# Phoneme awareness span : a neglected dimension of phonemic awareness

John Munro

University of Melbourne

**Key words**: phonemic awareness , 'phonemic awareness span', phonological network, connectionist theories, phonological development, early literacy development

1 This article was published as Munro J. (2000). Phoneme awareness span: a neglected dimension of phonemic awareness Australian Developmental and Educational Psychologist, 17, 1, 76- 89.

# Abstract

The importance of phonological and phonemic awareness knowledge in learning to be literate has been demonstrated in many studies. One dimension of the acquisition of this knowledge, the developmental trend from an implicit awareness of rimes to an explicit awareness of phonemes has attracted substantial interest. A second dimension, a trend in the amount of phonemic knowledge that can be manipulated, or 'phonemic awareness span' is examined in the present study.

One hundred and sixty children from Prep to Grade 3 completed five phonological tasks; rhyming, onset-rime segmentation, recognition of initial sound, phoneme segmentation and phoneme substitution. Each task involved words of different phonemic length; five each of three, four and five phonemes. As well, the phoneme segmentation and substitution tasks involved words with six phonemes.

Over this grade range the amount of phonemic knowledge students can manipulate increases such that students can deal with more complex phonological tasks. Phonemic length influenced performance for each task. The grade levels at which the influence was greatest varied. For the rhyming task, phonemic length influenced Prep and grade one performance, for onset-rime segmentation and initial sound recognition the influence extended to grade two performance, while for phoneme segmentation and substitution, performance at grades one, two and three were affected.

Trends in the erroneous responses showed that while younger students were more likely to display phonological errors consistent with substituting sounds in words, older students were more likely to display errors consistent with deleting sounds from words and saying blends as single sounds. These data support the gradual differentiation of the phonological knowledge into a set of phonemic units, with the weightings between the units learnt gradually and leading to an increasingly elaborated system of links.

The implications of the findings for subtypes of dyslexia and for the diagnosis of reading disabilities and for the design of optimally effective instruction are discussed.

A plethora of investigations over the last three decades has shown the importance of phonological and phonemic awareness knowledge in learning to be literate. Skilled readers are seen as having access to a phonemic awareness knowledge that comprises representations of individual sounds and sound combinations at the sub-word and word levels. This knowledge allows them to detect and manipulate sound patterns that do not necessarily arise independently as separate units in spoken language. Its acquisition suggests the capacity to reflect on, analyse and extrapolate the sound patterns that make spoken words.

Development of this knowledge has been in terms of a trend from the capacity to represent the sound properties of spoken words through an implicit awareness of shared rime in words, an explicit awareness of onsets and rimes to an explicit awareness of phonemes (Lenchner, Gerber & Routh, 1990; Vandervelden & Siegel,1995; Yopp, 1992). The latter aspects of the phonemic differentiation begin with the representation of some consonantal phonemes during onset-rime segmentation. Exposure to text and early literacy teaching contribute to this trend (Stanovich, 1986). The developmental sequence has been well documented and used as a basis for both assessment and instruction.

A number of tasks have been used to chart the gradual emergence of this knowledge. These examine the ability to detect and produce words that rhyme, to segment one-syllable words into onset and rime, and into separate phonemes, to count the number of sounds in spoken words, to delete sounds from words and to substitute sounds in words. Differential performance on these tasks is assumed to indicate progress through the developmental sequence.

Recent studies have recognised the need to distinguish between changes in phonemic knowledge per se and its use in these types of tasks. Wagner and colleagues propose a phonological knowledge base characterised as "phonological processing abilities (that) have coherence and stability and that is characteristic of other cognitive abilities as opposed to representing relatively malleable measures of reading related knowledge" (Wagner, Torgesen, Laughton, Simmons & Rashotte, 1993, page 100). They note the increasing differentiation of this knowledge with age from kindergarten to second grade and that impoverished phonological representations restrict both memory span and phonological analysis performance. Stahl and Murray (1994) show how linguistic complexity as well as task differences account for phonemic awareness task performance. The knowledge base referred to here needs to be distinguished from the 'general cognitive ability' identified by McBride-Chang (1995) as a component of phonemic awareness and operationalised as IQ.

A possible model for this knowledge is in terms of a 'connectionist type structure'. Connectionist theories have been used to explain how readers vocalise written words (Plaut & McClelland, 1993; Seidenberg & McClelland, 1989). They propose that readers have a set of orthographic units that they use to process and code letter strings and a set of phonological units that they use to vocalise the data processed. The links between the two sets of units are acquired or 'programmed' during exposure to spoken and written language.

A limitation of the connectionist theories is that they have not specified in detail the structure of the phonological knowledge and do not assist in describing how this knowledge develops during childhood (Hulme, Quinlan, Bolt & Snowling, 1995). The present study examines aspects of this phonological knowledge base. It proposes that phonological knowledge can be thought of as consisting of a set of phonological units linked in a weighted network, with the weighting values determined by the types of sound patterns to which the individual had been exposed. Activation of particular units leads to the activation of other units, principally those for which the links have highest weightings. The weightings are learnt gradually, such that young children become aware gradually that some phonemes are more likely than others to co-occur. The networks of phonemes may change from ones comprising few links between units to ones comprising an elaborated system of links. These units are acquired during exposure to spoken and written language.

Changes in the phonological network can account for the developmental trends noted earlier. Onset rime segmentation indicates the explicit awareness of sub-word sound units. An awareness of the initial sound in spoken words indicates the awareness of particular consonants. The links between the phonemes in a rime at this time are based on their co-occurrence in particular words. Children may not be aware that each can occur separately from the others. Their knowledge of the "amp" rime informs them that "m" is linked with "p". As their phonological networks differentiate, they learn that any one sound in an onset or rime unit can be linked with one or more sounds other than those in the unit. They learn that particular sounds co-occur, such that some sounds are more likely to precede or follow other sounds, for example, that "m" is more likely to followed by "p" or "b" than by "t".

Individual differences in phonemic awareness can be explained in terms of these models. The observations that some children in the course of phonemic awareness development treat certain blends as a single sound when asked to name the first sound in words (Stahl & Murray, 1994) or insert or add sounds to words they are required to segment may be explained in terms of an inflexibility in the phonemic links. The observation that phonological analysis performance is frequently correlated with memory span (Wagner, Torgesen, Laughton, Simmons & Rashotte, 1993) has been attributed to the possibility that both draw upon phonological representation. The present study elaborates this explanation by explaining short term memory span in terms of the phonemic knowledge available for information encoding and links between phonemic units. Span increases with the extent to which links in phonemic knowledge facilitate the ability to chunk phonemic information.

The connectionist model of a phonological network leads to predictions about the amount of phonemic knowledge children can manipulate during the acquisition of phonemic awareness. This aspect of the development of phonological knowledge is frequently overlooked. In terms of task performance, this refers to the number of sounds in the words that are to be manipulated. Most studies of the development of phonemic awareness knowledge do not control this aspect (McBride-Chang, 1995; Wagner et al., 1993). Some assume implicitly that performance on words of three or four sounds is sufficient to infer the targeted phonological ability. Others use words comprising a range of sound lengths but without control of this variable.

The present study proposes that the number of sounds children can manipulate at any time provides a comparative indication of the complexity of their phonological networks at that time. The various phonological awareness tasks require children to perceive the orally presented information, encode it, manipulate it in ways required by the task and display a response. They encode the information using their existing phonological knowledge. Children whose networks are more elaborated can encode phonemically longer words than those who have a less elaborated phonological network and can, therefore, detect the set of separate sounds in longer words. The words they find easier to manipulate have sound sequences that match the links they have formed between phonemes. The more closely the links between phonemes match the sequence of sounds in words, the more able they are to manipulate the sound information relatively automatically. If they lack some of these network links, they need to use other procedures to attempt to retain the sounds in order. These alternative procedures are assumed to be more attention-demanding. If children manipulate sound information in an attention-demanding rather than automatic way, it is likely that they can perform tasks such as phoneme segmentation for words with fewer sounds before they can perform them with longer words. The number of separate phonemes (not in blended form) that children can manipulate at once is referred to as their 'phoneme awareness span'. It is a measure of the longest spoken words the child can segment accurately into separate sounds.

The amount of phonemic knowledge that can be manipulated at once influences word reading ability. As noted earlier, connectionist theories propose that a reader's set of phonological units is linked to a matching set of orthographic units (Seidenberg & McClelland, 1989). The model of phonological knowledge proposed in the present study explains the link between phonemic awareness and reading in terms of the extent of differentiation of the reader's phonemic network. Corresponding phonemic and orthographic units must have the same size and can vary in size from words to single letters / phonemes (Van Orden 1987; Van Orden, Pennington, & Stone 1990). Multiple links exist between corresponding orthographic and phonological codes of the same segment size ( Berninger & Abbott, 1994). Each orthographic code (for example, written words, single letters, letter clusters) and each phonological code (for example, spoken words, phonemes, onset and rime, syllables) contribute unique increments of variance in reading real words and pronounceable non words and in spelling dictated words (Berninger, 1994).

Earlier studies support indirectly the prediction that the extent of phonemic differentiation influences the number of sounds that can manipulated during phonemic awareness tasks. In a study of the segmentation of nonsense words into separate phonemes by third and fourth grade children, words of three phonemes were easier to segment than five-phoneme words (McBride-Chang, 1995). The interpretation of the findings merit analysis. The grade range of these children would suggest that they were at the final stage of phonemic development. The nonsense stimuli comprised successive phoneme links that ranged from ones that arise frequently in one syllable words to ones that have a low frequency. Combining the data from this range of sound links may introduce a confounding short-term memory influence; manipulation of stimuli that contain sound links that are unlikely to be encountered in words would be expected to make a greater short term memory demand than those that have familiar links. The observation that task performance could be explained by short term memory ability supports the present proposal of a influence of phonemic differentiation on task completion. Because the third and fourth grade children would be unlikely to have phonemic links within their networks for several of the nonsense words used, they would need to remember the links provided in the stimulus.

The present study predicted that for children in the course of phonological development, performance on phonological tasks would be influenced by the number of phonemes in a word; words with fewer sounds would be easier to manipulate than longer words. Task difficulty for words of the same phonemic length is assumed to be influenced by the complexity with which the phonological knowledge needs to be manipulated. Its focus is different from that of McBride-Chang's (1995) study in that it examines trends for phonemic links that are typical of spoken language.

This study also examines the influence of an immature phonological knowledge on patterns in phonemic task performance. An emerging phonological network may lead to characteristic error patterns. Characteristics of the developing phonemic network at any time may include

(1) particular phonemic units not being represented; one might expect that students substitute sounds.

(2) particular phonemic units being linked in inflexible or restricted ways such that the activation of one sound always leads to the activation of a second sound; this may lead to the insertion or addition of sounds to responses.

(3) particular phonemic units not being represented as separate units; one might expect that students treat certain blends as a single sound when asked to name the first sound in words (Stahl & Murray, 1994) or say vowel-consonant or consonant-vowel units as single sound units when they have not fully differentiated vowels.

(4) restricted networks of links so that the set of links for some phonemes may not permit the chunking of two- or three- phoneme onset units or three- phoneme rime units; one might expect students to delete consonants from otherwise correct responses.

It is proposed that (1) to (4) indicate a general developmental trend and that errors patterns in students' responses will indicate these.

## Method

**Subjects.** The subjects were 160 children , 40 at each of grades from Prep to Grade 3 and drawn from primary schools in metropolitan Melbourne. The population from which they were selected spoke English as their first language, did so without the display of articulation difficulties (assessed using an articulation screening procedure (Bryant & Bryant, 1983) and showed no evidence of sensory impairment. They were within the span of normal intellectual development (assessed using developmental observational scales for Prep and Grade 1 and the Verbal Reasoning Test Series (NFER, 1992) for Grades 2 and 3 and displayed average reading ability (assessed using the Reading Progress Tests (Vincent, Crumpler & De la Mare, 1996)). Approximately equal portions of females and males were selected at each grade level. The ages in months at each grade level for females and males were as follows: 72 and 75 months for Prep, 87 and 85 months for grade 1, 97 months for both genders at grade 2, 118 and 120 months age grade 3. None of the classes from which the subjects were drawn taught explicit phonic or phonological knowledge. In a questionnaire examining the characteristics of the literacy education to which the students had been exposed, all teachers reported adopting a 'whole language' approach to literacy education and indicated that phonological and phonemic knowledge was taught if at all only incidentally as 'the need arose' in individual or small group interactions.

### Tasks used

A set of five phonological tasks that comprised rhyming, onset-rime segmentation, recognition of initial sound, phoneme segmentation and phoneme substitution was administered to all children in the order mentioned. These tasks were selected because together they span the acquisition of phonological knowledge, from implicit awareness through simple explicit awareness to compound awareness (Munro & Munro, 1993; Yopp, 1988).

**Rhyming task.** In this task the children saw rows of four pictures, each showing a black on white line picture of a familiar item with a one-syllable name, for example, a picture of a cat, a rat a tin and a hat. They heard the name of each item, repeated the names of the row of items and were asked to say the name that didn't 'sound like the other, that didn't rhyme' . A set of nine practice items, in which feedback was provided, preceded the experimental tasks. There were fifteen experimental words, five each of three, four and five sounds. They were presented in a random order to each child.

The criterion for correct performance : The child selected the instances that did not rhyme in each case.

**Onset- rime segmentation task.** In this task the children saw rows of four pictures, each showing a black on white line picture of a familiar item with a one-syllable name, for example, a picture of a duck, a crab and a star. They heard the name of each item, repeated the names of the row of items, heard the name of the first item segmented into onset and rime and were asked to say the remaining names in a similar way. A set of eight practice items, in which feedback was provided, preceded the experimental tasks. The sequence of instructions for one row were "Look at these pictures. Listen to how I say their names: duck, crab, drop and star. Now you say their names. I'm going to break up this name. Listen to how I do it. D-uck. Now you break up the names and say them just like I did." The test words consisted of fifteen items, five of each the phoneme lengths three to five. They were presented in a random order to each child.

The criterion for correct performance : The child said accurately the two segments, with one comprising the consonant/s before the vowel and the second comprising the vowel and following consonant/s.

**Recognition of initial sound task.** In this task the children saw rows of four pictures, each showing a black on white line picture of a familiar item with a one-syllable name, for example, a picture of a duck, a dog, a pan and a star. They heard the name of each item, repeated the names of the row of items, heard the name of the first item repeated and were asked to select the name of the item that started with the same sound as the first item. A set of six practice items, in which feedback was provided, preceded the experimental tasks. The sequence of instructions for one row were "Look at these pictures. Listen to how I say their names: duck, dog, pan and star. Now you say their names. Which picture here starts with the same sound as duck." The test words consisted of fifteen items, three for each of the phoneme lengths three to five. They were presented in a random order to each child.

The criterion for correct performance : The child selected the picture whose name had the same initial sound as the target word in each case.

**Phoneme segmentation task.** In this task the children heard a spoken word and then said each of the sounds in it, in the order in which the sounds occur in the word (Wagner, Torgesen, Laughton, Simmons & Rashotte, 1993). A set of eight practice items, in which feedback was provided, preceded the experimental tasks. The children were told "Listen to how I say cat. C-a-t. I am cutting the word cat up into its sounds. I say each sound in the word. Now you try it with dig. Cut dig up into its sounds. Say each sound." The corrective feedback included the following: If children ran sounds together, they were asked to "make a bigger space between each sound". If they spelt a word (for example, "bike") by saying the letter names they were reminded that the activity is to say the sounds in the word, not the letters. The test words consisted of twenty one syllable words, five for each the phoneme lengths three through to six. They were presented in a random order to each child.

The criterion for correct performance : The child said accurately each sound as a separate sound, that is, with a brief time period between separate sounds.

**Phoneme substitution task.** In this task the children heard a spoken word and were asked to replace one of its sounds by another sound. A set of eight practice items, in which feedback was provided, preceded the experimental tasks. They were introduced as follows: This time we are going to swap sounds in words. Listen to what I do. I start with camp. I swap the c for l. I make lamp. I changed camp to lamp. " The test words consisted of twenty one syllable words, five for each the phoneme lengths three to six. They were presented in a random order to each child.

The criterion for correct performance : The child said the intended word.

### Analysis of incorrect responses.

As noted earlier, patterns in the erroneous responses of students may be expected to be indicative of intermediate stages in the emergence of phonemic knowledge. Student responses to the phoneme segmentation task were examined in terms of the following types of error patterns. Students

(1) substituted sounds in responses, on occasions with sound deletion. Examples of this error pattern include students segmenting "glen" as "gr-a-nd", "deep" as "dro-b".
(2) inserted or added sounds to otherwise correct responses. Examples of this error pattern include students segmenting "bend" as "br-e-n-d", "hound" as "h-ou-n-d".
(3) said consonant-consonant, vowel-consonant or consonant-vowel units as single sound units in otherwise correct responses. Examples of this error pattern include students segmenting "drank" as "dr-a-nk", "hound" as "h-ou-n-d".
(4) deleted consonants from otherwise correct responses when their network of links did not permit the chunking of two- or three- phoneme onset units or three- phoneme rime units. Examples of this error pattern include students segmenting "drank" as "dr-a-k", "hound" as "h-ou-d".

### Procedure

The rhyming task was administered to all children first, followed by the onset-rime segmentation, recognition of initial sound, phoneme segmentation tasks and finally the phoneme substitution task. Each took approximately 8 minutes to complete and was administered in a small room in the school of each subject. Interfering noise was minimised.

The trend in performance with increase in sound length for each task at each grade level was examined using planned comparisons, with the MANOVA procedure used to compare successive levels of span. This procedure was also used to examine trends in the type of error displayed during the phoneme segmentation task.

## Results

The mean score and distribution (standard deviation in parenthesis) for each phonemic length for each task at each grade level are shown in Table 1 .

Insert Table 1 about here

The data show the influence of phonemic load on task performance at each grade level. The comparison of successive levels of span using the MANOVA procedure and planned comparisons showed that the influence of phonemic load depended on the task and grade level of the students.

For the rhyming task, phonemic load influenced Prep and grade one performance ($p <.01$); for the Prep students, three-sound words were easier to rhyme than four- or five- sound words while for first grade students, three- and four-sound words were easier to rhyme than five- sound words. Increase in grade level influenced performance for words of four and five sounds ($p < .01$).

The three tasks assessing simple explicit phonemic segmentation elicited a similar pattern:

(1) For onset-rime segmentation, phonemic load influenced Prep and grade one and grade two performance ($p < .01$); for the Prep students, three-sound words were easiest to segment and five- sound words most difficult, for first grade students, three- and four-sound words were easier to segment than five- sound words.

(2) For initial sound recognition, phonemic load influenced Prep and grade one and grade two performance ($p < .01$); for the Prep students, three-sound words were easiest to segment and five- sound words most difficult, for first grade students, three- and four-sound words were easier to segment than five- sound words.

(3) For phoneme segmentation, phonemic load influenced performance at the grades one, two and three levels ($p < .01$). For first grade students, three- sound words were easier to segment than four-, five- or six- sound words, for second grade students, three- sound words were easiest to segment and five- or six- sound words most difficult while for third grade students, three- and four- sound words were easier than five- and six- sound words.

For the phoneme substitution task, a performance pattern similar to that for the phoneme segmentation task was observed; first and second grade students found three- and four- sound words easier to segment than five- or six- sound words while third grade students found three-, four- and five- sound words easier to segment than six- sound words.

These data show that over the range Prep to grade 3, the amount of phonemic knowledge students can manipulate increases such that students can deal with more complex phonological tasks. Increase in grade level paralleled increased efficiency in handling the phonemic load for all tasks ($p < .01$) . For the developmentally simpler tasks, the increase in efficiency was most marked for the Prep to grade 1 transition, for the tasks of intermediate difficulty for the grade 1 to grade 2 transition and for the more difficult tasks, for the grade 2 to grade 3 transition.

Trends in the emergence of phonemic knowledge was also examined by categorising the erroneous responses of the students into the error types described earlier. The proportion of errors attributable to each category for each sound length at each grade level of the phoneme segmentation task is shown in Table 2.

Insert Table 2 about here

These data support the predicted trend in the type of error made. The MANOVA procedure for planned comparisons showed that while younger students were more likely to display phonological errors consistent with substituting sounds in words ($p < .01$) , older students were more likely to display errors consistent with deleting sounds from words and saying blends as single sounds ($p < .01$) . In other words, those who displayed segmentation errors and who segmented correctly three- or four- sound words were more likely to say a sound blend as single sound or to delete consonants than to substitute or insert sounds (a mean ratio of 7 : 1) , while those who segmented incorrectly three- or four- sound words were less likely to say a sound blend as single sound or to delete consonants than to substitute or insert sounds (a mean ratio of 15 : 1). The error data provide support for the predicted changes in the organisation of phonemic knowledge.

Taken together, these data support the gradual differentiation of the phonological knowledge into a set of phonemic units, with the weightings between the units learnt gradually and leading to an increasingly elaborated system of links. They support and extend McBride-Chang's (1995) finding that third and fourth grade children found non-words of three phonemes easier to segment than non-words of five phonemes. The data also show that children display the phenomenon of a phoneme awareness span for one syllable words across a range of phonological tasks. They support the proposition that this be seen as a second dimension in the acquisition of phonemic awareness, in parallel with the development from implicit through simple explicit to complex explicit awareness (Yopp, 1992).

## Discussion

The generality of the phoneme awareness span effect for tasks that did not require the students to manipulate or retain the sounds in each word separately supports the proposition of a phonological knowledge that is becoming increasingly elaborated. The rhyming, onset-rime segmentation and recognition of initial sound tasks did not require students to retain each sound in the words as a unique entity, as is required in the phoneme segmentation task. These tasks required the students to encode each word and manipulate one part of it. The observation that, for the younger children, task accuracy was affected by the number of sounds in the word is consistent with access to a phonological network that is in the process of becoming increasingly differentiated. The younger children, it is proposed, accessed networks that had fewer links between phonemes and were therefore less efficient in chunking and encoding the longer words. Future studies may indicate the extent to which task performance with increase in sound length provides a comparative indication of the extent of phonemic differentiation of the knowledge base.

The phoneme awareness span phenomenon was not restricted to the expressive components of the phonemic tasks. It was displayed also for the recognition tasks, in which students displayed their knowledge through gesture. The rhyming and recognition of initial sound tasks did not require students to say the sounds in words but to identify sounds by selecting pictures. Had its influence been restricted only to the expressive tasks, it is possible that it affected processes to do with the display of phonological knowledge, for example, retaining the separate sounds in order in short term working memory after they had been identified but prior to expressing them. In that case the span could have influenced pre-motor response planning processes.

Instead, the generality of the findings suggest that the effect is more likely to be due to the extent of differentiation of the phonological knowledge base. It is used to encode and process the phonological information.

The association between phoneme awareness span and short term memory also merits consideration. While earlier studies have reported a positive correlation between phonemic awareness knowledge and short term memory span (Wagner, et. al., 1993), they have argued strenuously that this knowledge is more than an aspect of short term memory. The present study proposes that the phoneme awareness span is more an index of the extent of elaboration or differentiation of the phonological knowledge than a measure of short term memory span. The observation that it arises in tasks that do not draw ostensibly on short term auditory sequential memory is seen to support this position.

The gradual differentiation of the phonemic network in terms of connectionist models is also useful in examining the continuing debate of subtypes of dyslexia. One approach to subtyping has been in terms of the alternative routes for word recognition, that is, the 'dual route' theory (Coltheart, 1978). Subtypes have been described in terms of their performance on word reading tasks; phonological dyslexia is characterised by a difficulty reading pseudowords but not familiar exception words, while surface dyslexia is characterised by a difficulty reading familiar exception words but not pseudowords (Castles & Coltheart, 1993). The dual route theory explained the two subtypes in terms of difficulties in lexical and sublexical phonological recoding processes for surface and phonological dyslexia respectively.

The two subtypes can also be explained in terms of the gradual acquisition of the phonemic network. Comparatively poor phonemic differentiation may be expected to lead to phonological dyslexia. Without this knowledge, students lack the capacity to learn the phonemic recoding rules and lack the phonemic units onto which they can map the corresponding orthographic information. Differentiated phonemic knowledge that is characterised by an immature, impoverished network of links may be expected to lead to surface dyslexia. Stanovich, Siegel and Gottardo (1997) support this interpretation. They note that 'surface dyslexia may arise from a milder form of phonological deficit than that of the phonological dyslexic' (page 123). The present findings provide one option for that nature of the deficit in both cases.

The findings have implications for the diagnosis of reading disabilities and for the design of optimally effective instruction. They draw attention to the need to take account of the phonemic load that students can handle both automatically and with an investment of attention during the administration of phonemic awareness tasks. They suggest that it is insufficient to infer the targeted phonological ability using performance on words of three or four sounds. Given the relationship between the amount of phonemic knowledge that can be manipulated and word reading ability (Berninger, 1994; Van Orden 1987; Van Orden, Pennington, & Stone 1990), they suggest the need to match an assessment of word reading knowledge with the assessment of phonemic knowledge using words that match in sound length those used on the reading task.

In terms of the design of instruction, they recommend that students be assisted to develop phonemic awareness for words of increasing sound length and that the assumption that knowledge gained for shorter words will transfer automatically to longer words may be inappropriate. It also suggests that teaching develop procedures for assessing and monitoring the gradual differentiation of the phonemic knowledge and design instructional procedures that target it .

## References

Berninger, V.W. (1994). Introduction to the varieties of orthographic knowledge I: Theoretical and developmental issues. In V.W. Berninger (Ed.), *The varieties of orthographic knowledge I:*

*Theoretical and developmental issues* (pp one-25). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Berninger, V.W. and Abbott, R.D. (1994). Multiple orthographic and phonological codes in literacy acquisition: an evolving research program. In V.W. Berninger (Ed.), *The varieties of orthographic knowledge I: Theoretical and developmental issues* (pp 277-319). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Bradley, L., and Bryant, P.E. (1983). Categorizing sounds and learning to read: a causal connection. *Nature*, 301, 419-421.

Castles, A. and Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition*, 47, 3, 127-139.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), *Strategies of Information Processing*. New York: Academic Press.

Hulme, C., Quinlan, P., Bolt, G., and Snowling, M. (1995). Building phonological knowledge into a connectionist model in the development of word naming. *Language and Cognitive Processes*, 10, 4/3 387-391,

Lenchner, O., Gerber , M.M. and Routh, D.K. (1990). Phonological awareness tasks as predictors of decoding ability: Beyond segmentation. *Journal of Learning Disabilities*, 23, 4, 240 - 247.

Manis, F.R., Custodio, R. and Szeszulski, P.A. (1993). Development of phonological and orthographic skill: A two-year longitudinal study of dyslexic children. *Journal of Experimental Child Psychology*, 56, 64-86.

McBride-Chang, C. (1995). What is phonological awareness ? *Journal of Educational Psychology*, 87, 179-192.

McDougal, S. and Hulme, C. (1994). Short-term memory, speech rate and phonological awareness as predictors of learning to read. In C. Hulme and M. Snowling (Eds.) *Reading Development and Dyslexia*, pp 31-44. London: Whurr Publishers Ltd.

Munro, J. and Munro, K. (1993). Phonemic awareness: A major problem in dyslexia. *Australian Journal of Remedial Education*, 25, 4, 7-13.

Plaut, D. and McClelland, J. (1993). Generalization with componential attractors : Word and non word reading in an attractor network. In *Proceedings of the 15th Annual Conference of the Cognitive Science Society.* Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Seidenberg, M.S., and McClelland, J.L. (1989). A distributed, developmental model of word recognition and naming. *Psychological Review,* 96, 523-568.

Stahl, S.A. and Murray, B.A. (1994). Defining phonological awareness and its relationship to early reading. *Journal of Educational Psychology,* 86, 2, 221-234

Stanovich, K.E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly,* 21, 360-407.

Stanovich, K.E., Siegel, L.S. and Gottardo, A. (1997). Converging evidence for phonological and surface subtypes of reading disability. *Journal of Educational Psychology ,* 89, 1, 114-127.

Van Orden, G.C. (1987). A ROWS is a ROSE: Spelling, sound, and reading. *Memory and Cognition,* 15, 181-198.

Van Orden, G.C., Pennington, B.F., and Stone, G.O. (1990). Word identification in reading and the promise of subsymbolic psycholinguistics. *Psychological Review,* 97, 488-522.

Vandervelden, M.C. and Siegel, L.S. (1995). Phonological recoding and phoneme awareness in early literacy : A developmental approach. *Reading Research Quarterly,* XXX, /4, 854 - 875.

NFER (1992) Verbal and Non-verbal Reasoning Test Series. Windsor, Berkshire : NFER-Nelson.

Vincent, D., Crumpler M., and De la Mare, M. (1996). *Reading Progress Tests.* London : Hodder and Stoughton Ltd.

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

Yopp, H.K.(1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly,* XXIII / 2, 159 - 177.

Table 1 : The mean score and standard deviation in parenthesis for each phonemic length for each task at each grade level (maximum score = 1.00)

| Task | Phonemic span | Prep (n=40) | | 1 (n=40) | | 2 (n=40) | | 3 (n=40) | |
|---|---|---|---|---|---|---|---|---|---|
| Rhyming | 3 | 0.83 | (0.13) | 0.87 | (0.11) | 0.92 | (0.14) | 1.00 | (0.00) |
| | 4 | 0.41 | (0.15) | 0.61 | (0.13) | 0.81 | (0.16) | 0.96 | (0.06) |
| | 5 | 0.27 | (0.03) | 0.36 | (0.15) | 0.78 | (0.09) | 0.89 | (0.09) |
| Onset-rime segmentation | 3 | 0.48 | (0.21) | 0.87 | (0.05) | 0.94 | (0.02) | 1.00 | (0.00) |
| | 4 | 0.26 | (0.10) | 0.63 | (0.13) | 0.88 | (0.06) | 0.96 | (0.03) |
| | 5 | 0.15 | (0.03) | 0.40 | (0.09) | 0.67 | (0.11) | 0.83 | (0.02) |
| Recognition of initial sound | 3 | 0.43 | (0.15) | 0.93 | (0.13) | 1.00 | (0.08) | 1.00 | (0.00) |
| | 4 | 0.53 | (0.09) | 0.81 | (0.10) | 0.89 | (0.15) | 0.95 | (0.02) |
| | 5 | 0.28 | (0.23) | 0.67 | (0.04) | 0.79 | (0.13) | 0.92 | (0.03) |
| Phoneme segmentation | 3 | 0.20 | (0.08) | 0.52 | (0.07) | 0.74 | (0.20) | 1.00 | (0.00) |
| | 4 | 0.16 | (0.13) | 0.31 | (0.08) | 0.49 | (0.14) | 0.82 | (0.23) |
| | 5 | 0.18 | (0.02) | 0.23 | (0.23) | 0.25 | (0.07) | 0.73 | (0.16) |
| | 6 | 0.12 | (0.15) | 0.20 | (0.13) | 0.25 | (0.14) | 0.68 | (0.09) |
| Phoneme substitution | 3 | 0.17 | (0.06) | 0.23 | (0.13) | 0.44 | (0.07) | 0.96 | (0.03) |
| | 4 | 0.13 | (0.12) | 0.23 | (0.12) | 0.45 | (0.14) | 0.89 | (0.05) |
| | 5 | 0.08 | (0.04) | 0.07 | (0.07) | 0.22 | (0.03) | 0.78 | (0.08) |
| | 6 | 0.12 | (0.03) | 0.05 | (0.05) | 0.15 | (0.12) | 0.68 | (0.20) |

Table 2 : The proportion of errors (per cent) attributable to each error category for each sound length at each grade level of the phoneme segmentation task (maximum score) .

| Grade | sound length (number of errors) | category of error | | | |
|---|---|---|---|---|---|
| | | substitute sounds | insert sounds | say blend as single sound | delete consonants |
| Prep | 3 (n= 112) | 73 | 21 | 3 | 3 |
| | 4 (n= 116) | 89 | 3 | 3 | 0 |
| | 5 (n= 113) | 87 | 13 | 0 | 0 |
| | 6 (n= 118) | 97 | 0 | 3 | 0 |
| 1 | 3 (n= 69) | 24 | 43 | 22 | 11 |
| | 4 (n= 93) | 37 | 32 | 25 | 5 |
| | 5 (n= 103) | 68 | 26 | 3 | 3 |
| | 6 (n= 111) | 75 | 26 | 6 | 3 |
| 2 | 3 (n= 35) | 9 | 12 | 48 | 29 |
| | 4 (n= 72) | 15 | 15 | 43 | 27 |
| | 5 (n= 69) | 23 | 31 | 35 | 11 |
| | 6 (n= 99) | 6 | 23 | 56 | 15 |
| 3 | 3 (n= 0) | 0 | 0 | 0 | 0 |
| | 4 (n= 27) | 3 | 6 | 12 | 79 |
| | 5 (n= 35) | 0 | 8 | 6 | 86 |
| | 6 (n= 47) | 0 | 4 | 28 | 68 |