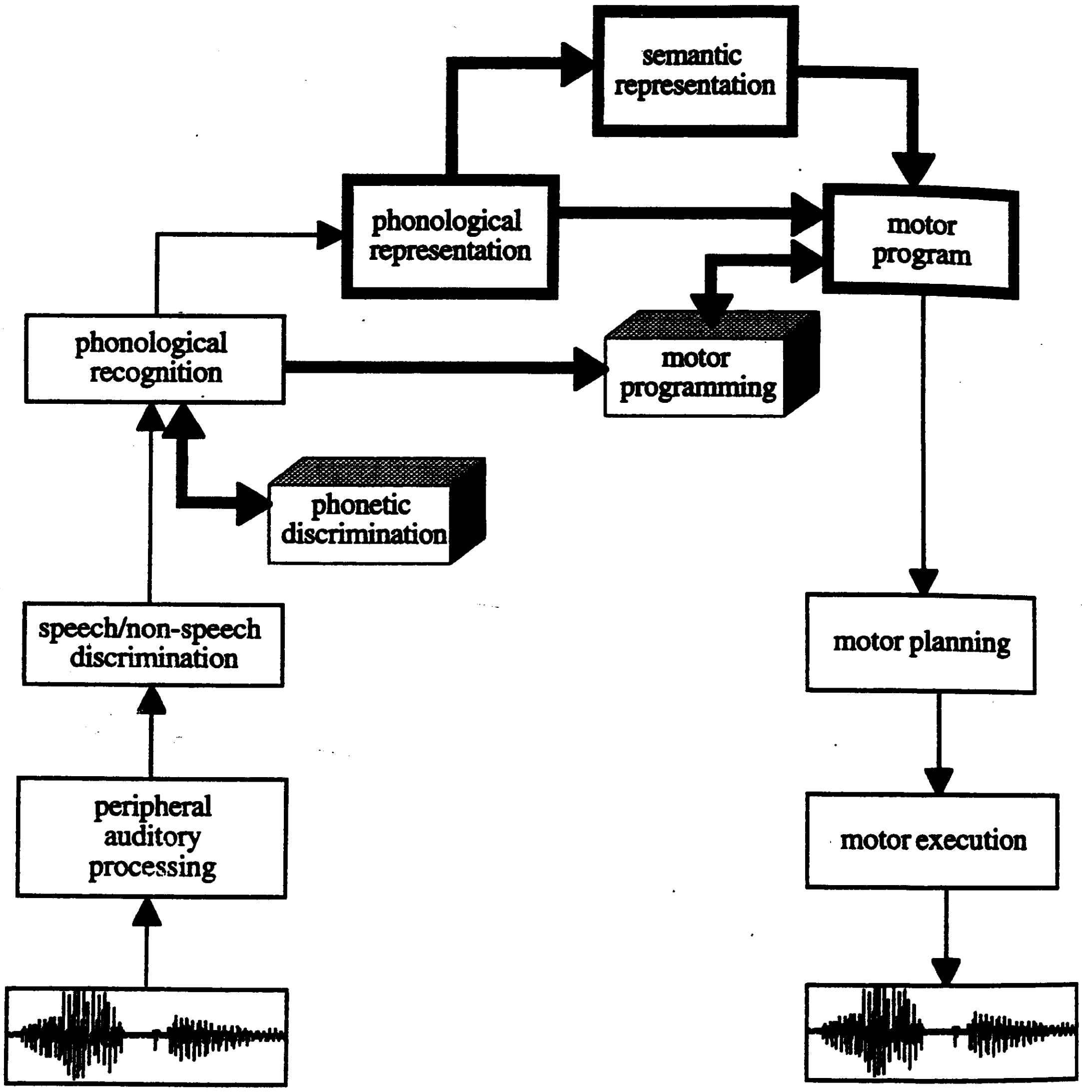
7. APPENDICES

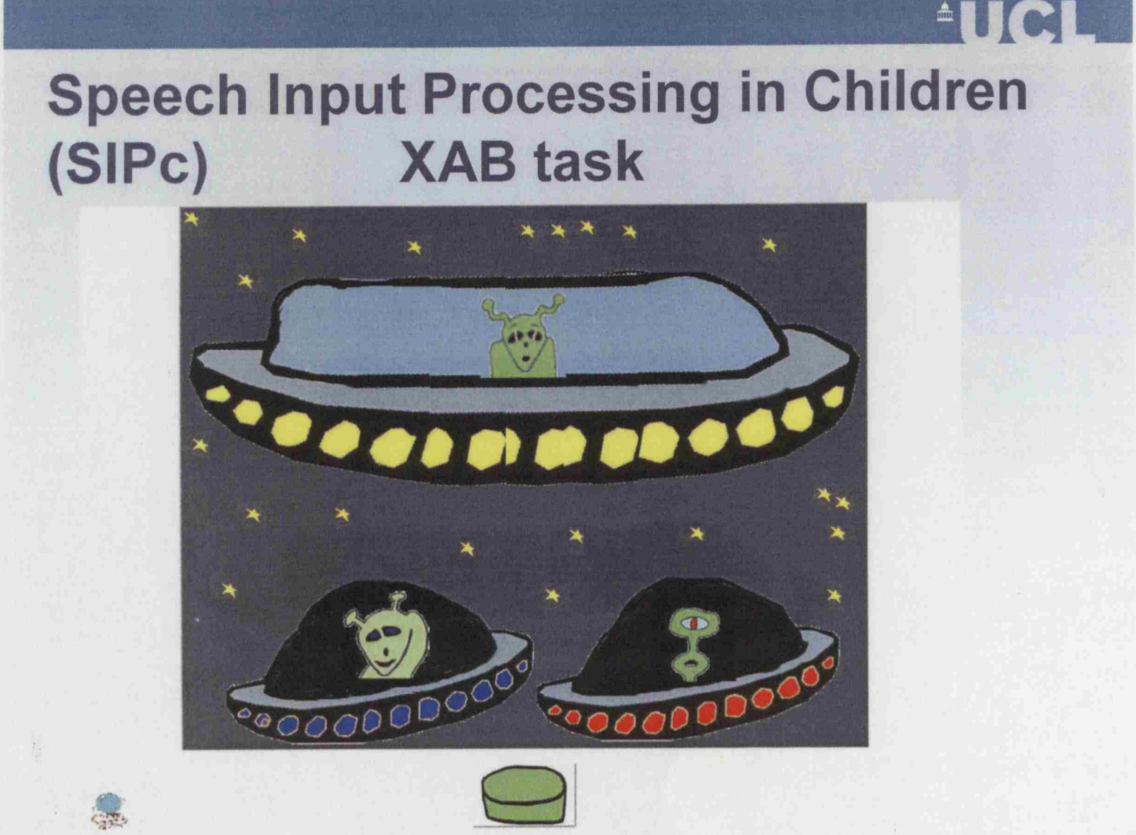
7.1. Appendix 1.

The Speech Processing Model



Taken from Stackhouse & Wells (1997): Children's Speech and Literacy Difficulties.

7.2. Appendix 2.



Above is an example of the display seen by each child on the laptop screen when completing the speech perception assessment:

1. The alien in the large spaceship at the top of the screen accompanied presentation of the first non-word (X).
2. Two aliens in the smaller spaceships at the bottom of the screen accompanied presentation of two further non-words (A and B), one of which matched the non-word presented previously.
3. Children used the mouse to click on whichever of the aliens in the smaller spaceships produced the same word as that spoken by the alien in the large spaceship.
4. A coloured balloon was added to a space on the left hand side of the screen for each correct response.
5. A green 'Go' button in the middle of the bottom of the screen was used to progress to the next item.