The Role of Phonemic Awareness in the Acquisition of Reading and Spelling Skills of Infant School Children.

Ian A. Stuart-Hamilton

A thesis submitted to the University of Manchester for the degree of Ph.D in the Faculty of Science, October, 1984.

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other University, or other institution of learning.

Ian A. Stuart-Hamilton

Acknowledgements

Many people have helped me in creating this thesis, and to the following my thanks are especially extended. First, to Drs. Christansen, Giorgi and Manstead, and Roselyne Edwards for help with computing on the SPSS amd BMDP systems. To Messrs. Hidden and Clark for revealing the mysteries of word processing. For typing the Tables, my thanks go to Fran Morris, and to my father for drawing the Figures. To Mr. John Lamkin at Rank-Xerox for photocopying. To the staff and pupils of the many test schools for their kindness and hospitality, and to Janice Pascoe for performing the blind testing. To Dr. Graham Hitch for much helpful advice. To Alison Dodd for kind permission to use her tests. To Prof. Peter Bryant and Dr. Lynette Bradley for much stimulating discussion and correspondence, and especially to Prof. Bryant for firing my initial interest in this study. Most especially I wish to thank Prof. Sebastian Halliday, whose guidance and kindness over the past three years have made this thesis possible.

Abstract

Phonemic awareness, (p.a.) can be defined as the conscious realisation that words can be decomposed into discrete units, (phonemes) and that words have phonemes in common. P.a. has been found to be strongly linked to early reading ability. Existing research on p.a. is reviewed, and 2 major conclusions are reached. (1)Many tests of p.a. may be misleading because either they present the child with too large a cognitive/mnemonic load, or they can be performed purely by a tacit sensitivity to similarities in sound. (2)P.a. has almost invariably been investigated in terms of its correlations with reading ability. The nature of this correlation has not been examined.

These findings stimulated the creation of a new p.a. test, more stringent than its predecessors. This was used in four experiments. (1)2 classes of infant school children were followed in a longitudinal study from their 1st. to 3rd. year in school. Their development of p.a., reading, and spelling skills were compared. Reading and spelling ability were found to be strongly correlated with length of possession of

p.a. P.a., as measured by this test, was found to arise in an all-or-none manner, in contrast to earlier tests, which had found a gradual development. (2)100 infant school children, (aged 5:0-7:3) were tested on their reading and spelling skills. Their performance was compared with their abilities at the p.a. test and Bradley's (1980) "odd man out" task, which, it was argued, was not a test of p.a. (as the author had claimed) but of tacit phonemic sensitivity. The p.a. test was found to be a markedly better predictor of reading and spelling than Bradley's. The two tests also differed in the nature of what they measured, and in the hierarchy of difficulty of their sub-tests. (3)1st. year infant school children were tested by an assistant, and grouped into pairs matched for reading and chronological age, but differing in possession/non-possession of p.a. The subjects were then tested by myself on, (a)sensitivity to changes in graphemic structure, and (b)reading style. The results of (a) showed a significantly better performance of p.a.-possessors, whilst (b) found that p.a.-possessors made significantly fewer reading miscues, and their pattern of errors significantly differed from that of the non-possessors. (4)There seemed to be a possible link

between the acquisition of p.a. and the onset of the phonemic confusability effect in short-term recall. To test this, first year infant school pupils were tested for p.a. and short-term recall of two sets of spoken word lists. A significant correlation between length of recall and level of p.a. was found, and in one list a significant relationship between level of p.a. and the confusability effect. A working model to explain these results is proposed.

The results of these experiments indicate the need to consider p.a. in wider terms than its correlation with reading ability. In the final chapter, p.a.'s possible relevance to various facets of educational and psychological research is discussed.

CONTENTS

Chapter 1 ~ Introduction I. The historical background to phonemic awareness research.

Children differ in their ability to learn to read. For many, the process is relatively painless, but a substantial proportion will encounter serious barriers, and may fail to become competent adult readers. Figures for the proportion of the population below the level of "functional" literacy vary between 1 and 20%, depending upon the criteria imposed. However, a conservative estimate is 5%, (c.f., Jorm, 1983a) and this figure is probably doubled or trebled if one considers those subjects who are on the borderline, (c.f., Sticht et al, 1972). This problem is usually not attributable to poor perceptual skills. Downing & Leong (1982) estimate that between 10 and 15% of schoolchildren with no apparent visual, auditory or cognitive deficits, will encounter difficulties in learning to read. Inadequate literacy is a serious problem - it bars the subject from much further education, and makes life in a society which assumes adult literacy fraught with difficulties.

Attempts to explain this problem have led to the identification of various related skills at which poor readers are less adept than good readers. Essentially, reading is the extraction of meaning from print. This process can be divided into two sub-components: (a) the decoding of print into a language which the reader can recognise, and (b) the comprehension of this language. The latter comprehension skill plays an important role in reading. Frazier & Rayner (1982) for example, showed that the attention of adult readers, (measured by their eye movements) was significantly more frequently directed to words upon which the meaning of a sentence pivoted, (e.g., "fell" in "while she was sewing the sleeve fell off her lap"). Carpenter & Daneman (1981) found the same results from a similar experiment. Again, it has been found that young poor readers are less able to extract syntactic and semantic information than good readers, (e.g., Byrne 1981).

However, important as comprehension might be to reading, we need to make two important qualifications. (1) Comprehension very heavily relies upon information drawn from stored knowledge, (c.f., Schank & Abelson 1977). This store is not exclusive to reading. (For example, one can comprehend a report one reads of a cricket match; yet very few people have ever learnt the rules of cricket by actually reading them). So failure to comprehend a script may be due to a general failure of comprehension, rather than a reading-specific problem, (c.f., Crowder 1982). Such people might be able to read a text, as long as the information conveyed is sufficiently simple. This distinction between ability to read and ability to comprehend need not be limited to cognitively less gifted persons. For example, most reasonably intelligent people could read every word of "Ulysses" or "The Wasteland", but very few could understand these texts. (2) The reader has to translate the print into a recognisable language before s/he can comprehend it. If the basic decoding process is defective, then translation may be disjointed enough to make a fluent extraction of meaning impossible, (c.f., Introduction to Reading Styles chapter in this thesis).

This distinction between basic decoding of text and general comprehension has some experimental support in Carver (1983). He observed the eye movements of adult readers in reading text. Carver found that the readers' movements adjusted for spacings between words, but did not adjust for differences in the information carried by the words, (i.e., the difficulty of the material). The reading rate for texts of all difficulties, once word length was adjusted for, was found to be "approximately constant", (there was a slight non-significant rise in reading time for the hardest-to-comprehend material). Hence, reading failure due to comprehension difficulties may either reflect an effective reading system hampered by a poor ability to comprehend, or an efficient ability to comprehend hampered by an inefficient decoding system. Either way, it would seem that the basic decoding system is of prime importance in reading.

The literature on the basic decoding system is vast. Of necessity, only a brief review is included here, which, for obvious reasons, will concentrate on aspects of phonemic processing. An important caveat must first be made, however. No assumptions will be made about the nature of the "interpretable language" into which the reader translates text. It is plausible that in the early stages of reading, where the subject reads everything "out loud", the "interpretable language" is speech, (which in turn has to be processed to extract meaning). However, when reading becomes silent and faster, the decoding processes might skip the translation into speech, and translate directly to meaning, (c.f., Conrad 1972; Crowder 1982). Whichever way text is finally made available for comprehension, none of this affects the central issue of which cues are used, and how, by readers translating text into this "interpretable language".

In order to understand this issue, one must first consider how a language is written. English, (like all Indo-European languages) is written using an alphabetic system. That is, letters, (graphemes) represent, singly or in combination, individual word sounds of speech, (phonemes). There are two major advantages of this system. The first is that, given the sound values of graphemes, the beginning reader should be able to work out what any written word "says". The second is that it is a very economical writing system. Other languages' (e.g., Chinese) representation is at the word, (morpheme) level. That is, the minimum distinctive written unit is the morpheme. It should thus be easier to build up a large reading vocabulary by remembering the sound values of 26 or so letters than by trying to memorise the meanings of several thousand morphemes. However, there are disadvantages to the alphabetic system. The most common criticism is the "irregular spelling" of many words; the sound values assigned to graphemes simply are not consistent. This has led some commentators, (e.g., Smith 1971) to suggest that the teaching of spelling rules to children learning to read English is pointless, so great are the number of exceptions. Again, other researchers have argued that reading a word letter by letter is very tedious, and it is probably too slow for fast reading. Thus, they have argued that developing reading involves a switch from letter-by-letter reading to reading a word by its "gestalt" shape, with minimal attention being paid to phonemic cues.

Research on adult reading strategies indicates that reading is certainly not performed purely by phonological/letter-by-letter analysis. Cattell (1886) argued that if adults read letter-by-letter, then words should take longer to read than single letters. However, he found that: (a) words embedded in prose were read almost as quickly as letters; (b) it takes longer to read letters than words; and (c) visual recognition of words was faster than for letters. Ninety years later, Cosky (1976) with more advanced technology at his disposal, concluded much the same as Cattell. He measured subjects' recognition latencies for each letter, and found that the recognition latency for words was not significantly correlated with the latencies of their constituent letters. A further assumption for letter-by -letter processing is that eye movements follow a regular left-to-right movement, (so that letters can be read in serial order). Research indicates that this is not the case - movements are rarely smooth, with subjects jumping from one fixation point to another, (e.g., Hochberg 1970; c.f., Brewer 1972). There are a vast number of other studies which have similarly shown that adult reading is not purely letter-by-letter, (c.f., Henderson 1982) which are beyond the scope of this thesis to include.

However, whilst adult reading is not a purely letter-by-letter process, phonological encoding certainly has an important role in it. For example, Locke (1971) measured the EMG of students whilst silently reading. He found that all showed signs of subvocal activity, and that this changed with the phonetic content of the text akin to reading aloud. Thus, adult reading is not devoid of some phonological processing. In fact there is a strong body of evidence for adult reading involving phonological processing modified by other sub-skills. Theoretically, this could be a wise strategy. The drawback of phonological processing is its inability to cope with irregular spellings. However, if the subject possesses supplementary skills to identify irregular words, (e.g., by recalling their visual characteristics) then these should enable him/her to bypass the problems of a purely phonological system whilst retaining its advantages, (c.f., Adams 1979).

Baron & Thurston (1973) provided proof of such interfacilitation of visual and phonological skills in adult reading. They briefly displayed a letter string, (the target) and then asked the subject to select the target from a list of alternatives. They found that the "word superiority effect" (i.e., words are processed more efficiently than nonsense letter strings) held just as strongly for pronouncable non-words as for words. This result cannot be attributable to solely visual processing, or the pronounceable non-words would have been treated in the same manner as the unpronounceable non-words. Again, the effect was not purely acoustic. When the subjects were asked to choose the the target from two homophones, the effect was not diminished. Baron & Thurston concluded from these results that the effect was due to combining phonemic and graphemic information into "spelling chunks". In support of this, they cited the following experiment. Chemical formulae follow conventions in their "spelling". For example, "ClNa" is not correct, but "NaCl" is. Clearly, correct and incorrect spellings are only apparent to chemists and chemistry students. The researchers found that when chemical formulae were used as targets, chemistry students were significantly faster at choosing correct than incorrect "spellings", whilst non-chemists showed no difference between spelling groups.

Other researchers have examined the relative importance of visual and phonological processing. All have found that visual processing is more dominant in mature reading. For example, Claxton (1975) gave subjects tachistoscopically presented words, and asked them to report what they had seen. All words were disyllabic, and either the frequency of the words or the frequency of the constituent syllables was varied. Claxton found that the prime determinant of successful identification was word frequency. However, analysis of the partial errors, (i.e., where half of the word was correctly reported) showed that subjects were also paying attention to syllabic content, (there was a slight advantage of 1st. over 2nd. syllables). Seidenberg & Tanenhaus (1979) asked their subjects to judge if pairs of words rhymed. They found that response latencies were shorter for orthographically similar rhyming words, (e.g., "pie-tie") than for orthographically dissimilar words, (e.g., "pie-rye"). Similarly, negative responses to non-rhyming, but orthographically similar pairs, were slower. Baron & McKillop (1975) gave subjects 3 types of phrases to read: sense(s) - e.g., "a victim of circumstance"; nonsense(n) - e.g., "his temperature remained contest"; and homophone(h) - e.g., "bat and bawl". Subjects were given three types of pairing - sn, hn, and sh. They were asked to choose the sentence in each pair which made the most sense, (i.e., s in the sn and sh pairings, and h in the hn pairing). In order to perform the tasks successfully, they would have to use a visual strategy to pick s from sh; a phonemic strategy to pick h from hn; and either a visual or a phonemic strategy to pick s from sn. Baron & McKillop found that subjects who were especially fast on the "visual"(sh) condition were faster on the "basic"(sn) condition than subjects who were especially good on the phonemic(hn) condition. In other words, sophisticated use of a visual strategy is faster than use of a phonemic method.

Hence, there is evidence for adult phonological processing in reading, but it is tempered by visual strategies. It seems unlikely that adult reading could totally dispose of phonemic processing. Work on adult dyslexics has identified a group specifically lacking phonemic processing skills, (e.g., Patterson 1978; Saffran

& Marin 1977). These subjects lack any ability to phonemically encode, (e.g., read nonsense words or recognise rhymes) and their reading is characteristically poor. Subjects can learn to read without phonological encoding, as work on the profoundly deaf has shown, (e.g., Conrad 1972). However, their reading is usually retarded.

We can conclude from these results that adult reading has a strong phonemic content, which interacts with other skills, especially visual processing. A word of caution must be made, though, in assuming that subjects studied in the children's reading experiments reported below will all develop into the adult readers described here. Almost without exception, the subjects used have been university staff and students. Claxton (1979, p.9) justifies this approach in the following quote:

"As I am interested in intellectual skills, I study students, not sheet-metal workers, dockers, or dinner ladies. However, if I wish my hypothesis, based on students, to be applicable to the human race [sic], I must, eventually, try them out on some different samples of people."

An important question might be when this comparison is going to take place. Students form a minority of the reading population, and read for purposes largely unique to that group. That is, they usually read in order to extract information for essays. Their reading style is therefore likely to be far more adept at searching for meaning and argument, and at skipping irrelevant text, than the average reader who is reading for pleasure, and probably enjoys dwelling on particular passages of prose. We therefore cannot automatically assume that the reading style of students is representative of all adult readers. Similarly, we cannot therefore judge if the reading behaviour of schoolchildren, (the majority of whom are not going to become students) will only evolve along the path of the university undergraduate.

Adult reading research is chiefly concerned with examining the workings of reading in what is assumed to be its "ultimate" form. Child reading researchers seek to discover what skills children need to reach this goal, and why some fail to. Their aims can be broadly divided into four inter-dependent areas: to see (a) how best to teach the child to read; (b) what factors influence a child starting to learn to read; (c) what a child learns about print; and (d) how the child uses the skills acquired in (b) and (c) in reading. This final factor will not be discussed in this Introduction, but in the Rationale of the reading style experiment below. This is for a structural reason. Adequate discussion of reading style could not be made without the establishment of several caveats, which are to be drawn from the two experiments preceding the reading style study. In any case, the reading style discussion is not centrally relevant to the studies to be reported before it. For the rest of the Introduction, we shall consider the first three factors of reading development.

(a) The teaching of reading. Because English is written alphabetically, the traditional approach has been to teach the child the "sound values" of each letter, and teach by rote the high frequency words with irregular spellings. From a grounding in these basic principles, it was hoped that the child would develop into a competent reader, by being able to phonemically decode every new word s/he met. This teaching method has its roots in Ancient Greece, (c.f., Crowder 1982). By the Middle Ages, this system had become fairly standardised, through the use of hornbooks or similar devices. Crowder criticises this method as being hopelessly inadequate for coping with irregular words. However, it should be remembered that until the late 18th century, spelling was not standardised. People largely spelt words as they saw, (or rather, "heard") fit. In other words, their spellings were usually phonemic, and a great variety of spellings could exist for single words. Thus, learning to read by sight would be a useless strategy because of the wide variety of spellings. Only a basic "word attack" skill, (i.e., building up words letter by letter) would really be of any use, and this is what the "abecedarians" taught. In the 19th century, educationalists began to take a serious interest in reading teaching, and the above method was christened "phonics".

In the 20th. century, criticisms that the method was boring, and left the child unable to read irregular spellings, have led different education authorities at different times to swing in favour of "whole word" teaching. That is, the child is taught to read words by their shape, with little attention being drawn to their phonemic content. The method has the advantage of avoiding the pitfalls of irregular spellings, but leaves the child with few word attack skills to read new words for him/herself. For this reason, education authorities have often swung back in favour of phonics teaching. Then more evidence has been put forward for the whole word method, and the pendulum has swung again. These changing fashions have been a cyclical feature of infant school education for the past few decades, (c.f. Drummond & Wignell 1979). Perhaps the most drastic swing to the phonics method was the the introduction of the "initial teaching alphabet" (i.t.a.) in the 1960's. This used the 26 conventional alphabetic symbols, and each grapheme uniquely represented one phoneme. Representations of other phonemes, not represented by the 26 "normal" graphemes, were dealt with by a set of specially-created graphemes. These too uniquely represented single phonemes. Thus, words spelt in i.t.a. were all regular. Reading progress using this system was far more rapid than for a conventional alphabetic system. The child could read any word by phonic attack skills, and did not have to worry about learning any troublesome irregular spellings. However, et in arcadia ego ... I.t.a. was easy to teach; what was not so easy was transferring the children, fluent in reading a perfectly phonic system, to reading conventional text, with its myriad "exception" rules, and with single letters representing not one, but several different word sounds. This led to serious problems. Downing (1967), in a study of over 1,000 subjects, compared the reading performance of children learning to read conventional and i.t.a. text. He found that initially the i.t.a. readers performed better than conventional text readers, (i.e., in terms of complexity of text, reading vocabulary, etc) but lost this advantage, or even fell behind when they transferred to normal text. This lent empirical support to the qualms of many schools about the practicality of the scheme, which required capital outlay on two libraries of reading books, and also diverted middle and final year teachers' time towards teaching basic decoding skills, work which had previously outside their domain. For these reasons, i.t.a. was abandoned by many schools.

A counter-surge against phonics was almost inevitable, and it came in the shape of Frank Smith, (e.g., Smith 1971). Smith argued that to stress word attack skills is to divert the child's attention away from the fact that the primary purpose of reading is to extract information fluently. If the child was allowed to read at his/her own pace, and with the minimum of interruption, then s/he would initially make many mistakes, but with practice the reading should get better. The child would in the meantime have hopefully learnt that reading can be fun, rather than an exercise for word attack skills. Smith gave the effective analogy of an adult reading a

Russian novel. If one starts to read "Crime and Punishment" and tries to pronounce and learn the name of every new character, then one quickly loses the thread of the plot. The better strategy is to ignore the names, and press on regardless; after about fifty pages, everything should resolve itself. Smith's ideas were enthusiastically received by many. Some L.E.A.'s went so far as to issue guidelines against the use of phonics, (Morris 1983).

There is now a move away from the Smith school of thought, (c.f., Morris 1983). There are two major reasons for this. (1) The problem with any whole word teaching method remains that it leaves children inadequately equipped to deal with new words (c.f., Groff 1974). (2) Smith was attacking "synthesis" phonics teaching, rather than phonics teaching in general. "Synthesis" phonics places great stress upon the child "building up" every word that s/he encounters. However, phonics can also be analytic. That is, the child tries to decode a word by its phonics content only if s/he cannot recognise it by other cues. Thus, phonics is most used in the early stages of reading, when the child has a low "sight vocabulary". In the later stages of reading, it should be used less and less frequently, as the sight vocabulary increases. If one accepts this argument, then the best teaching method would be an "eclectic" approach, (Weaver & Shankoff 1978). That is, in the beginning, great stress is laid upon phonics, and this emphasis gradually gives way to stress on whole word recognition, use of context, etc, by the third year of infant school. Whilst teachers tend to be slightly biased towards whatever happens to be the latest theoretical argument, most schools in this country now adopt this eclectic approach, (Drummond & Wignell 1979; Morris 1983).

It should be noted that studies on the teaching of reading are concerned with which skills should be taught to get the best <u>results</u> rather than with the skills a child actually <u>uses</u> in reading. For example, both the i.t.a. and Smith methods, though differing vastly in their rationales, produce good readers, when used correctly. This emphasis on results, rather than the reasons why, places a large gulf between teaching studies and the rest of reading research. For example, in the 1970's when Smith's theories were in the ascendant, the reading theorists were providing strong evidence that phonological skills were the prime determinants of reading performance, (see below).

This apparent dichotomy between theoretical prediction and practical reality need not concern us unduly. What aspects of reading are taught and what aspects are ultimately learnt are two separate matters. The phonics and whole word methods provide two different ways of making reading more comprehensible to the child. Ultimately, however, there is no difference in attainment using the two curriculum approaches, (c.f., Tunmer & Bowey 1984). Though the child may initially learn to read in the manner prescribed by his/her teacher, we have no guarantee that s/he will not develop personal reading strategies of his/her own. There is some experimental evidence for this. Alegria et al (1983) found that children taught by a pure whole word scheme, had within 8 months of starting school, developed an awareness of phonemic structure. This same awareness arises earlier in phonics-taught children (Alegria et al 1982). Thus, although teaching style may colour reading processes, the end product may not differ much.

To summarise this argument. Educationalists have long recognised the usefulness of teaching phonemic structure. However, in recent times, the poverty of a pure phonemic approach has been argued and demonstrated. This has ultimately led to many teachers adopting an "eclectic" teaching approach, which recognises the need for phonics to be combined with visual recognition skills. This accords well with the arguments made above about adult reading style. However, the primary concern of teaching methods is to obtain results. It does not necessarily follow that the child will learn to read solely from what s/he is taught. Success of teaching schemes might thus depend in part upon what the children teach themselves. This potted history of reading teaching is, of course, grossly simplified. I am aware that there are other teaching methods, beyond phonics and whole word, such as Gleitman & Rozins' (1983) system of teaching by syllables. However, such schemes are in the minority. The main area of dispute in reading education is between teaching by sight and teaching by sound.

(b) What a child already possesses when s/he starts to learn to read. The child does not come to reading as a totally blank slate. S/he already possesses very considerable language and cognitive skills, and it is the extent to which these are applicable to reading which is the subject of this discussion. Let us begin with phonological skills. The average beginning reader will already have a complete, or near-complete repertory of phonemes used in spoken English, (Fry 1977). From about the age of 1:5, s/he has been able to distinguish between spoken sounds, and this ability has become more sensitive and accurate with increasing age, (Garnica 1973). Thus, any sound whose printed representation the child encounters should already be present in his/her phonological store.

General intelligence has usually been found to be a poor predictor of reading performance, (e.g., Fontes 1977). However, cognitive sub-skills may play a role in determining future reading performance. Mason (1977), for example, tested a group of 44 (U.S.) pre-schoolers. He found that their future word recognition ability was positively correlated with classification and symbol matching skills. Dimitrovsky & Almy (1975) reported that beginning readers' performance on a Piagetian number conservation task strongly predicted future reading performance. Brekke & Williams (1975) found that pre-readers' conservation skills on five Piagetian conservation tasks correlated well with listening comprehension, auditory and visual discrimination and visual-motor co-ordination, (interestingly, though, not with auditory blending). Polke & Goldstein (1980) found that precocious readers had better conservation skills than non-reading pre-schoolers. The strength of conservation's role in reading is difficult to assess. None of the above experiments showed cause and effect. Thus, we do not know if a rise in conservation skills causes any change in reading. More probably, conservation ability reflects general academic attainment, which correlates well with reading ability. In theoretical terms, a direct link between conservation and reading would seem improbable. Dodd (1982) observed, (in a different context) that the child spends the first few years of life learning about the consistency of objects, regardless of orientation. Text is the first item s/he has encountered whose meaning alters with changes in orientation, (e.g., "cow" -> "woc"). It would therefore seem highly unlikely that conservation, which stresses the invariance under transformations involving rearrangement, should be of any use in learning about the immutable nature of print.

Further, more general factors may play a role in beginning reading. Moore et al (1979) argued that home background is a decisive factor. The greater the stress the family places upon the importance of learning, and the greater the books and opportunities for quiet study that are provided, the better the reader. Durkin (1961,

1963) found that pre-school readers came from similarly supportive homes. Durkin also observed the critical importance of encouragement and help from older brothers and sisters. Jorm (1983b) in a recent review of the literature, also cited the importance of sibling encouragement in early reading. Other factors in addition to home environment indirectly impinge upon reading. For example, the emotional stability of the child; degree of parental guidance (Bee et al 1969); and general physical health. These factors are not specific to reading, but all still play a part, and are included in teachers' assessments of "reading readiness", (c.f., Downing & Thackray 1975; Drummond & Wignell 1979).

Metalinguistic awareness. Reading is, by Venezky's (1976, p.6) definition, "the translation from writing to a form of language from which the reader already is able to derive meaning". Or, more simply, reading is the extraction of meaning from print. A child who learnt to read by rote learning the correct verbal response for each unit of text is not reading, so much as "barking at print". In order to move beyond barking to reading, the child has to obtain insight into what s/he is doing. No matter how sophisticated or fast the word recognition strategies - without insight the child is no more reading than Premack's chimpanzee "Sarah" who learnt to identify shapes by their spoken name. It is this insight, or, metalinguistic awareness, which creates _reading_. Tunmer & Bowey (1984) have identified several components of awareness:

general awareness: knowing what reading is, and how it differs from other activities.

phonemic awareness: knowing that words are composed of phonemes.

word awareness: knowing that speech can be divided into morphemes.

form awareness: knowing that words have to be formed into phrases and statements to be meaningful.

pragmatic awareness: knowing that meaning has to be extracted from an analysis of a passage of prose, and not just individual sentences.

Form and pragmatic awareness essentially deal with comprehension rather than basic decoding, and for the reasons outlined above, will not be discussed here. We shall instead concentrate on general, word, and phonemic awareness.

(_a_) _General awareness_. Reading teaching cannot begin unless the child realises that the object of the exercise is to translate text into speech, (children are almost invariably taught to "read aloud"). Reid (1966) interviewed beginning readers, and found that they had no clear idea of what was done in reading. This study was greatly extended by Downing (1970a, 1970b). He interviewed 13 children 2 months after entering school. Using a structured interview, (devised by Reid) he found that only 2 of the subjects knew that books have writing in them, and none mentioned words, nor had a clear idea of how reading took place, (although 7 of them insisted that they could read). However, most of the children could recognise pictures of reading versus non-reading activities, and all but one of them knew that to choose the right bus, you had to look at its sign, (Downing 1970a). Six and nine months later the subjects were re-tested with the same measures. At these sessions, they showed greater general awareness of reading, and had learnt more of the practical uses of reading, such as "L" plates, (Downing 1970b).

How important a causal factor general awareness is in reading development has not been established. Clearly a child with good general awareness is likely to be a better reader than one who barks at print. Indeed, Downing has recently produced a test of general awareness as a predictive measure of reading readiness, (Downing et al 1984). However, we cannot be sure how much of general awareness is merely a by-product of good reading ability, and also, of home background, (one would expect a child of a "good" home to have a far better general awareness).

(b) Word awareness. Words in written English are visually separated by spaces. Words in spoken English are not separated by equivalent silent pauses. Instead, the final and initial sounds of words "shingle" into each other, (c.f., Lewcowicz 1980). Thus, a child learning to read words has no experience from spoken language to match it. One of the first tasks of the beginning reader is therefore to become aware of the existence of words. Downing & Oliver (1974) charted the development of this awareness. They studied (U.S.) pre-school, kindergarten, and 1st. graders, who were asked to identify words from a list of various stimuli: real words, phrases and sentences, phonemes, syllables, and non-verbal sounds. Downing & Oliver found that subjects under 6:5 years tended to confuse all these stimuli with words, except for the non-identifiable sounds, (e.g., a high pitched tone).

Subjects under 6:5 years also tended to exclude long words from their conception of a word. All subjects tended to confuse syllables and phonemes with words. This latter finding has caused some commentators to argue that the children could not distinguish between phoneme clusters and phonemes. However, this might not be the case. The subjects of Downing & Olivers' study were of an age when children are constantly encountering new words. If they encounter a syllable or a phoneme which they can identify as "wordlike", then they might well presume that it is a word they have not encountered before, and rather than display their ignorance, identify it as a word. Ehri (1979) has reported similar findings to those of Downing & Oliver. She made the additional observation that children depended upon context in attaining word awareness. Pre-reading, or beginning reading children, given a sentence to look at, would often state that one word of the sentence "said" the whole sentence. The remaining words of the sentence would be held to be descriptions of the action portrayed in the sentence. This finding might explain the results of Ollila & Chamberlains' (1979) study. They found that kindergarten children remembered context-free words, (nouns) better than context-dependent words, (verbs, adjectives, etc.). Ehri (1976) found a similar result in a task involving the pairing of words to nonsense figures. Further studies in this field have confirmed this, (c.f., Ehri 1979; Tunmer & Bowey 1984).

Another aspect of reading the child has to become aware of is the existance of the word. Part of this process involves the acoustic isolation of the spoken word, and the removal of the word from context. Ehri (1975, 1976) has shown that word awareness usually arises after reading experience. This suggests that it is, like general awareness, a by-product, rather than a critical determinant, of reading. However, it should still be remembered that word awareness is a mark of reading, and a move away from barking at print. Again, the child who has word awareness before s/he starts to read is likely to have at least an initial advantage over a child who has not. This is an interesting suggestion, which, as far as I am aware, has never been tested.

(c) Phonemic awareness. We have already seen that general and word awareness, though indicative of a shift from barking to reading, may be by-products of good reading, rather than causal factors. Furthermore, it would seem from the results of the above experiments that all readers attain these insights. Indeed, it is difficult to see how any reader could fail to learn what reading or a word was, no matter what his/her ability. Let us now consider the importance of an awareness of phonemic structure. The basic principle of the alphabetic writing system is that an attempt is made to represent spoken words at the level of the phoneme. If the subject cannot understand this principle, then the only way s/he can learn to read is by memorising the visual shape of every new word which s/he encounters. Given that this may extend to 20,000 new words by the time s/he is an adult, (Rozin & Gleitman 1972) one can readily appreciate the problem of such an approach. If we assume that the subject read in a "whole word" method as well as a Chinese scholar, then his/her total reading vocabulary would be unlikely to exceed about 3,000 words, (Rozin & Gleitman 1972). The need, therefore, to have an understanding of phonemic structure is important. This cannot be attained simply by rote learning. The child who learns to blend together letters to make a word sound , without any understanding of why s/he does this is still barking at print. It is the understanding of the process which is the critical factor. Researchers became interested in this issue in the 1970's, and christened this metaknowledge "phonemic awareness".

Phonemic awareness will be defined in this thesis as <u>the realisation that words can be decomposed into a limited set of subcomponents, (phonemes), and that words have phonemes in common</u>. Two major qualifying statements need to be made about this definition. (1) Testing for p.a. requires the subject to explicitly identify phonemic structure; an ability to detect words which "sound the same" without an identification of the source of the similarity is not sufficient proof of the presence of phonemic awareness. For example, any normal child from the age of a few months upwards could identify "cat" and "bit" as sounding the same. However, only if s/he could identify the reason for this similarity being a common a common "t" ending would s/he be said to have phonemic awareness. There is a strong reason for making this distinction. The alphabetic script only makes sense if the child can identify phonemes. Identification of similar sounding words provides no evidence that the child is aware of phonemic structure. This fact has been recognised by many researchers. The following are representative quotes:

"What is important for the teaching of reading ... is not whether phonemes play any part at all in speech perception, but whether they play any conscious, or potentially conscious part" Savin (1972).

"While tacit knowledge of the role of the relevant categories, (phonemes) can be shown from oral language use to exist in the head, this is insufficient to form the basis of reading acquisition. The prospective reader must acquire phonological awareness , or quite explicit access to the phonological mechanisms or principle at work in his speech system." Rozin & Gleitman (1972).

"In order to understand the relationship between written items and their oral counterparts the child must explicitly analyze speech into the units considered in his own writing system." Alegria & Content (1983).

In linguistic terms, phonemic awareness allows an insight into the "dual structure" of language which tacit sensitivity does not. "Dual structure" means "that the units on the lower level of phonology, (the sounds of a language) have no function other than that of combining with one another to form the "higher" units of grammar, (words). It is by virtue of this double structure that languages are able to represent economically many thousands of different words", (Lyons 1968 Ch. 2.1.3).

Thus, it is important to distinguish phonemic awareness from tacit sensitivity, since, although the two may have a surface similarity, they almost certainly play very different roles in the acquisition of reading.

(2) It is also important to stress that phonemic awareness not only requires the identification of the phonemic content of words,

but also that words have phonemes in common. Without realising the communality of phonemes, subjects could regard the phonemic content of each word as being unique. This may appear to be a pedantic point, but, as will be shown below, mere segmentation of a word into its constituent phonemes is not synonymous with an especially deep understanding of word structure.

The above arguments underlie the study of phonemic awareness, (p.a.). A review of p.a. experiments performed to date forms the next section of this Introduction. Before we reach this, however, there is a pressing need for several caveats. (1) "grapheme" and "phoneme" are used in the layman's definition of "letter" and "word sound". I realise that this will irritate linguists, but in mitigation I plead that I am, for the sake of conformity, only copying the practices of other p.a. researchers. (2) discussion throughout will assume that the child is learning to read English. This is not due to chauvinism , but purely from a desire for clarity. One could equally well be discussing any other alphabetic writing system. In fact, the bulk of research has used English readers; the exceptions will be noted. (3) for convenience's sake, I will talk about young children "knowing that words are composed of phonemes", etc. Clearly, this does not mean that young children could define a phoneme if asked. Such phrases should be taken as indicating that the child understood the concepts implied within them, in the same sense as we say that a child of 8 or 9 "knows about" class inclusion or conservation.

Chapter 2 ~ Introduction II. Phonemic awareness research, circa 200 B.C. - 1984.

"P.a. is the realisation that words can be decomposed into a limited set of subcomponents, (phonemes) and that words have phonemes in common."

The importance of an explicit knowledge of phonemic structure in learning to read has been recognised for a considerable time. Consider the following (extreme) example:

> "Wealthy Greeks in the ancient world hired 24 slaves to coach their children, each slave to represent one of their letters, a "hot" teaching approach worthy of our contemporary Sesame Street." Crowder, (1982) Ch 10.

The same principle, in less dramatic form, is extolled in the phonic teaching schemes. However, a methodological testing of the role of p.a. in beginning reading did not begin until the 1970's. Researchers recognised the need to distinguish p.a. from tacit phonemic sensitivity, ("p.s." - sensitivity to differences in word sounds, without necessarily being able to judge why they sound different). However, despite recognising the need, many created tests which the subject could successfully perform without necessarily having insight into phonemic structure. This is not to imply that they are worthless tests, but rather, that they are better classified as tests of other types of phonic skills. Other tests of p.a. truly required knowledge of phonic structure, but also placed an undue cognitive load upon the subject. Thus, the children could fail the test, not because they lacked p.a., but simply because they did not understand the task instructions. Let us look at examples of these two kinds of studies, before considering some valid tests of p.a.

We shall consider first those studies with undue cognitive demands. Perhaps the most widely quoted of all p.a. studies is that by Liberman et al (1974). The experimenters asked subjects, (U.S. schoolchildren) to tap out either the number of syllables or the number of phonemes in a spoken word, the argument being that if the subjects could detect the phonemic/syllabic content of speech, they could certainly tap it out. Briefly, it was found that none of the 4 year old subjects could do the phoneme task, though about 50% successfully identified the number of syllables. This compared with the successful performance of 17% of the 5 year olds, and 70% of the 6 year olds on the phoneme task, and 90% of the 6 year olds on the syllable task. However, it is quite likely that the younger subjects, asked to tap along to the words, might behave as though tapping along to a piece of music. As a word's syllabic and rhythmic structures nearly always correspond, these children will perform the syllable task well, whilst being out of step on the phoneme task. That the task was introduced to the subjects, "under the guise of a tapping game" makes this likelihood even stronger.

Another test with a possibly over-large cognitive load is that by Bruce (1964), who devised what I think was the first p.a. test, (though he did not label it as such). He asked his subjects, (U.K. schoolchildren aged 5:1-7:6) to remove specified phonemes from 30 familiar words, and say what remained, (e.g., to remove "k" from "pink" or "s" from "nest"). Bruce found that only children above the mental age of 7 years could successfully perform the task, although children above the mental age of 6 years could segment the words into their constituent phonemes. Bruce concluded that " a certain level of basic mental ability is necessary before the child can analyze words in this way". Bruce's task seems rather a complex way of testing p.a.: the child has not only to be aware of the word's phonemic content, but also has a considerable mnemonic load to cope with. The child has to possess p.a. to perform the task, otherwise s/he would not be able to identify phonemic content, nor would s/he realise that alterations in phonic structure create new words. However, the mnemonic load is great. The child has to segment the word, and whilst remembering the constituent phonemes in their correct order, remove a specified phoneme, then remember the remaining phonemes in their serial order to recombine them. The younger subjects might have p.a., but this is hidden by an inadequate cognitive/mnemonic system. This seems to be borne out by Rosner & Simon (1971). Their subjects, (U.S. children from kindergarten to 6th grade) were given an "auditory analysis test" which bore a close similarity to Bruce's test, except that the test words were varied in length from 1 to 4 syllables. The researchers found that all subjects could perform some of the test at least, and that there was an improvement across age, (e.g., kindergarten, avg. 3.5 words correct; 1st. gde, 17.6; 2nd. gde, 19.9; 3rd. gde, 25.1). Difficulty increased with word length, with the youngest subjects only capable of successfully manipulating the shortest words. Thus, the age effect on Bruce's task might be due to word length, rather than phonic ability. Rosner & Simons' work is still subject to the same criticisms as Bruce's - we cannot tell how much of the improvement on the test is due to p.a., and how much to developing cognitive/mnemonic skills.

This problem also faces a study by Morais et al (1979), who used Bruce's paradigm with real and nonsense words. The subjects were two groups of 30 adults from a "backward" region of Portugal, who had received no schooling as children. One group had attended adult literacy classes for a year, whilst the other (matched) group had not. Morais et al found no group difference on the nonsense word task. However, there was a very significant difference on the real word task - only 19% of the illiterate group could perform the real word task, compared with 72% of the literate group. The results were roughly comparable with the performance on the same tasks of Belgian 1st., (6yrs) and 2nd., (7yrs) graders respectively. Morais et al concluded that whilst p.a. could be acquired without stimulation from reading print, in most cases p.a. is acquired through reading experience. Certainly p.a. does not arise through mental maturation alone.

Elegant as Morais et al's experiment is, we cannot unreservedly accept its conclusions. First, there are the problems associated with the Bruce paradigm which have already been mentioned, though these problems may not be great in adult subjects. Second, we cannot assume without further evidence that the Portuguese adults and the Belgian schoolchildren were using the same cognitive strategies. Third, and more pertinently, we cannot be sure if the difference between the two adult groups was not due to the literate group having been trained in "playing with words" as part of their lessons, and thus, the difference might be due to being taught to read, rather than to the process of reading itself. For example, the child might spontaneously realise that the morphemes s/he was "sounding out" in reading represented sounds s/he heard in everyday speech. However, it is equally plausible that the insight could be gained through the teacher stressing phonemic content and teaching "sounding out" skills, and also by playing "word games" in the classroom.

This final criticism has been partly answered by another paper from the Morais et al group. Alegria & Content (1983) studied a class of Belgian children being taught by a rigid "whole word" method; the teacher never made any mention of phonics to the pupils. The subjects were tested 4 and 8 months after the onset of reading instruction on two tasks - the Liberman et al tapping test, and the Bruce paradigm. The subjects' performance at the first test session was poor, and correlated weakly with reading ability. However, at the second session, test performance had improved, and now was significantly correlated with reading ability. Hence, it would seem that children can acquire p.a. solely through the experience of reading, without regard to teaching. There are problems with Alegria & Contents' study, however. We have seen that the Bruce and Liberman et al paradigms have a possible cognitive/mnemonic overload. The subjects capable of performing the tasks are genuinely displaying p.a., but there may be further subjects with p.a. who are barred from successful performance by lack of the same cognitive/mnemonic skills.

The Morais et al and Alegria and Content studies raise the general, but for this thesis, important question of reading versus teaching experience as a source of reading skills. Alegria & Content found evidence for the importance of reading experience. Scribner & Cole (1981) found evidence for the importance of teaching method in a study of the Vai tribe of Liberia. The Vai have three different writing systems - Vai, which is informally taught; Arabic, taught in Koranic schools; and English, taught in European-type schools. Scribner & Cole found that the Vai's language abilities varied according to the way they had been taught. For example, a group of Vai literates were asked to write a letter describing a new board game. The English and Vai literates provided more explicit verbal information than the Arabic literates. This was attributed to the fact that the Arabic literates used their literacy almost solely for learning the Koran, whilst the English and Vai readers used it as a means of communication. In fact, the Arabic literates were on a par with illiterate adults asked to dictate a letter. Thus, we have evidence that in some cases, it is not reading, but how reading is taught, which determines language skills. Further support for this conclusion comes from the study by Alegria et al (1983), (cited in Chapter 1) which found that age of acquisition of some phonic skills was strongly related to the teaching method employed. Thus, we can conclude from the above studies that the acquisition of language skills may be determined not only by literacy, but also by the method by which reading is taught. We shall return to this point in the review of valid tests of p.a. below.

To summarise the above studies - the tests require the presence of p.a. to be performed, but also require a level of additional cognitive/mnemonic ability which is likely to exclude some subjects, (whether they have p.a. or not). All the studies found that their test scores correlated well with reading ability/age. The two studies which specifically addressed the problem - Morais et al and Alegria et al - found that the phonic skill they were assessing arose from reading experience, (though it could conceivably arise from being <u>taught</u> to read in certain circumstances).

Let us now turn our attention to the body of studies purportedly testing p.a., which may be successfully performed without conscious awareness of phonemic structure. That is, tests performable by tacit phonemic sensitivity, (p.s.) alone. Note that I am not saying that subjects with p.a. do not use it on these tests; rather, that subjects without p.a. can perform them successfully.

One of the most popular types of this sort of test is the segmentation task, in which the subject is asked to split up a word into its constituent phonemes. For example, Lewcowicz & Low (1979) used this technique on (U.S.) pre-readers, and found that whilst many of them could segment a CVC word into C:VC or CV:C fragments, only about half of them could segment into C:V:C. Zifcak (1981) showed a strong relationship between U.S. first graders' reading performance and their segmentation ability. Zhurova (1971) found that Russian kindergarteners' ability to segment improved across age, (range = 3-7 yrs). Morais et al (in press) have shown that (6-9 yr old Belgian) poor readers' segmentation ability is significantly worse than good readers', but this ability applies only to segmenting speech, and not to segmenting musical tone sequences.

These are fascinating findings in their own right. However, segmentation is not a test of p.a.; rather, it is a necessary but not sufficient requirement for it. Breaking a word into its constituent phonemes indicates that the child is aware of the word's phonemic content; it does not show, however, that s/he is aware that these sounds are from a common pool, (i.e., that they are present in other words as well) or that s/he can tell what position a phoneme occupies in a word. This may seem pedantic, but that segmentation is not synonymous with an especially deep understanding of phonemic structure is borne out by Skjelfjord (1976). In attempting to teach beginning readers to pick out phonemes from a word, he found a number of subjects who would spontaneously segment the entire word. However, having done this, many of them could not judge which phoneme belonged in the location specified. Thus, concluded Skjelfjord, "reporting all the sounds in sequence seemed to be easier than just reporting the sound in one of the positions".

Another popular test of p.a. has been blending, where the subject, having been given the constituent phonemes of a word in correct serial order, has to say what word they form. Although accepted by many as a valid test, (e.g., Guthrie, 1973; Lewcowicz, 1980; Roberts, 1975; Williams, 1980) blending need not require conscious insight. It has been argued that it can be successfully performed by the child saying the letters quickly together. The resulting sound will not be exactly like the word, but will probably be close enough to enable the child to make a good guess. This accords well with teachers' observations of some children forced to sound out a word. However, could a child's immature pronunciation of the letters be used to successfully blend them into a word? For example, could "buh", "uh" and "tuh" be blended into "but", or would the above method result in "buhuhtuh"? Many teachers train children to ignore the "uh" sound, but for those unconvinced by this argument, there are two further reasons for rejecting blending as a true p.a. test. First, a blending task does not ask a child to identify phonemic content - it tells him/her what it is. Second, blending, like segmentation, only tests an ability to deal with itemised words, and does not assess knowledge about the communality of phonemes, etc.

A rather more complex issue to deal with is Bradley & Bryants' work on p.a., (e.g., Bradley & Bryant 1983). Their test is the "odd man out" procedure, (Bradley, 1980) where the subject is asked to detect the dissimilar-sounding word from a group of four. For example, the subject might be asked to say which is the odd man out from "cat, rat, bat, man ", (correct answer underlined). The test comprises three groups of 8 lists, in which the difference lies in the initial, medial or final letter of the word. The test has discriminative validity. For example, Bradley & Bryant (1978) found that poor readers performed significantly worse on it than reading age matched controls, (i.e., chronologically younger). More recently, the researchers conducted a longitudinal study on a group of children from pre-school to the end of infant school, (Bradley & Bryant, 1983). They found that test performance at pre-school level predicted future reading quite well, even after allowing for the confounding effects of such factors as mathematical and general reading attainment. They also took a group of children lacking in these phonic skills, and gave them training in classifying words by their sounds. This group's reading performance improved slightly but significantly over other groups which similarly lacked phonic skills, but who had either received no training or had been trained in classifying words by their meaning. Thus Bradley & Bryants' test assesses a phonic skill related to reading. However, is it a test of phonemic awareness ? In the introductory session preceding testing, the child is told to pay attention to the source of the difference/similarity between the words only in the initial letter condition. In the final and medial conditions, s/he is only told to listen for the word which does not "sound the same", (Bradley 1980) with no attention being drawn to the source of the difference. It is thus possible that the child could successfully perform the odd man out task by noting that the word does not sound like the others, without regard for the reason why. An analogous situation is of a musically "illiterate" person being asked to judge which is the odd one out of a series of chords, three being harmonised, and one not. The person can tell you this without being able to tell you why. Hence, the subject need not have insight into phonemic structure to perform the odd man out task, (though it might make the task easier); it might be done quite successfully by tacit p.s.

alone.

To summarise the above studies - they purport to test p.a., but can be successfully performed by tacit p.s. alone. All who have addressed the issue have found that their test measures correlated well with reading ability. However, in contrast to the "cognitive/mnemonic overload" studies described above, the p.s. researchers found that their phonic skill preceded reading. One explanation for this apparent discrepancy is to suggest that there are at least two types of phonic skill being tested here: that in a task demanding conscious awareness arising from reading/teaching; and that in a task requiring only tacit sensitivity preceding reading, and therefore probably tapping speech. This is a reserved conclusion, however. The "conscious awareness" tasks all have a cognitive/mnemonic overload, which may be confounding the results. An interesting question, therefore, is if a test which assessed conscious awareness, without overloading the subject's cognitive/mnemonic capacities, would display the same pattern of results. Again, a direct comparison between a p.s. and a p.a. test has never been made, and it would seem central to establish if these cross-study differences are maintained in a direct comparison within individual subjects.

If we are prepared to alter the labelling, then the above "p.a. tests" are still very useful as tests of other phonic skills, and the literature is greatly enriched by them. We shall now turn our attention to studies which unequivocally test p.a. The criteria are that a p.a. test should assess if a child knows, (a) that words are composed of phonemes, and (b) that words have phonemes in common. Unfortunately, the research using "real" p.a. tests follows several rather disparate threads. Hence, what follows is largely a catalogue of studies.

It was noted in the review of "cognitive overload" p.a. tests above that reading and being taught to read exerted different influences on language skills. Whether p.a. was a product of reading or being taught to read could not be determined, because the tests of p.a. were possibly invalid. Alegria et al (1982) addressed this problem, though this time a "genuine" p.a. test was used. Their subjects were Belgian 1st. graders, (6yrs old) tested 4 months after the onset of reading teaching. They were being taught either by the whole word <u>or</u> the phonics method, and were equally good readers. The subjects were given two tasks. The syllable task was to reverse the syllables of nonsense words, (e.g., "para" -> "rapa"); the phoneme task was to reverse the phonemes in a syllable, (e.g., "so" -> "os"; "ol" -> "lo"). The phoneme task is a test of p.a. since it requires the subject to identify phonemic content and to recognise that phonemes can be recombined to form a new "word". Alegria et al found that there was no significant difference between the phonics and whole word taught groups on the syllable task, (75.3 and 67.5% correct respectively). However, there was a large and significant group difference on the phoneme task: whole word group 15.4% correct; phonics group 58.3% correct, (the group/task interaction was significant at .005). Thus, p.a. seems to be more strongly influenced by particular types of reading instruction than by reading experience itself, at least in the early stages of reading. It should be noted that the researchers were studying extreme teaching styles. Most British schools adopt an eclectic mixture of whole word and phonics, so differences between pupils of "normal" schools may be much less clear-cut. Alegria et al's study also shows that p.a. would seem to be totally absent in many pre-readers, whilst other studies have shown that most have some p.s. This further reinforces the argument that there is a real difference between the two abilities. Alegria et al, in finding that the syllable task was performed successfully at an earlier age than the phoneme task, have provided further evidence for would seem to be a "hierarchy of awareness". It has already been shown that most schoolchildren have to learn what "reading" is, (e.g., Downing, 1970b; Ehri, 1979); and that this latter skill probably arises from an introduction to reading, (e.g., Ehri, 1979). The present evidence suggests that this linguistic awareness further develops, homing in on finer and finer segments, from syllables to phonemes. This progress may in some cases be halted, retarded, or imperfectly achieved, as many researchers have argued. For example:

> "The lower the level of the language feature that must be attended to and assessed for, in any languagelike activity beyond comprehension, the more individual differences we find in adults; further, the lower the level of the language, the later its accessibility to the language-learning child." Rozin & Gleitman (1972) p.90.

This issue was examined by Byrne & Ledez (1983). They studied two groups of reading disabled adults, (either very or moderately reading retarded) and a group of able readers. They found that the disabled groups were deficient in: reading non-words, (which can only be read using a phonic strategy); performing phoneme reversal in simple words, (as in the Alegria et al study detailed above); phonemic encoding of real words in a continuous recognition task; and serial recall of words. However, they were no worse than controls in their phonemic encoding of non-words in a continuous recognition task, and in their acoustic confusion in serial recall. Byrne & Ledez concluded that, "The picture of metalinguistic processes in these subjects is very similar to that found in children with reading problems, indicating that reading ability and metalinguistic skills are non-independent over a substantial period." As far as this discussion is concerned, only the reversal test is a p.a. test. It would seem that the ability measired by this test, along with other phonic tests, is eventually possessed by all readers, regardless of ability. The critical factor would seem to be the degree of aptitude with which they can utilise these skills in later reading. That is, all subjects possess the skill, but some use it more skilfully than others. To make an analogy - many people can ride a bike, but there is a huge difference between the average cyclist and the winner of the Tour de France. Thus, the acquisition of a "basic" skill does not mean that it will be used with the same felicity by everyone. A similar conclusion can be drawn from a study by Calfee et al (1973). They gave subjects, (U.S. schoolchildren from kindergarten - 12th grade) the task of matching the phonemic structure of spoken words to coloured blocks, (a phoneme was always represented by a particular block). This is a valid test of p.a., since the child has to identify phonemic content, and recognise that the same phoneme can occur in different words. The test is graded in difficulty, and the later stages probably have a cognitive/mnemonic overload, (though the early stages do not). Calfee et al found that the test correlated well with reading ability. They also found that about 10% of 7-12th graders were performing at the level of the average kindergarteners/1st graders. Given that the majority of 4th graders scored near-ceiling on the test, it seems unlikely that <u>all</u> of the 10% were barred from higher performance by lack of cognitive/mnemonic skills. One must therefore conclude that a sizeable proportion of readers fail to develop very advanced p.a. skills. It should be noted, however, that Calfee et al tested across several schools, and there appears to be a lack of concordance between schools in the selection of subjects.

Byrne & Ledez and Calfee et al's studies raise an interesting question as to how the very poor readers acquire p.a. It has been suggested that a child attains p.a. because s/he sees the value of it. However, might it not be the case that the very poor readers acquire p.a. through rote learning of word attack drill, and fail to perceive its full usefulness? If this is the case, then it raises interesting questions about the role of "metareading", which need to be answered. The issue is beyond the scope of this thesis, which is confined to the study of 5-7 years old children, and does not attempt to assess differences between retarded and normal readers. This is for three principle reasons. (a) It is difficult to assess severely retarded reading at this stage. Subjects have not been reading long enough for severe retardation to be noticeable. (b) There is the problem of sorting out children who will be retarded, from normal readers who are late developers. (c) It is difficult, (if not impossible) to examine "metareading" at this level of understanding in children of this age. A pilot study using a semi-structured interview technique to assess this point met with no success. Thus, for practical reasons, the "efficiency" of subjects' p.a. will not be discussed here. It should be noted, however, that there may be a few subjects reported in the studies presented here who, whilst displaying p.a., are not efficiently using it. Thus, the reported correlations between p.a. and the skills it is being compared to might be slightly lower than their "true" value, (i.e., if the efficiency with which p.a. was being used could be calculated).

Alegria et al (1982) showed that p.a. arises primarily from reading teaching, and to a lesser extent from reading experience; and hence, that pre-readers largely lack p.a.. However, it might be argued that the reason why pre-readers lack p.a. is not the absence of reading teaching/experience, but rather, the lack of cognitive skills. By definition, pre-readers are younger than readers; is it purely the latter's increased cognitive maturity which explains the results that have been obtained? Content et al (1982) addressed this problem. They took a group of Belgian pre-schoolers, (5yrs old) and gave them four half hour training sessions. These consisted of a series of games intended to get the children to identify and isolate phonemic segments, (e.g., grouping words by their initial letter). Content et al found a significant improvement in ability, (28 -> 69% correct) over the training sessions. There was no difference in the performance of subjects tested on the same phonemes they were trained on, and those tested on different phonemes. Thus, the training was not task-specific, and the children did seem to be learning about general principles of phonemic structure. Thus, pre-schoolers did appear to possess the cognitive capacity to acquire p.a.. This conclusion is further supported by examining across studies. The youngest children in Calfee et al's study, for example, were 2-3 yrs. younger than Content et al's, and many of the kindergarteners, (4yrs) and 1st. graders, (5yrs) scored well on that p.a. task. It would thus seem that p.a. is accessible to subjects younger than those in Content et al's study. What has not so far been examined is if the degree of training required to bring a child to some criterion of awareness is critically dependent upon cognitive/mnemonic abilities, etc.

The studies which have unequivocally tested p.a. have yielded some interesting results. What picture do we have of p.a.? That it is usually a product of reading experience/teaching, but can be trained before the onset of reading, and that poor readers do not use p.a. as proficiently as good readers, even in adulthood. These findings, valuable as they are, still leave a very incomplete picture of p.a. For example, they give no measure of the development of p.a. within individuals; there is no direct comparison with a p.s. task; and there is no indication of <u>how</u> p.a. interacts with reading, beyond conjecture, (e.g., does p.a. affect some sub-skills more than others?). The main object of the work reported in this thesis was to fill some of these gaps in knowledge. The studies and their rationale are summarised below.

Synopses of the studies.

The p.a. test I devised a p.a. test for an undergraduate project in 1981. This was before details of other "true" p.a. tests had been published, and the need for such a measure was more apparent then than it is now. My test is in four parts; the subject is asked: (a) to judge if spoken word pairs "end the same"; (b) if spoken word pairs "begin the same"; (c) to produce a word ending with the same sound as a spoken example; and (d) to produce a word beginning with the same sound as a spoken example. The test conforms to the definition of a "true" p.a. test given earlier. In order to perform the task successfully, the subject has to realise that words are composed of phonemes, and that words have phonemes in common. The mnemonic/cognitive load is kept to a minimum; the tasks do not use a complicated elision procedure; the maximum mnemonic load is two words; and all words used were simple real CVCs. The test differs in an important way from other p.a. measures. It seeks to judge if p.a. of word beginnings and word endings differs. This has not been assessed by other "true" tests, which have always examined a "blanket awareness" of phonic structure. Clearly, if p.a. of sections of words arises at different times, this is not only of great theoretical interest, but is also of practical value to teaching schemes, etc.

The longitudinal study. The p.a. test was run in a pilot study, and a healthy correlation, (r=.7) between test scores and reading ability, (as measured by the Carver Word Recognition Test) was found in a cross-section of infant school children. It was then decided to perform more substantial studies using the test. Little is known about the development of p.a. Researchers have usually been interested in how it is initially acquired, and how it relates to reading ability. As has been mentioned, the measures which have been used have not assessed awareness of different sections of words. Thus, we have only a vague notion of the development of p.s. For example, does awareness of all sections of words arise simultaneously, or does it arise piecemeal? If so, is the nature of p.a.'s acquisition reflected in changes in reading? We have seen that good readers have greater p.a. than poor readers. Does this mean that good readers are superior because, (in part) they have better p.a., or is their superior p.a. a reflection of a generally better reading strategy, and in itself of little use? Without the answers to such questions, p.a. research would seem to be in limbo. Unless we can show its role in, rather than its correlational relationship to, reading, then p.a. research becomes an exercise in cataloguing. In response to this argument, the longitudinal study was devised. Infant school children, from their first term to their final year were to be tested termly for their level of p.a. This development was to be placed in context by a termly assessment of their reading and spelling abilities. In this way it was hoped to see if a change in p.a. preceded a change in reading and spelling, or vice versa.

The p.a.-p.s. study. As mentioned in the Introduction, there are strong theoretical reasons for running a study directly comparing a p.a. and p.s. test, and comparing performance on these tests to reading and spelling ability. The Bradley & Bryant test was chosen as the p.s. test, first, because it has had won widespread acceptance, and second, because its comparison of abilities to deal with word endings and word beginnings made a detailed comparison with my p.a. test possible. The study had three principle aims: to discover if p.a. and p.s. had had fundamentally different "natures", (e.g., if the former showed signs of being reading-derived, and the latter of having its origins in speech); to determine if one test was a better predictor than the other; and finally, to determine p.a.'s relationship to spelling performance, a factor which had been largely ignored by other researchers.

The reading style study. The results of the p.a.-p.s. study were encouraging, and, amongst other things, showed a strong correlation between p.a. and reading. However, this was a blanket statement - it told us nothing of how p.a. was related to reading. In order to assess this, it was decided to examine p.a.'s relationship to reading sub-skills. Two tests were performed. The first was a miscue analysis, which, by an analysis of oral reading errors, assesses the emphasis children place upon different types of contextual and graphemic information in reading. This gave information about the weighting they placed upon different sub-skills. It was expected, for example, that acquisition of p.a. would cause a shift in emphasis towards phonemic content. The second test was more specific. It assessed a child's sensitivity to changes in the graphemic structure of words. Again, I was interested in assessing p.a.'s effect upon this.

The STM study. The above study established p.a.'s general role in reading sub-skills. P.a.'s most obvious link with reading was graphemic processing, and this too had been tested. How else might p.a. be related? Work being performed in the Department at this time was concerned with the phonemic confusability effect in STM. Its positive correlation with reading ability had been noted by several researchers, and it had been argued that poor readers' failure to display the effect was not due to memory failure per se, but an inability to encode phonologically, (e.g., Jorm, 1983c). Given p.a.'s strong links with reading ability, and its probable links with phonological encoding, it was decided to compare infant school children's p.a. and their sensitivity to "phonemic confusion" in STM. This was intended as an exploratory study, but the results were so clear that this study has been allowed to stand on its own merits.

The above histories give the reasons why I decided to carry out each experiment. The theoretical support, (which may differ from the original reasoning because of studies which came to light after the experiments had been run) is given before the description of each experiment. Often this rationale will contain a fairly detailed literature review of topics not covered in the Introduction. I am aware that this deviates from the conventional practice of placing the entire literature survey at the head of the thesis. However, I have especial reason for adopting this course. Two of the studies especially, (the reading style and STM), and others to a lesser extent, draw upon research peculiar to that study alone. To include all this information in the Introduction would cause confusion and possibly disguise the progression of ideas which run through all the studies. For the same reasons, discussion of the implications and importance of findings will come after each study in turn. The concluding discussion will not contain detailed analysis of any of the studies, but instead will try to summarise the relevance of the studies to various areas of research.

To summarise this chapter. The role of phonic skills in reading has long been recognised. However, until the 1970's, no methodical examination of sub-types of phonic skill had taken place. Researchers identified p.a. as a skill distinct from a tacit p.s. However, the experimental design of many researchers fail to maintain this distinction, whilst other designs make excessive cognitive/mnemonic demands upon the subject. Valid p.a. tests indicate that p.a. is correlated with early reading ability, and is probably a product of reading experience/teaching. However, little is still known about p.a., and various experiments, designed to increase our knowledge of this skill are to be described in this thesis.

Chapter 3 ~ The Experiments.

3.1 The Longitudinal Study.

Introduction

In Chapter 2, we saw that p.a. is usually a product of reading experience/training, and does not usually arise spontaneously in a young child. It is very difficult to detect phonemes in a spoken word, since, as can be seen from a sound spectograph, they overlap each other in pronunciation, (Liberman et al, 1974). Text, however, explicitly presents inner structure, since letters are shown as discrete units. Lewcowicz (1980) has elegantly demonstrated this difference diagramatically, (see fig. 1). The realisation that graphemic structure is a representation of phonemic structure should, it has been argued, trigger p.a. Existing studies support this hypothesis, but only at a general level. As outlined in the last chapter, finer details, (e.g., if p.a.'s acquisition is dependent upon passing a certain level of reading skill; if awareness of different sections of words arises at different times) have yet to be revealed. One aim of this study, for reasons explained above, was to

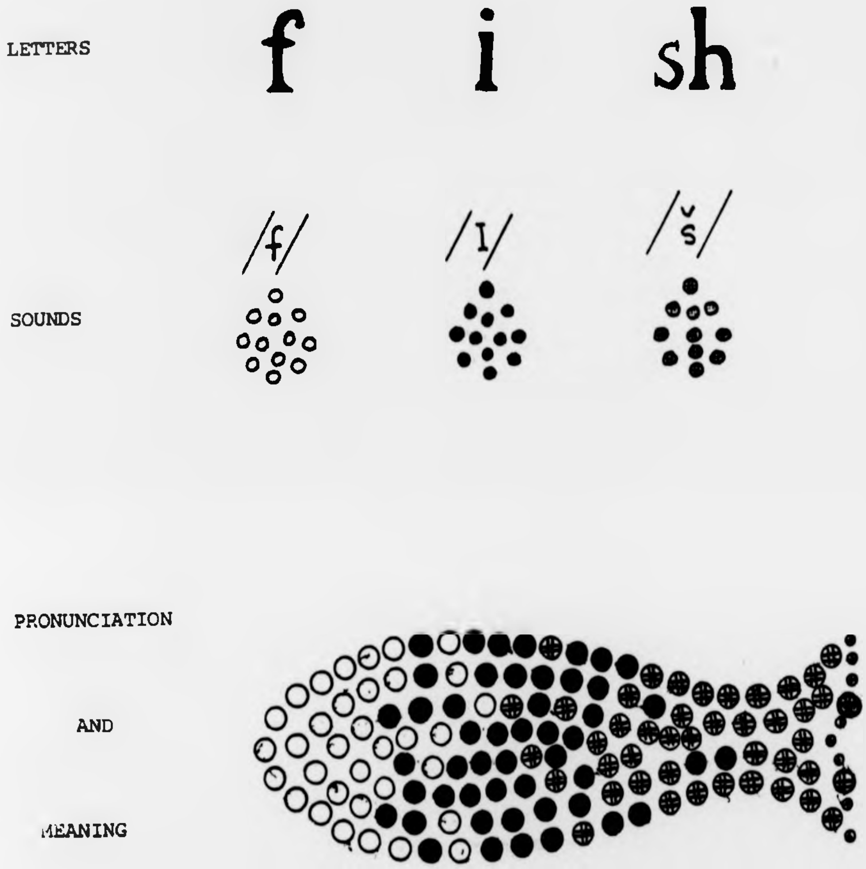


FIG.1. THE SPELLING, PHONEMIC STRUCTURE, PRONUNCIATION AND MEANING OF THE WORD FISH

(FROM: LEWKOWICS (1980)

uncover some of them.

In Chapter 2, p.a.'s examined purely in terms of its relationship with reading. It may have appeared surprising that the role of p.a. and spelling was not discussed. One would reasonably expect that knowledge of where in a word a particular phoneme fell would be of great value to the child learning to spell. In fact, I am only aware of one study which directly addresses this issue. Snowling & Perin, (in press) compared 5-7 year olds' performance on their phonemic segmentation skills and their reading and spelling performance. Perhaps not surprisingly, they found that there were strong relationships between the four factors. ANOVAs, collapsed across chronological age, showed that one of the phonemic tasks, a segmentation task, correlated particularly strongly with spelling performance. The other phonemic task, which required the subject to identify the source of the difference between two words, (e.g., "sip" and "slip") correlated equally well with reading and spelling performance, ($F(2,45)=1.35$). Snowling & Perins' latter test might have an over-large cognitive/mnemonic load, though it certainly assesses a child's p.a. There is a complicating factor that the subjects could only successfully perform the elision task when using words which they could already read and spell. This suggests that the subjects were using knowledge drawn from graphemic structure, rather than from phonemic structure per se. (The possible differences between p.a. drawn from graphemic and phonemic structure are discussed in the final chapter of this thesis). This is the only study I am aware of which directly assesses "true" p.a. and spelling. However, many studies suggest and show that phonemic skills play a role in spelling, (e.g., Bradley & Bryant, 1983; Bryant & Bradley, 1980; Frith, 1980). Thus, a test of spelling was included in this experiment, in an attempt to discover more precisely what the role of p.a. in it was.

Hence, it was decided to examine the development of p.a. and its relationship to reading and spelling. Typically in studies such as this, the subjects' mental age is also taken into account. An intelligence test was not included in the measurements for several reasons. First, there was the practical reason that not all schools were willing to have this test performed on their pupils. Second, there were limitations on the amount of time which could be spent with each subject; and third, the link between beginning reading and intelligence has usually been found to be weak, (cf, Jorm, 1983a). Two more decisions had to be made - what age range of children and what method of testing? The first question was decided by the pilot testing, which found that the proportion of children capable of performing the test was near-zero in the reception class, and near-ceiling in the final year of infant school. Thus, only infant school children were used as subjects, as only they fell within the effective range of the test. This also accorded with the age range used by many other p.a. researchers. The test method chosen was a longitudinal study, since this gives a clearer indication of cause and effect than a cross-sectional experiment. Whilst the cross-sectional study can show strong links between two skills, the longitudinal study can show not only this, but whether one skill precedes the other. For example, if we found that the acquisition of p.a. preceded a rise in reading skill, then we would have an indication that p.a. might be influencing reading/spelling. Conversely, if reading/spelling skills have to pass a certain threshold before p.a. is acquired, then we have a good indication that p.a. is a product of reading/spelling skill. Of course, this method cannot unambiguously prove cause and effect. The observed developments might be due to the influence of a third factor. A frequent solution to this problem is to run a training study, to see if training in one skill directly affects the performance of the other, (if the skills are dependent upon the influence of a third factor, then the effect of training should be negligable). However, this method cannot irrefutably show cause and effect, since we do not know if the two skills have a reciprocal effect upon each other, (e.g., an improvement in skill x causes skill y to improve; skill y in turn causes an improvement in x, etc, etc,). Limitations of resources in any case prevented the running of a training study.

Reasons for the decision to devise a new p.a. test have been given in the Introduction.

Thus, the principle aims of the study are: (1) to chart the development of p.a. and this relationship to reading and spelling; (2) to establish if p.a. arises for the whole word at once, or if awareness of one section of a word arises before another, and (3), to see if p.a.'s acquisition depends upon passing a "set point" of reading ability.

Method.

Subjects

The subjects were drawn from two infant schools in the north-west of England. At the request of the head teacher of one school, detailed SES data were not collected. The mean age of subjects at their first test session was for one school, ("O") 4:10 yrs.; and for the other school, ("H") 4:8 yrs.. 38% of the "O" school sample were girls, compared with 40% of "H" school. All children were native English speakers and came from English-speaking homes. The subjects were from a cross-section of working- and middle-class backgrounds. Both schools used an "eclectic" reading teaching method.

Materials

Four sets of material were used - the Carver Word Recognition Test,(Carver, 1970),the Schonell Spelling Test (Schonell,1932) and two tests of

TABLE A - NATURE OF INPUT PAIRS IN P.A. TEST

Target pairs

"Full rhyme" - identical vowel and consonant ending (e.g., "bag, wag")

"Half rhyme" - identical consonant ending only (e.g., "fat, cut")

"Full alliteration" - identical vowel and consonant beginning (e.g., "bat, ball"

"Half alliteration" - identical consonant beginning only (e.g. "boy, bag")

Non-Target pairs

"Full non-targets" - only medial vowel in common (e.g. "boy, dog")

Only coupled with "full rhyme" and "full alliteration" pairs.

"Half non-targets" - no letters in common (e.g. "bag, cot")

Only coupled with "half rhyme" and "half alliteration" pairs.

p.a. of my own devising.

The Carver test consists of 50 items; in each item the subject is told a word in isolation and in a high context sentence, and is then required to locate its printed representation from a list of alternatives. The Schonell test requires the subject to spell single words read out by the experimenter. The words get harder the further the subject gets into the test run, which is terminated when the subject has scored ten consecutive errors. There are 100 items in the test, though very few subjects in this age range get beyond the 40th item, because the test is suitable for administration to subjects up to 15 years of age.

There were two p.a. tests, as has already been mentioned. The first of these, termed "Input", was in itself in two parts. The first of these - "Input Rhyme" - required the subject to judge if two spoken words "ended the the same". There were two groups of words presented, with five target pairs and five non-target pairs in each, (see Table A). The target pairs ended the same, whilst the non-targets did not. The full targets have more letters in common than the half

TABLE B - WORDS USED IN THE P.A. TESTS

INPUT					
FULL RHYME	bed, fed	well, bell	lot, pot	but, nut	tub, rub
FULL NON-TARGET	cat, man	ten, leg	cut, run	top, lot	pen, red
HALF RHYME	run, hen	not, but	doll, well	fill, ball	gun, ran
HALF NON-TARGET	leg, box	sad, pin	run, big	cup, red	got, pen
FULL ALLITERATION	bed, bell	cup, cut	box, boy	run, rub	fed, fell
FULL NON-TARGET	cat, man	top, got	hill, big	fun, cup	doll, not
HALF ALLITERATION	bed, bag	lot, lip	fat, fed	bell, big	wall, wet
HALF NON-TARGET	cat, dig	but, sad	bot, tub	cup, big	box, red

OUTPUT					
RHYME	bed	log	pot	fell	gun
ALLITERATION	cut	pen	sat	box	dog

targets. This was in an attempt to see if the subjects were sensitive to different strengths of similarities between words. The full non-targets had medial letters in common to ensure that the subjects were not making similarity judgements on the medial letters.

The second section of the Input task - "Input Alliteration" - required the subject to judge if two words began with the same sound. Again, two groups of words were used - full targets coupled with full non-targets, and half targets coupled with half non-targets, (see Tables A&B). The similarities between the words are identical to those in the input rhyme section, except that the difference now lies at the start of the word.

The second p.a. test, termed "Output" was again divided into two parts. The first of these, "Output Rhyme" required the subject to say a word which "ended the same" as a presented spoken word. Five real CVC words were presented in total; these are listed in Table B. The second section of the "Output" task, "Output Alliteration" required the subject to say a word which began the same as a spoken example. A list of the examples is given in Table B.

Design

Subjects were tested individually in the final 3-4 weeks of each school term from the first term in reception class to the end of the first term in their final year. It should be noted that some subjects began school in the winter term, whilst others began in the spring. The p.a. tests were given at every test session. Testing on the Carver test began in the summer term of the first year.* Testing of spelling was not begun until the winter term of the second year, (again because earlier attempts had proved fruitless). The order of presentation of Carver, Schonell and p.a. tests was counterbalanced using a latin square design, as was order of presentation of the p.a. sub-tests.

Procedure for p.a. tests

In order to avoid the type of problems which befell the Bruce-type studies, especial care was taken to ensure that the subjects understood the procedures. Subjects were given examples, and those who did not understand the task were given

*An attempt was made to assess reading at the first and second test sessions, but as subjects responded randomly on these occasions, testing was halted.

remediation. Also, care was taken to ensure that the children were not responding purely to the fact that the words sounded "the same".

To take the p.a. tests in turn: the "Input Rhyme" task was introduced to the child by asking if a spoken word pair "ended the same". This first pair to be presented always consisted of words which ended the same, though not of words which would appear in the test, (e.g., "car,tar"). If the subject said that they did, then further practice examples were given. To ensure that the subject was not responding purely to the phrase "the same", amongst these were some pairs which began the same,(e.g.,"cat,car"). If the subject, even after correction, said that three examples of these same-beginning words "ended the same", then a score of zero was given for this section of the test.

Subjects who failed because they were responding purely to a similar sounding word were quite rare. Much commoner was the subject who was obviously responding randomly, persistently replied "yes" or "no", or simply expressed incomprehension. In these cases, various remedial measures to make the task accessible to the subject were attempted. Of necessity, the precise procedure differed from subject to subject, but included in it were, employment of different terms in explaining the task, the breaking of the task into sub-components,(e.g., asking the subject to identify just the final letter of one word), and working through an example with the subject.If the subject after all this was still answering incorrectly, (by which I mean that s/he either was still persistently saying yes or no; or, was answering randomly; or, was still telling the experimenter that s/he did not know) then the test was terminated, and the subject was given a score of zero.

Following this introductory phase, the p.a. test proper began. The word pairs in the Input Rhyme task were presented in two blocks, which were counterbalanced. The "Full" group consisted of the full rhyme and full target pairs,(see Tables A&B). Within this block, the words were presented randomly. The "Half" block,(the half pairs and the half non-targets) was similarly presented to the subject. The aim of this pairing of targets and non-targets was to ensure the subject was not responding to any similarity in the medial sounds of the words.

An identical procedure was adopted in the presentation of the Input Alliteration task, except that the subject was here required to judge if a pair of words "began the same".

The output rhyme task was introduced by asking the subjects to think of a word which "ended the same" as a spoken example. This example was not one of the test items. Should the subjects produce a correct answer, then they were given some more practice examples, and then the test items. Should they respond incorrectly, then explanatory measures were again attempted. These of necessity varied from subject to subject, but included changes of terminology,(e.g.,"finishes" instead of "ends") , attempts to break the test into smaller components,(e.g., to say what letter the word ended with), and working through an example with the subject. (Unlike the Input task, a few subjects responded to this treatment). Subjects who began to respond correctly were treated from then on like subjects who had responded correctly from the first example. If they persistently failed to respond, then this section of the test was terminated, and they were given a score of zero.

The Output Alliteration task was conducted in an identical manner, except that the subject was required to produce a word which "started the same".

Scoring

For the Carver and Schonell tests, one point was given for each correct answer. Thus, the Carver test was scored out of 50. Note that for the Schonell test however, there is no well defined maximum score. One point was also given for each correct answer on the p.a. tests, (as mentioned above, a zero score was given for a failure to even commence the test). Thus, each block of the input section was scored out of 10, whilst the two output tasks were each scored out of 5.

Results

The size of the subject sample was greatly diminished through the period of testing. One test school, ("O") lost about ten subjects through children leaving the area, leaving a sample of 24. The other school, ("H") suffered more, losing twelve subjects, to reduce the sample to ten children. Due to lack of resources, I was unable to keep track of the subjects when they had left the schools.

A further point to note is that some children entered school at the start of the school year, whilst others entered in the spring term. It was possible that the spring intake would lag behind the winter intake because of lack of this extra term's schooling. To compensate for this, the most straightforward course would be to consider the spring and winter intakes separately, but the already small sample size precluded this. Alternatively, one could weight the scores of the spring intake. However, no satisfactory method of doing this could be found. Therefore, we cannot determine if any differences we might find between the spring and winter intake scores are due to differences in ability or schooling, and interpretation of the results in this regard is limited*.

The children scored on the p.a. sub-tests at

*This does not of course affect analysis of correlations of test scores within subjects, the manner in which scores are analysed here.

TEST SCORE

	9	10	11	12	13	14	15	16	17	18	19	20
n	2	0	1	2	4	4	3	8	4	15	25	76

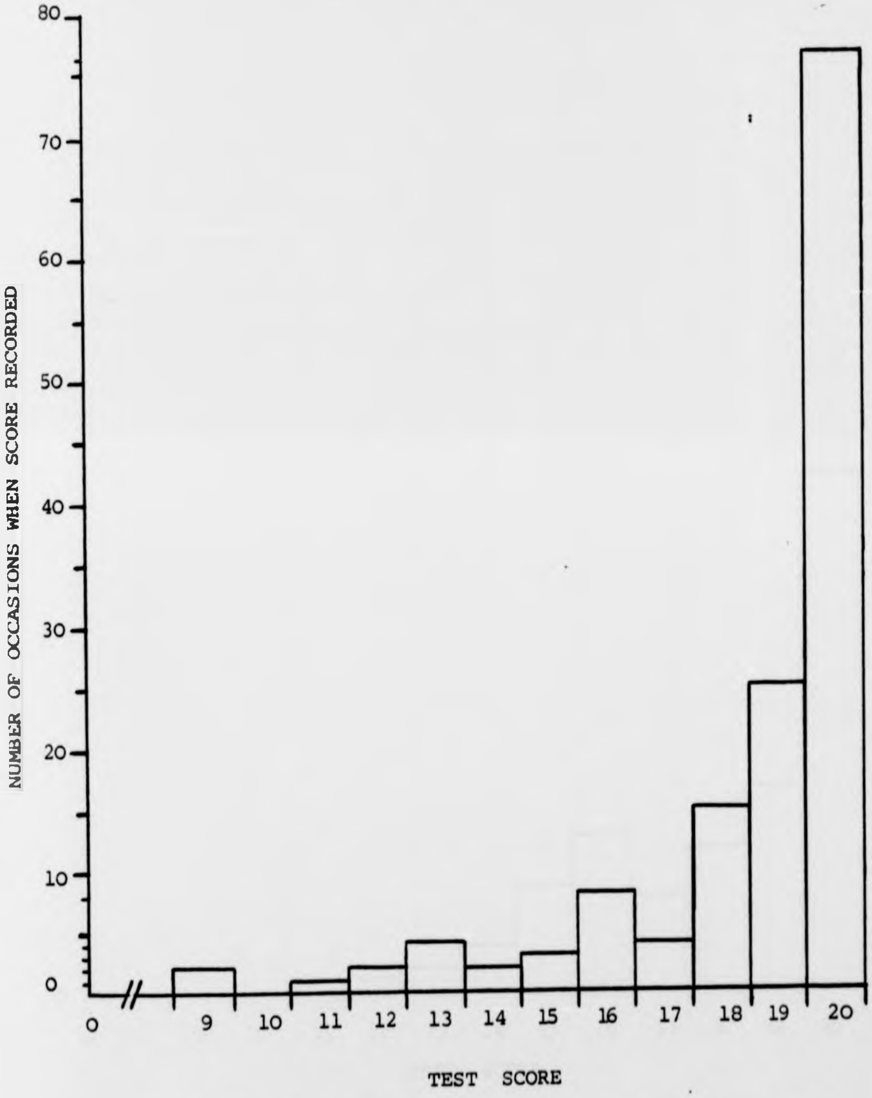


FIG.2.(i) DISTRIBUTION OF INPUT ALLITERATION SCORES ACROSS ALL TEST SESSIONS OF LONGITUDINAL STUDY

TEST SCORE

	9	10	11	12	13	14	15	16	17	18	19	20
n	0	0	1	1	2	4	8	13	7	12	17	42

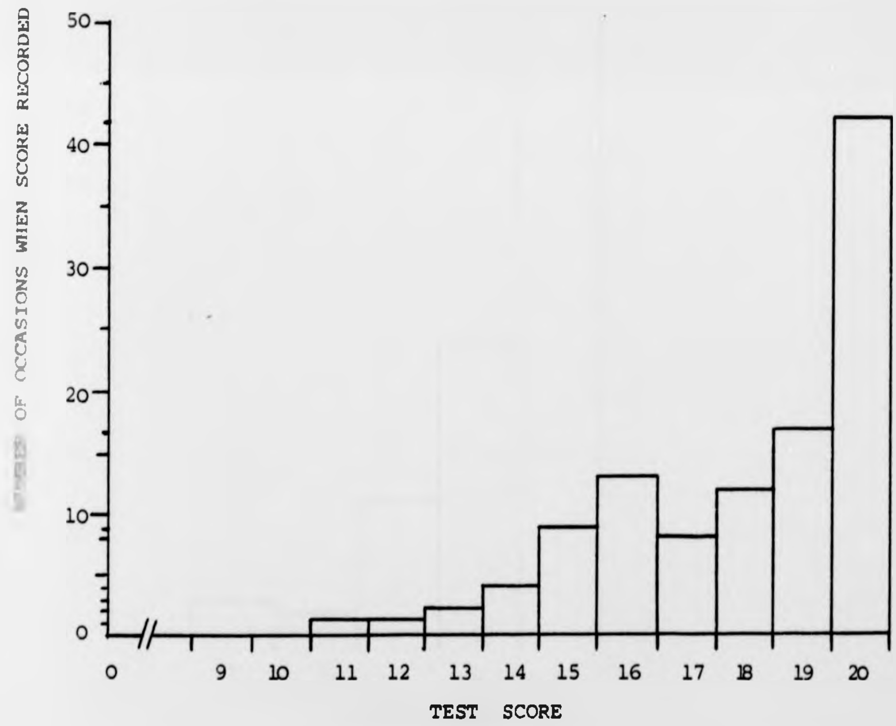


FIG. 2. (ii) DISTRIBUTION OF INPUT RHYME SCORES ACROSS ALL TEST SESSIONS OF LONGITUDINAL STUDY

TEST SCORE

	9	10	11	12	13	14	15	16	17	18	19	20
n	0	0	1	1	2	4	8	13	7	12	17	42

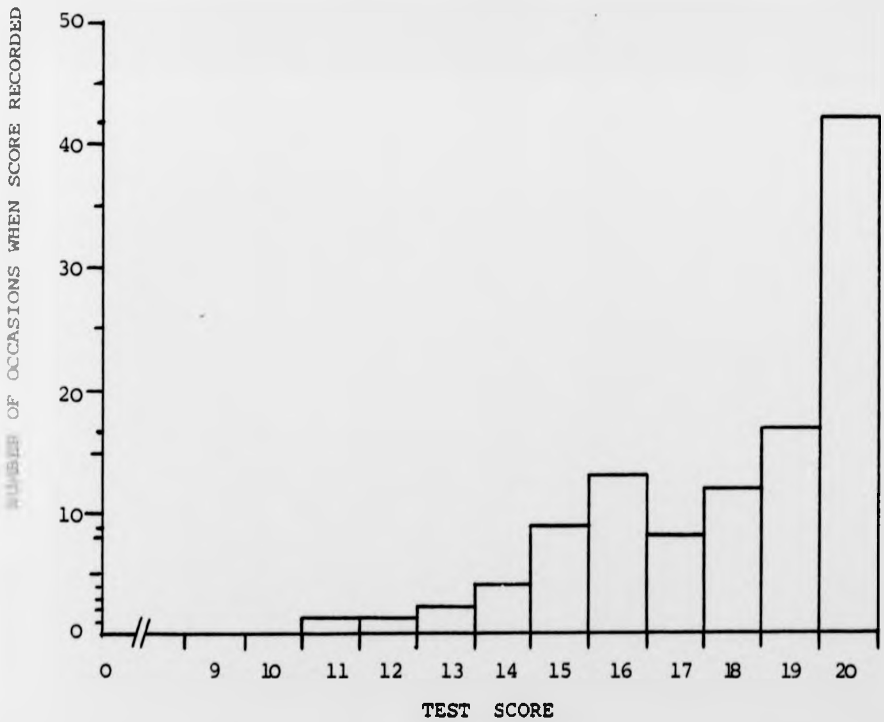


FIG. 2. (ii) DISTRIBUTION OF INPUT RHYME SCORES ACROSS ALL TEST SESSIONS OF LONGITUDINAL STUDY

TEST SCORE

	1	2	3	4	5
n	3	2	14	33	112

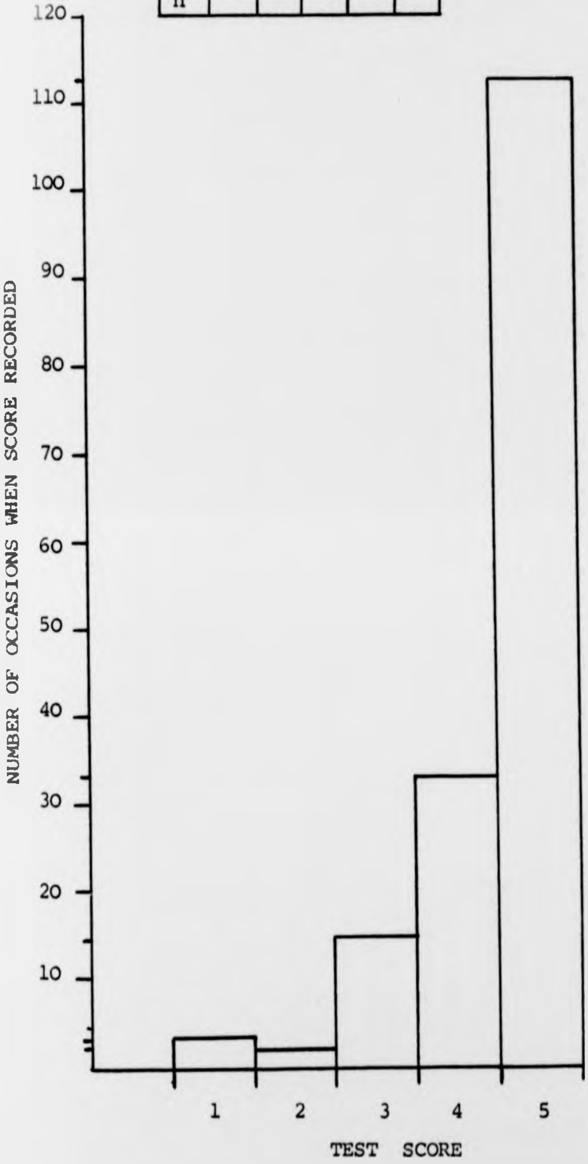


FIG.2.(iii) DISTRIBUTION OF OUTPUT ALLITERATION SCORES ACROSS ALL TEST SESSIONS OF LONGITUDINAL STUDY

TEST SCORE

	1	2	3	4	5
n	7	14	20	25	41

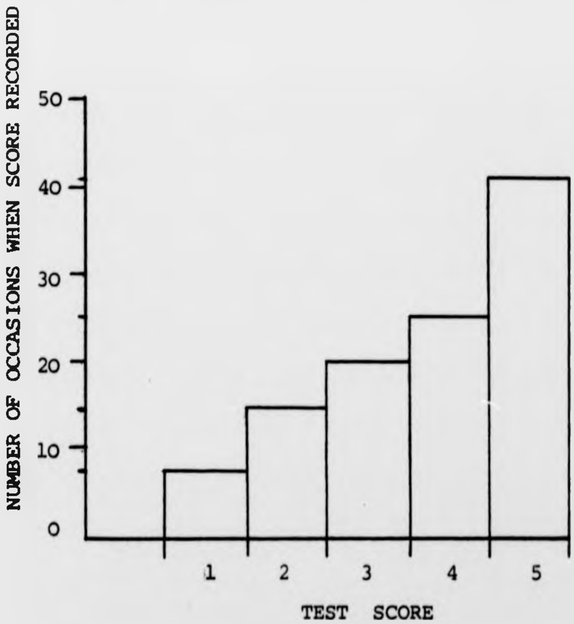


FIG. 2. (iv) DISTRIBUTION OF OUTPUT RHYME SCORES ACROSS ALL TEST SESSIONS OF LONGITUDINAL STUDY

all sessions in an "all or none" manner. That is, they either scored zero, (i.e., could not do the task at all) or scored 15/20 or above. Allowing for possible extraneous factors of lapses of attention, fatigue, etc., these suggest an "all or none" performance. The distribution of p.a. sub-test scores is shown in fig. 2. As can be seen, the distribution of scores is extremely bimodal. As further proof of the "all or none" nature of the test, the following analysis was performed. If subjects were <u>not</u> scoring in an all or none manner, then their scores should significantly improve over test sessions. This was tested using the following procedure. For each sub-test, the scores of subjects who scored above zero on it in 2 or more test sessions were taken. The percentage improvement between the first and last scoring sessions was then calculated*. the percentage improvement was then correlated with the number of scoring sessions. The analysis found none of the correlations to be significant$. It was thus felt valid to classify the children simply by

---

*For example, A's scores on the input alliteration task over 7 sessions are: 0,0,0,15,17,17,18. A's improvement over the 4 scoring sessions is 3/15; i.e., 20%.
$Input Alliteration: $r(30)=0.11$, $t=0.64$; Input Rhyme: $r(29)=0.33$, $t=1.82$; Output Alliteration: $r(30)= -0.29$, $t=1.71$; Output Rhyme: $r(29)=0.18$, $t=0.95$.

TABLE C - PROPORTION OF SUBJECTS SCORING ABOVE ZERO ON P.A. SUB-TESTS AT EACH SESSION OF LONGITUDINAL STUDY; WITH MEAN CARVER & SCHONELL TEST SCORES OF ALL SUBJECTS

TEST SESSION	n	INPUT ALLIT.	INPUT RHYME	OUTPUT ALLIT.	OUTPUT RHYME	MEAN CARVER	MEAN SCHONELL
1	16	38(%)	13	7	0		
2	34	8	0	13	3		
3	34	44	18	44	15	18.56	
4	34	59	50	85	50	25.29	7.65
5	34	79	68	97	74	30.97	13.38
6	34	97	82	97	97	34.35	16.97
7	34	97	91	100	97	38.15	20.94

possession of p.a., rather than by strength of possession. The children were awarded 1 point for each p.a. sub-test they possessed the ability to perform, (i.e., they scored above zero on it). Thus, their total p.a. "score" could range from zero, (no p.a.) to four, (full p.a.). The proportion of subjects who could perform each sub-test at each test session is shown in Table C. As can be seen, there would seem to be a hierarchy, with the easiest test being output alliteration, and the hardest being output rhyme. In order to further assess this, it was decided to examine whether the subjects acquired the sub-skills in this order. That is, if output alliteration was acquired before input alliteration, which in turn was acquired before input rhyme, which came before output rhyme. This was found to be the case in 28 of the 34 subjects. This was statistically highly significant. Ignoring "ties" there are 24 possible orders of acquisition. The probability of 28/34 orders being the same is 2.35 x 10-33, (binomial test; p=1/24; q=23/24). Of the "exceptions", 4 displayed output rhyme before input rhyme, 1 displayed input alliteration before output alliteration, and one could perform the two output tasks before the input tasks. There would therefore seem to be good evidence that p.a. arises in a definite hierarchical order. It should also be noted that once a subject displayed a p.a. sub-skill on one session, they very rarely failed to display the same skill on subsequent test sessions. Of the 34 subjects, only 3 failed to display a sub-skill they had previously exhibited, (in two cases, this lapse was for only one test session).

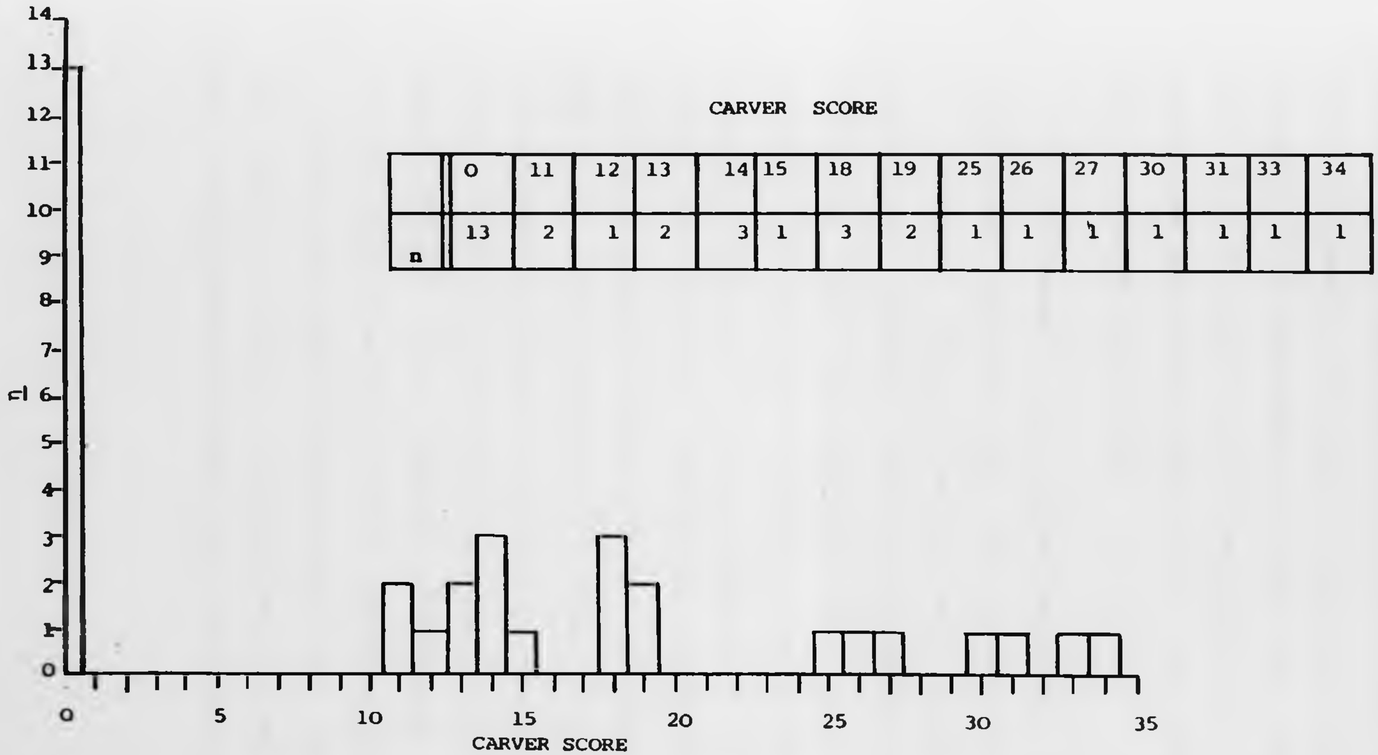
In order to assess the effect of p.a. on reading and spelling, the following procedure was adopted. The number of sessions a subject had displayed each p.a. sub-skill was assessed. A "total p.a." score was calculated by adding together the number of sessions' possession of the four sub-tests, (e.g., a subject who had displayed input alliteration for 3 sessions, input rhyme for 2, output alliteration for 4 and output rhyme for 1, would have a total p.a. score of 10). The length of possession scores for the four sub-tests and "total p.a." were correlated with the Carver and Schonell scores separately. The Carver score was calculated as the mean score across the 5 sessions it was tested for. This method enabled subjects who had consistently scored well to be

TABLE D - CORRELATION OF LENGTH OF POSSESSION OF P.A. SUB-SKILLS WITH READING/SPELLING ABILITY

	CARVER	SCHONELL
INPUT ALLIT.	.702	.736
INPUT RHYME	.755	.646
OUTPUT ALLIT.	.630	.657
OUTPUT RHYME	.766	.714
"TOTAL" P.A.	.710	.800

All correlations : d.f. = 32; $p<.01$

distinguished from subjects who had one "flash in the pan" good score amongst a string of mediocre ones. For the same reasons, the Schonell scores was treated as the mean across the four test sessions it was assessed. The results of the correlation analysis are shown in Table D. These results were further analysed using a stepwise multiple regression. By this method, the correlation of each predictor variable with the dependent variable is assessed, not just for its simple correlation, but also for the variance it shares with the other predictor variables. The variable with the highest correlation, (simple + shared correlation) is entered first into the equation. Further variables, (shorn of their shared variance with the first entered variable) are only added into the equation if their inclusion significantly increases the correlation between the predictor variables and the dependent variable. Using this method, the four p.a. sub-tests were assessed for their correlation with reading and spelling separately. In both cases, output rhyme was found to be the best predictor, (Carver, $r=.77$; Schonell, $r=.79$; both significant at $p<.0000$). The other p.a. sub-tests failed to make a significant contribution to the



CARVER SCORE

	0	11	12	13	14	15	18	19	25	26	27	30	31	33	34
n	13	2	1	2	3	1	3	2	1	1	1	1	1	1	1

FIG. 3. DISTRIBUTION OF SUBEJECTS' READING SCORES ON FIRST DISPLAYING P.A.

correlation. These results give a false impression of the importance of output rhyme, however. Because of the hierarchical structure of the sub-tests, possession of output rhyme is virtually synonymous with possession of full p.a. Thus, these results just as effectively argue that the earlier the possession of full p.a., the better the reading/spelling will be.

We would seem to have good evidence from the correlational analysis that the acquisition of p.a. affects future reading and spelling performance. However, this does not exclude the possibility that the acquisition of p.a. is dependent upon the subject passing a certain level of reading ability, as some commentators have argued. If this is so, then we would expect that the reading scores of subjects on the test session when they first displayed any type of p.a., (almost invariably output alliteration) should be fairly uniformly bunched above a certain level of reading ability. If we examine a histogram of subjects' reading scores on first displaying p.a., we can see that this is far from being the case, (see fig. 3). Subjects who displayed p.a. before their reading could be tested are classified as having scored zero on the Carver test when they first had p.a. 13 of the group seem to have acquired p.a. before they read. This rules out the possibility that reading ability is essential for p.a. to arise. Of the remaining subjects, there seems to be no indication that scores are "bunched" above a certain level of reading ability. The lowest reading scores in this group are 11,12,13,14, and 15. Given that a score of 8-10 can be obtained by random responding, (Carver, 1970) it seems highly unlikely that these scores represent the passing of some reading "criterion", given that they are just above the level of chance responding*. Furthermore, given the evidence of Morais et al that p.a. can be trained in kindergarteners, it would seem highly unlikely that p.a.'s acquisition is dependent upon a particular level of reading ability. This does not rule out the possibility that p.a. is influenced by reading experience, as we shall argue in the discussion below.

An attempt was made to assess the effect of

*These results may in part reflect the difficulties in getting reading scores from very young readers. However, the Carver test is very sensitive - the test manual claims it can assess down to the reading level of a 4 year old.

type of schooling and age of entry upon p.a. Potential differences in schooling were assessed by an unpaired t-test of the "total p.a." scores of the two schools. No significant difference was found, (t(32)=0.85, p=.59). Differences between winter and spring intakes had to be assessed separately for the two schools, because they used different criteria for admitting a child in the winter or in the spring term. Comparing "total p.a." scores, the winter-spring difference was not significant for "H" school, (t(8)=0.818, p=.54). However, there was a sizeable difference in the "O" school, (t(22)=3.24, p=.018). This difference may in part be due to differences in length of schooling, as outlined above. However, the results also probably indicate a difference in the abilities of the two groups. At the time of testing, the reception class teacher was bemoaning the unusually poor standard of the spring intake. This may well have been exacerbated by the unusually high incidence of socioeconomic problems facing the families of this group. The effect may in part be also attributable to the teaching method used at "O" school. The winter intake were usually transferred from the reception class to a middle year class in the spring term, unless they displayed unusually retarded learning. Thus, the winter intake's abilities might have been extended by the company of older children, whilst the spring intake might have been slightly retarded by lacking this environment. "H" school kept the spring and winter intake in the same class throughout the year. Whatever the reason for the "O" school's winter-spring disparity, there is no reason to suppose that this adversely affects our interpretation of the p.a. results per se.

Discussion.

The findings of this study further confirm that p.a. is strongly related to reading ability. The evidence, put simply, shows that the longer a child possesses p.a., the better his/her reading and spelling. This in itself does not prove a causal relationship. However, the finding that for many subjects, p.a. first appears before their reading can be measured, and that for others, reading level upon acquisition does not appear to be critical, strongly indicates that p.a. is not triggered by reading ability per se. This does not exclude the possibility that p.a. is affected by reading experience. This is most clearly demonstrated in the findings about the hierarchy of sub-tests. As will be recalled, the alliteration tasks, whether input or output, were significantly easier to perform than the rhyming tasks. In teaching a child to read, the part of the word which is most stressed is the start of the word, (cf, Drummond & Wignell, 1979). It would thus be most surprising if the child did not become aware of the beginnings of words before the endings. If the acquisition of p.a. is not governed by such teaching strategies, it is difficult to see why one should observe so <u>consistent</u> a hierarchy. If children acquired p.a. by themselves, one would surely expect a sizeable number who would acquire insight into final sounds first, because they are more salient when spoken out loud, (cf, Shankweiler & Liberman, 1972, and discussion of p.a.-p.s. study below). Furthermore, there is the supporting evidence from the findings of the Morais et al group that phonic skills in general are strongly influenced by teaching methods, though the influence of reading experience alone can cause a change in phonic skills. The novelty of this study's findings is that it would seem that reading experience not only generally affects p.a., but also seems to cause p.a. to be acquired in a particular manner.

The gap between the acquisition of output alliteration and the attainment of full p.a. is approximately 2 test sessions, (about 6 months). There is no evidence available to argue how this transition is made. The most plausible explanation is that once the child has realised that words begin with certain sounds, it is only a matter of time before s/he realises that the chunk of the word which remains once the initial letter is segmented out is composed of letters too. This is again most probably aided by reading, through the "sounding out" of words, etc. However, until more evidence is available, this remains a moot point.

It might be argued that the hierarchy is due to an effect of test difficulty. However, if this was so, then one would expect both the output tests to be harder or simpler than both the input tests. As it is, the hierarchy cuts across the input/output division.

Thus, p.a. probably arises through reading experience. However, we have also seen that it strongly predicts future reading ability. The reasons why p.a. is of use in the processing of an alphabetic script have already been examined. The present evidence indicates that it is not only p.a.'s presence, but also how early the child acquires p.a. which is critical. This indicates that p.a.'s role is not simply to give reading a single "boost" upwards. If that was the case, then the acquisition of p.a. would lead to a single rise in reading ability, at no matter what age p.a. was acquired, and then would have no further effect upon reading. By this reckoning, the length of possession of p.a. should not be related to reading/spelling ability, but as we have seen, it is. However, this causes a problem of interpretation. How can an all or nothing skill cause a gradual improvement? A plausible explanation is that p.a. makes reading more efficient through improving graphemic processing. If graphemic processing improves, then the child has to give less attention to the drudgery of basic word attack skills, and can spend more time concentrating on meaning, building up a sight vocabulary, etc. That is, on developing the hallmarks of a "mature" reading style. The child with p.a. can of course also read words by their visual shape. The child without p.a. can only use this option. Therefore the p.a.-less child is handicapped by having fewer types of word attack skills at his/her disposal, and also should be less able to read novel words. Hence, children without p.a. will not develop their reading skills as quickly as children with p.a., because their basic word attack ability is slower, and they have less time to spend on more sophisticated reading strategies. We cannot verify this from the present study. However, the experiments on reading style and memory to be reported below provide firmer evidence for this argument.

These results confirm that p.a. is strongly correlated with spelling. Experimental design prevents a statistical comparison of the reading and spelling correlation, but the two measures would appear to be correlated with equal strength with p.a. An interesting point to note is that there was a substantial number of subjects who had no or only partial p.a., (i.e., could only do the alliteration tasks,) but who could spell competently. This is at first sight surprising. Surely, one might argue, a child who can spell a word must know what letter is written at the end of it; so if s/he fails the "rhyme" sections of the p.a. test, it is because the test is invalid, and not because the child lacks p.a. However, the p.a. test is somewhat easier than the spelling test. The former requires the subject only(!) to juggle with word sounds, the latter to do this and then to recall the visual representation of the word. I have observed several young subjects quite correctly sound out the letters of a word, only to proceed to write gibberish. So it would seem highly unlikely that a child could exhibit p.a. in the harder skill of spelling, and then fail to display it in the comparatively easier p.a. test. This questions how a child can spell without p.a., or with only partial p.a. It is possible that a child could spell purely by visual shape without regard to phonemic structure. For example, there were several instances of children with only "alliteration p.a." bemoaning the fact that they could not remember how to write a letter which started a word, yet quite happily, (and seemingly unwittingly) writing the same letter correctly at the end of the word. Thus, it would seem that very early in their spelling development , children use "spelling chunks", without regard to the phonemic content, and even in some cases being unaware that the letters they have written in one word have the same symbolic value in another. This is in contrast to the findings of Bryant & Bradley p.a. test is somewhat easier than the spelling test. The former requires the subject only(!) to juggle with word sounds, the latter to do this and then to recall the visual representation of the word. I have observed several young subjects quite correctly sound out the letters of a word, only to proceed to write gibberish. So it would seem highly unlikely that a child could exhibit p.a. in the harder skill of spelling, and then fail to display it in the comparatively easier p.a. test. This questions how a child can spell without p.a., or with only partial p.a. It is possible that a child could spell purely by visual shape without regard to phonemic structure. For example, there were several instances of children with only "alliteration p.a." bemoaning the fact that they could not remember how to write a letter which started a word, yet quite happily, (and seemingly unwittingly) writing the same letter correctly at the end of the word. Thus, it would seem that very early in their spelling development , children use "spelling chunks", without regard to the phonemic content, and even in some cases being unaware that the letters they have written in one word have the same symbolic value in another. This is in contrast to the findings of Bryant & Bradley

(1980). They gave their subjects, (a backward reading group, age 10:6 and reading matched controls, age 7yrs) words to read and spell. They found that there were some words which the subjects could read but not spell, and, surprisingly, other words which the subjects could spell but not read. Closer examination revealed that the read but not spelt words were phonemically irregular, whilst the spelt but not read words were phonemically regular. Furthermore, miscue analysis revealed that the misreadings often bore no phonological relationship to the target word. Conversely, the misspellings often had a phonological similarity to the target word, usually at the beginning or the end. Bryant and Bradley concluded that early spelling was characteristically phonemic, whilst early reading was comparatively visual. The experimenters' subjects were older than the ones used in this study, and probably were displaying the same characteristics which the subjects reported here will use as they get older. The results of this study suggest that subjects are using phonological information in spelling, but possibly not to as great an extent as Bryant & Bradleys' subjects. Again, the evidence of "spelling chunks", albeit anecdotal, suggests that young spellers may pass through a "visual" phase in spelling before they reach a phonological one. More research needs to be performed in this area. An interesting possibility which may be tentatively suggested from these findings is that p.a.'s advent brings with it a change in spelling style. However, this is as yet a moot point.

Thus, the study has found strong evidence for the role of p.a. in reading development. This in itself is not very informative. Many other researchers have found strong correlations between reading and p.a. More interestingly, we have shown: (a) that length of possession of p.a. strongly predicts reading and spelling ability; (b) that p.a. is probably usually a product of reading experience, and is not dependent upon reading ability for its acquisition; (c) that awareness of different aspects of word structure arise at different times; (d) that reading and spelling possibly use different aspects of p.a.; (e) that spelling is strongly linked to p.a., and is an area which merits further research; and (f) that p.a.'s effect upon reading and spelling is long-lasting, and suggests that it causes a radical change in reading and spelling strategies. However, there is a limitation to this study. It is virtually impossible to partial out the effects of age from a longitudinal study, using only one age band of subjects. This criticism does not seriously undermine this study's findings. For example, an age effect cannot explain why length of possession of p.a. should be strongly correlated with reading/spelling ability, in a group of children approximately the same age. Age might explain why there is a gap between acquisition of alliteration and rhyme p.a., but there are good reasons for thinking that this is an effect of teaching practices. Nonetheless, studies of developmental processes cannot comfortably ignore the effect of age. Partly in order to assess age's role in the acquisition of p.a., the cross-sectional study which constitutes Experiment 2 was devised. In Experiment 3, the hypothesis raised here that p.a. plays a role in graphemic processing is examined.

3.2 The p.a.-p.s. study.

Introduction.

Having determined something of the development of p.a., let us now turn our attention to its relationship with other reading sub-skills. The first of these to be considered is phonemic sensitivity, (the others will be graphemic sensitivity and reading style, and STM encoding of verbal material). We saw from the Introduction that tests which ambiguously tested p.a. fell into two camps: those which had an over-large cognitive/mnemonic load, and those which could possibly be performed by a tacit sensitivity to similar sounds alone. These latter, "phonemic sensitivity" (p.s.) tests assessed a skill which had a different pattern of development to that measured by "true" p.a. tests. That is, p.s. seems always to precede learning to read (and was therefore probably speech-based), whilst p.a., although often preceding measurable reading ability, was probably usually derived from reading experience/teaching. Again, the nature of the tests also differed. Taking Bradley & Bryants' "odd man out" test as an example, we can see that ability at this develops gradually with age, whilst p.a., as assessed by my test, comes in "all or none" spurts. Furthermore, within the p.a. test, detecting word endings is harder than detecting word beginnings, whilst the reverse applies in the "odd man out" task. These differences in the nature of the two skills further support the argument for p.a. being reading-based, and p.s. being speech-based. Shankweiler & Liberman (1972) showed by error analysis that young readers' attention in speech was drawn to word endings, and in reading to word beginnings. Certainly the p.a.-p.s. dichotomy would fit into this mould. If p.s. is a speech-based skill which impinges upon reading, then we might expect it to have a lower correlation with reading than the reading-based p.a. This effect should be especially prevelant if we enter chronological age of the subjects into the calculation. If p.s. develops with an improving speech system, then it will co-incidentally improve with the age of the subject. Hence, the partialling out of chronological age should considerably reduce p.s.'s correlation with reading. The partialling-out effect should be much less for p.a., because, as we have seen, the available evidence points to it being determined by exposure to reading teaching/experience, rather than maturational processes. In other words, partialling out of age gives us a measure of how much p.a.'s and p.s.'s correlation with reading is due to the coincidental effects of other developing processes.

Thus, one aim of this study was to compare the predictive powers of a p.a. and p.s. test. In addition to reading, this comparison was to assess the two skills' relationship with spelling. This was largely because, as has been mentioned above, scant attention has been paid to the role of p.a. (and p.s.) in spelling. There is reason to suppose that p.a. will be a much better predictor of spelling ability than p.s. P.a. is a skill which itemises words into phonological components, and can identify the ordering of phonemes in a word. This knowledge, for someone trying to remember how to spell a word, is clearly of importance. (We have already seen from the longitudinal study the strong correlation between p.a. and spelling). P.s., by only requiring the subject to recognise "gestalt" similarities in the sounds of words, without requiring their itemisation, cannot provide this information.

Having thus emphasised the differences between p.a. and p.s., it may seem incongruous to talk of a possible interaction between them. However, the p.a. test in part requires the subject to compare two segmented-out phonemes. This comparison requires phonemic sensitivity, (albeit a very rudimentary form of it) for it to be performed successfully, (i.e., one has to judge if two phonemes "sound the same").

Thus, drawing upon the arguments raised here and in the Introduction, we can see that there are three main aims to this study: (1) to directly compare the differences in predictive powers and "natures" of p.a. and p.s.; (2) to assess this difference in relation to spelling, as well as reading; and (3) to investigate possible interactions between p.a. and p.s.

It was decided to compare p.a. and p.s. using my test and the Bradley & Bryant "odd man out" test (Bradley 1980). There were three principle reasons for these choices: (a) the p.a. test, by separately considering awareness of word beginnings and endings, extracts more information than other p.a. tests; (b) the Bradley & Bryant test is perhaps the best standardised and accepted p.s. test; and (c), the "odd man out" test sub-sections deal separately with word endings and beginnings, which enables a more direct comparison to be made with the p.a. test. In order for possible comparisons to be made with the longitudinal study just reported, the same measures of reading and spelling ability were used.

Method

Subjects

The subjects were 100 pupils, (48 boys, 52 girls) drawn from the same infant school in the north-west of England. The school used an "eclectic" reading teaching method. The subjects ranged in age from 5:0, (the minimum age for the Carver and Schonell tests) to 7:3, (the oldest in the school). As far as possible, an even distribution of ages across this range was sought. All children were native English speakers from native English-speaking homes. The subjects were from a cross-section of working- and middle-class homes. At the request of the teaching staff, detailed SES data were not collected.

TABLE E - NUMBER OF EACH AGE GROUP SCORING ABOVE ZERO ON P.A. AND SCHONELL TESTS

n (out of 25)

AGE GROUP	INPUT RHYME	INPUT ALLIT.	OUTPUT RHYME	OUTPUT ALLIT.	SCHONELL
1	5	8	4	14	12
2	16	20	13	25	20
3	17	20	17	23	24
4	25	25	25	25	25

Materials

Five sets of materials were used - the Carver Word Recognition Test, (Carver 1970); Bradley & Bryants' test, (Bradley 1980); the Schonell Spelling Test (Schonell 1932); and the two p.a. tests of my own devising. Details of all these tests have been given above.

Design

Subjects were tested individually. The order of presentation of the Schonell, Carver, Bradley & Bryant and p.a. tests was counterbalanced, as was the order of presentation of the p.a. sub-tests, which were varied using a latin square design. Testing was split over two test sessions, (usually on consecutive schooldays). Details of procedure for the tests have been given above.

Scoring

Scoring on the Schonell, Carver, and p.a. tests was as detailed above. One point was given for each correct answer on the Bryant & Bradley test, which was thus scored out of 24.

Results

For an overview of the results, the subjects were ordered by age, and were divided into 4 groups of 25 by chronological age. Some results of this analysis are shown in Table E. It would seem from this that p.a. and p.s. are quite strongly age-linked. However, as in the longitudinal study, the scores on the p.a. test appear to have arisen in an "all or none" manner. Indeed, most subjects scoring above zero were scoring near ceiling on the p.a. tests. For example, the mean scores of those subjects scoring above zero suggest that there would seem to be very little difference between the four age groups; input alliteration mean scores range from 18.65-19.84;input rhyme,18.24-19.25; output alliteration, 4.39-4.92;output rhyme,3.75-4.68. In confirmation of this point, if the scores of only those subjects who score above zero are correlated with their ages,(in months) then we find the results expressed in Table G. These correlations are low and non-significant, except for output rhyme, which is just significant at the .05 level. Thus, it is reasonable to assume that p.a. as tested here is an "all or nothing" skill, and to treat it

TABLE F - MEAN SCORES OF SUBJECTS CAPABLE OF EACH TEST, WITH STANDARD DEVIATIONS (IN BRACKETS)

		PHONEMIC SENSITIVITY				PHONEMIC AWARENESS							
MAX.POSS. SCORE:	MEAN AGE (MONTHS) ---	"FINAL" SUB-TEST 8	"MEDIAL" SUB-TEST 8	INITIAL SUB-TEST 8	TOTAL SCORE 24	INPUT RHYME 20	INPUT ALLIT. 20	INPUT "HALVES" 20	INPUT "FULLS" 20	OUTPUT RHYME 5	OUTPUT ALLIT. 5	CARVER 50	SCHONELL ---
AGE GROUP													
1	63.72 (2.34)	4.28 (2.19)	4.16 (1.8)	3.68 (1.6)	12.2 (4.73)	19.2 (0.84)	19.63 (0.74)	19.38 (1.17)	19.75 (0.46)	3.75 (1.26)	4.57 (0.85)	18.4 (9.24)	10.58 (5.52)
2	71.2 (1.92)	6.12 (1.83)	5.48 (2.45)	5.08 (2.08)	16.64 (5.8)	19.25 (1.0)	19.45 (1.43)	19.2 (1.58)	19.1 (1.62)	4.31 (0.95)	4.64 (0.87)	29.36 (8.98)	17.15 (6.07)
3	77.28 (2.13)	6.68 (1.31)	6.6 (1.32)	6.24 (1.42)	19.52 (3.28)	18.53 (1.66)	18.65 (1.57)	18.2 (2.48)	18.9 (1.41)	4.0 (1.22)	4.39 (0.89)	34.68 (10.21)	15.75 (8.46)
4	84.32 (2.29)	7.8 (0.5)	7.52 (1.48)	7.44 (0.96)	22.88 (2.45)	18.24 (2.07)	19.84 (0.8)	18.36 (2.12)	19.72 (0.61)	4.68 (0.69)	4.92 (0.28)	44.28 (7.49)	25.64 (10.89)

TABLE G - CORRELATION OF CHRONOLOGICAL AGE WITH P.A. AND BRADLEY TEST SCORES OF ALL SUBJECTS SCORING ABOVE ZERO ON THESE TESTS

P.A./BRADLEY TEST	CORRELATION COEFFICIENT	d.f.	t	PROBABILITY
INPUT RHYME	0.05	60	0.41	N.S.
INPUT ALLIT.	-0.005	70	0.05	N.S.
OUTPUT RHYME	0.27	54	2.10	.05*
OUTPUT ALLIT.	0.19	83	1.75	N.S.
INPUT HALF	-0.23	70	2.02	.05
INPUT FULL	-0.01	70	0.09	N.S.
INITIAL P.S.	0.50	98	5.70	.01
MEDIAL P.A.	0.63	98	7.96	.01
FINAL P.S.	0.68	98	9.28	.01
TOTAL P.S.	0.70	98	9.76	.01

*N.B.: $p<.05$, 54 d.f., t = 2.00

as such. By way of contrast, the p.s. total and sub-test scores all correlate highly with age,(see Table G).

Having again decided to treat p.a. as an all or nothing skill, the subjects' scores were converted such that the subject scored one point for each p.a. test on which s/he scored above zero. Hence, the range of scores on the combined p.a. test ranged from 0 to 4. If we look at the whole group of 100 subjects, and consider the number of subjects scoring above 0 on each of the four p.a. sub-tests, then we find that the largest group of subjects could perform the output alliteration task, the next largest the input alliteration task, then the input rhyme task, and finally, the output rhyme task. It was decided to assess if this again reflected a genuine hierarchy of difficulty. If it did, then the subjects should only display 5 types of scoring pattern: those who could do none of the tasks; those who only scored above zero on the output alliteration task; those who only scored on the two alliteration tasks; those who scored on everything but the output rhyme; and finally, those who scored on everything. Dividing the subjects up in this way,

TABLE H - DISTRIBUTION OF SCORING PATTERNS ON P.A. TESTS ACROSS THE FOUR SUBJECT GROUPS

GROUP	ALL WRONG	OUTPUT ALLIT. ONLY	OUTPUT & INPUT ALLIT. ONLY	ONLY OUTPUT RHYME WRONG	ALL CORRECT
1	11	6	3	1	4
2	2	5	4	3	11
3	2	2	3	1	16
4	0	0	0	0	25

the results expressed in Table H were found. 99 out of the 100 subjects fell into this pattern,(the one exception scored on the two output sections only). This confirms the hierarchy of difficulty in the p.a. tests observed in the previous experiment. It could be argued that what is being shown is not that p.a. is an all or nothing skill, but rather, that we are looking at an all or nothing test of it. This would seem unlikely on the grounds that we would not expect a test of awareness to be anything but all or nothing. Indeed, given the arguments advanced in the Introduction, if one did find that the test measured a gradually improving skill, then one might argue that there was a "contaminating" influence of p.s. to expand on this point, (which I stress is speculative). Only "simple" words were chosen for the p.a. test. If more "difficult", (i.e., with subtler phonemic similarities/differences, such as "th" or "f") words had been included, then presumably the child could isolate the beginning or end of the word with just about equal ease. However, it is possible that a greater degree of phonemic sensitivity/cognitive skill would be required to identify similarities with other isolated phonemes

TABLE I - MULTIPLE REGRESSION ANALYSIS OF TEST RESULTS WITH CARVER AS DEPENDENT VARIABLE. PREDICTOR VARIABLES ENTERED IN FORWARD & REVERSE HIERARCHY OF SIMPLE REGRESSIONS

DEP VAR = CARVER

Variables	F	Multiple Reg	Multiple Reg.^{2}	Change Multiple Reg.^{2}	Simple Reg
Total P.A.	174	.80	.64	.64	.80
C.A.	41	.86	.75	.11	.77
Total P.S.	6.4	.87	.76	.02	.76
Total P.S.	137	.76	.58	.58	.76
C.A.	30	.83	.68	.10	.77
Total P.A.	32	.87	.76	.10	.80
C.A.	142	.77	.59	.59	.77
Initial P.S.	16	.81	.65	.06	.71
Input Allit.	27	.85	.73	.08	.70
Input Allit.	96	.70	.50	.50	.70
Initial P.S.	35	.79	.63	.14	.71
C.A.	34	.85	.73	.10	.77
Input Rhyme	139	.77	.59	.59	.77
C.A.	61	.86	.75	.16	.77
Final P.S.	2.9	.87	.75	.01	.73
Final P.S.	112	.73	.53	.53	.73
C.A.	44	.82	.68	.15	.77
Input Rhyme	29	.87	.75	.08	.77
C.A.	142	.77	.59	.59	.77
Total P.S.	28	.83	.68	.09	.76
Output Allit.	8	.84	.71	.02	.56
Output Allit.	45	.56	.31	.31	.56
Total P.S.	84	.80	.63	.32	.76
C.A.	25	.84	.71	.08	.77
Output Rhyme	168	.79	.63	.63	.79
C.A.	39	.86	.76	.10	.77
Total P.S.	9	.87	.76	.02	.76
Total P.S.	137	.76	.58	.58	.76
C.A.	30	.83	.68	.09	.77
Output Rhyme	31	.87	.76	.08	.80

TABLE J - MULTIPLE REGRESSION ANALYSIS OF TEST RESULTS WITH SCHONELL AS DEPENDENT VARIABLE. PREDICTOR VARIABLES ENTERED IN FORWARD & REVERSE HIERARCHY OF SIMPLE REGRESSIONS

Order of Entry of Predictor Variables	DEP VAR = SCH			Change Multiple Reg.^{2}	Simple Reg.
	F	Multiple Reg.	Multiple Reg.^{2}		
Total P.A.	137	.76	.58	.58	.76
Total P.S.	12	.79	.63	.05	.70
C.A.	2.1	.80	.64	.01	.64
C.A.	67	.64	.41	.41	.64
Total P.S.	25	.73	.53	.12	.70
Total P.A.	29	.80	.64	.11	.76
Inout Allit.	82	.68	.46	.46	.68
C.A.	23	.75	.56	.10	.64
Initial P.S.	3.0	.76	.57	.01	.62
Initial P.S.	60	.62	.38	.38	.62
C.A.	15	.68	.46	.09	.64
Input Allit.	25	.76	.57	.11	.68
Input Rhyme	151	.78	.61	.61	.78
C.A.	7.4	.82	.64	.03	.68
Final P.S.	8.5	.82	.66	.03	.64
Final P.S.	86	.68	.47	.47	.68
C.A.	12	.72	.53	.06	.64
Input Rhyme	39	.82	.66	.14	.78
Total P.S.	95	.70	.49	.70	
C.A.	7.1	.73	.53	.04	.64
Output Allit.	5.3	.74	.55	.03	.51
Output Allit.	34	.51	.26	.26	.51
C.A.	36	.68	.46	.20	.64
Total P.S.	20	.74	.55	.09	.70
Output Rhyme	147	.78	.60	.60	.78
Total P.S.	13	.81	.65	.05	.70
C.A.	1.2	.81	.65	.01	.64
C.A.	67	.64	.41	.41	.64
Total P.S.	25	.73	.53	.12	.70
Output Rhyme	35	.81	.65	.13	.78

than for "simple" words, (e.g., it is easier to spot that "sat" and "sad" start the same than "tar" and "train"). Thus, if the test words had been graded in difficulty, then conceivably one would have a gradual, rather than an all-or-none test, but one would be testing an all-or-none ability interacting with a gradually developing skill.

Having examined some of the aspects of the p.a. test itself, let us consider its relationship with the other tests. In order to assess this, the results were analysed using the SPSS multiple regression statistics package. The results of this are displayed in Tables I and J. This multiple regression package differs from the stepwise regression used in the longitudinal study: (a)The variables are entered in a set order, and the amount of variance taken by each variable entered in its set position is calculated. Hence, to get a clear picture of the relative importance of the predictor variables, they have to be entered in every order of entry. Thus, with three predictor variables, there are 6 regression equations. (b)Variables are not excluded from entry, no matter how small their contribution to the variance. And (c), the first entered variable only takes the variance from the other variables which they mutually share; it does not partial out all the variance it has in common with the other variables.

The p.a. and p.s. tests were assessed separately for their relationships with reading and spelling. In both cases, chronological age, (in months) was used as a third predictor variable. The total p.a. test score was compared with the total p.s. test score. In addition, the two p.s. tests which seemed to correspond most closely to the input rhyme and input alliteration tasks, (the final and initial odd man out tasks respectively) were compared with each other. To gain some idea of the predictive power of the output p.a. tasks, these were assessed against the total p.s. scores. For the sake of clarity, only two of the six analyses from each multiple regression equation are presented in the tables. These display the regressions produced when the predictor variables are entered in forward and reverse order of the strength of their correlations with the dependent variable. Hence, in the forward order of entry, the predictor variable with the highest correlation with the dependent variable is entered first, the predictor variable with the second highest correlation is entered second, and the variable with the weakest correlation is entered last. In the reverse order equation, the opposite order of entry is performed. The results from the complete multiple regression analysis display the same pattern, (see Appendix).

As can be seen, both p.a. and p.s. are good predictors of reading and spelling ability. However, overall, p.a. is a better predictor than p.s. In the 10 multiple regression analyses performed, p.a. has a higher correlation than p.s. on 7 occasions. On the three occasions when p.s. provided a higher correlation than p.a., two involved a comparison of the output alliteration sub-test against the full p.s. test score. Further evidence of the consistent predictive superiority of p.a. can be gained from studying the regression square change figures in the Tables I and J. On the 8 occasions upon which p.a. is the highest correlate and p.s. the weakest, we can see that p.a. when entered last takes more variance than p.s. when entered last, on every

TABLE K - RESULTS OF STEPWIDE MULTIPLE REGRESSION ANALYSIS OF P.A.-P.S. STUDY

Dependent Variable	Predictor Variables Entered	Predictor Variables Making Significant Contribution*	Multiple Regression	Multiple Regression 2	Change in Multiple Regression 2	F	PROB.
Carver	Total P.A.	1. Total P.A.	0.7998	0.6397	0.6397	174	.000
	Total P.S.	2. Chron.Age	0.8640	0.7465	0.1067	143	.000
	Chron.Age	3. Total P.S.	0.8731	0.7623	0.0159	103	.000
Carver	Input Allit.,	1. Chron.Age	0.7693	0.5919	0.5919	142	.000
	Initial P.S.,	2. Input Allit.	0.8418	0.7068	0.1167	118	.000
	Input Rhyme,	3. Initial P.S.	0.8524	0.7267	0.0180	85	.000
	Final P.S.,						
	Chron.Age.						
Carver	Input Allit.	1. Chron.Age	0.7693	0.5919	0.5919	142	.000
	Input Rhyme,	2. Input Rhyme	0.8642	0.7468	0.1549	143	.000
	Output Allit.,						
	Output Rhyme,						
	Chron.Age.						
Schonell	Total P.A.	1. Total P.A.	0.7634	0.5828	.5828	137	.000
	Total P.S.	2. Total P.S.	0.7933	0.6294	.0465	82	.000
	Chron.Age						
Schonell	Input Allit.,	1. Input Allit.	0.6746	0.4550	0.4550	82	.000
	Initial P.S.,	2. Chron.Age	0.7479	0.5593	0.1043	62	.000
	Input Rhyme,						
	Final P.S.,						
	Chron.Age.						
Schonell	Input Allit.	1. Input Rhyme	0.7789	0.6068	0.6068	151	.000
	Input Rhyme,	2. Chron.Age	0.8115	0.6585	0.0518	9.4	.000
	Output Allit.,						
	Output Rhyme,						
	Chron.Age.						

occasion. Thus, we would seem to have strong evidence that p.a. is a better predictor of reading and spelling ability than p.s., both in its overall score and in its sub-tests. These findings also tell against the suggestion that p.a. is merely a blunt measure of an all or none ability. Clearly the advent of the different stages of p.a. herald the onset of genuine changes in reading and spelling skills. Considering the p.a. test in isolation, we can see that, not unexpectedly, the four sub-tests have weaker correlations than the total test score with reading and spelling. It is interesting to note, however, that the correlations increase with the difficulty of the sub-test, (i.e., output alliteration has the lowest correlation, output rhyme the highest). This too seems to indicate that the hierarchy of difficulty within the p.a. test reflects a genuine change in reading/spelling ability. That is, the more the subject knows about phonic structure, the more critical its role.

The results were also analysed using the stepwise regression analysis, and the results of this are presented in Table K. As can be seen, they support the findings of the "standard" regression analysis. Total p.a. test score is a better predictor of reading and spelling than p.s. or chronological age. Chronological age still claims 11% of the variance when entered second when reading is the dependent variable. However, when spelling is the dependent variable, p.a. effectively claims all the variance to itself. P.s., the only other entered variable, can only claim an additional .05% of the variance. In a comparison of sub-tests, p.a. again displays its predictive superiority over p.s., which fails to contribute when spelling is the dependent variable, and only adds .02 to the variance when Carver score is the dependent variable. When the p.a. sub-test scores are entered as predictor variables, the predictive powers are less than the total p.a. score, but they are not "blocked out" by the predictive power of chronological age. In one case, p.a. is the better predictor, and in the remaining three cases, p.a. gleans at least 10% of the variance when entered second. The stepwise regression analysis, by removing <u>all</u> the shared variance, is a measure of predictive power. But equally, it masks any interaction that p.s. and age have with reading/spelling skills. Hence, the stepwise analysis, whilst showing the predictive

TABLE L - RESULTS OF THE PARTIAL CORRELATION ANALYSIS

CORRELATION PAIRS	OLD * CORREL.	CONTROLLING FOR:	NEW CORREL.	PROBAB-ILITY	NEW CORREL.SQUARED / OLD CORREL.SQUARED x100
INPUT ALLIT & CHRON.AGE	.54	Carver	-0.002	N.S.	0.000008
INPUT RHYME & CHRON.AGE	.59	Carver	-0.03	N.S.	0.002
OUTPUT ALLIT. & CHRON.AGE	.48	Carver	0.083	N.S.	0.03
OUTPUT RHYME & CHRON.AGE	.65	Carver	0.13	N.S.	0.04
TOTAL P.A. & CHRON.AGE	.64	Carver	0.19	N.S.	0.02
INITIAL P.S. & CHRON.AGE	.70	Carver	0.33	.001	22
MEDIAL P.S. & CHRON.AGE	.63	Carver	0.22	.01	12
FINAL P.S. & CHRON.AGE	.66	Carver	0.23	.01	12
TOTAL P.S. & CHRON.AGE	.72	Carver	0.33	.001	21
INPUT ALLIT. & CARVER	.70	Chron.Age	0.54	.001	58
INPUT RHYME & CARVER	.77	Chron.Age	0.62	.001	65
OUTPUT ALLIT. & CARVER	.56	Chron.Age	0.35	.001	38
OUTPUT RHYME & CARVER	.80	Chron.Age	0.60	.001	56
TOTAL P.A. & CARVER	.80	Chron.Age	0.62	.001	59
INITIAL P.S. & CARVER	.50	Chron.Age	0.38	.001	58
MEDIAL P.S. & CARVER	.69	Chron.Age	0.38	.001	29
FINAL P.S. & CARVER	.73	Chron.Age	0.46	.001	40
TOTAL P.S. & CARVER	.76	Chron.Age	0.47	.001	38

* All correlations significant to at least .05

TABLE L - RESULTS OF THE PARTIAL CORRELATION ANALYSIS (Continued)

CORRELATION PAIRS	OLD * CORREL	CONTROLLING FOR:	NEW CORREL.	PROBAB-ILITY	NEW CORREL.SQUARED / OLD CORREL.SQUARED X100
INPUT ALLIT. & CHRON.AGE	.54	Schonell	0.23	.03	13
INPUT RHYME & CHRON.AGE	.59	Schonell	0.17	.05	8.4
OUTPUT ALLIT. & CHRON.AGE	.48	Schonell	0.23	.01	23
OUTPUT RHYME & CHRON.AGE	.65	Schonell	0.35	.001	29
TOTAL P.A. & CHRON.AGE	.64	Schonell	0.33	.001	27
INITIAL P.S. & CHRON.AGE	.70	Schonell	0.49	.001	50
MEDIAL P.S. & CHRON.AGE	.63	Schonell	0.37	.001	34
FINAL P.S. & CHRON.AGE	.66	Schonell	0.4	.001	37
TOTAL P.S. & CHRON.AGE	.72	Schonell	0.5	.001	48
INPUT ALLIT & SCHONELL	.68	Chron.Age	0.51	.001	57
INPUT RHYME & SCHONELL	.78	Chron.Age	0.65	.001	70
OUTPUT ALLIT. & SCHONELL	.51	Chron.Age	0.3	.001	36
OUTPUT RHYME & SCHONELL	.78	Chron.Age	0.61	.001	62
TOTAL P.A. & SCHONELL	.76	Chron.Age	0.6	.001	61
INITIAL P.S. & SCHONELL	.62	Chron.Age	0.31	.001	26
MEDIAL P.S. & SCHONELL	.63	Chron.Age	0.37	.001	36
FINAL P.S. & SCHONELL	.68	Chron.Age	0.45	.001	44
TOTAL P.S. & SCHONELL	.7	Chron.Age	0.46	.001	42

*Correlations significant to at least .05

superiority of p.a. over p.s. and age, must be viewed in conjunction with the more descriptive regression analysis first described.

Having established that p.a. and p.s. differ in their predictive powers, let us now consider if they differ in their basic characteristics. As has already been noted, p.a. appears to arise in an all or none fashion, whilst p.s. gradually develops with age. The hierarchies of difficulty within the tests would also seem to differ. For the p.a. tests, the rhyme sections, (input and output) are performed by significantly fewer subjects than the alliteration sections, (Chi-squared(3) = 22.45, p<.001). Conversely, the initial-letter-same section of the p.s. test is significantly harder than the final-letter-same section, (paired t test; t(99)=4.10, p<.0002). Further evidence of differences is provided by a partial correlation analysis which was run on the results, (see Table L). As can be seen, p.a.'s correlations with chronological age are effectively eliminated when reading ability is controlled for, whilst p.s.'s correlational links, whilst greatly reduced, still remain significant. A similar effect is observed when spelling is controlled for, although in this instance, p.a.'s correlation remains reasonably robust. Conversely, when chronological age is controlled for, p.s.'s correlations with both reading and spelling are reduced by a considerably greater amount than p.a.'s. It would thus seem that p.a. is considerably less attached to maturation than p.s., and, (although of course we cannot unreservedly conclude this form this data) it would seem that p.a. is more strongly allied to reading and spelling processes than p.s. We shall return to this point in the discussion below. To summarise the results:

(a)P.a. arises as an all or nothing ability, whilst p.s. develops gradually over age.

(b)P.a. seems to largely arise during the subjects' first three years at school, whilst p.s. is possessed to some degree by all subjects.

(c)The hierarchy of difficulty in the sub-tests of p.a. and p.s. differs - in p.a. the start of words are easier to detect than the ends of words; in p.s., the reverse applies.

(d)From the partial correlation data, it can be seen that p.a. is better correlated with reading and spelling than age, whilst the reverse applies for p.s.

(e)P.a. is a consistently better predictor of reading and spelling performance than p.s. or chronological age.

Discussion

A criticism which can be levelled at this work is that the differences between p.a. and p.s. are not due to a genuine difference in the natures of the skills that the two tests are assessing, but that p.a. is merely a harder and less sensitive version of the p.s. test. This criticism can account for the fact that the p.a. test displays all or nothing characteristics, whilst the p.s. test assesses subtler improvements in performance with increasing age. However, it cannot explain why there should be differences in the internal hierarchies of difficulty of the two tests, nor can it account for why p.a., a supposedly less sensitive test, should take more variance than p.s. or c.a. in the multiple regression analysis. These findings are even more striking given the smaller range of p.a. scores, (0-5) compared with that of the p.s. test, (0-24).

It would seem, therefore, that this experiment has unearthed genuine differences in the nature of the phonemic skills assessed by the two tests.

The question to be answered now is how well these differences support the argument advanced in Chapter 2 and the introduction to this study. That is, that p.a. is a product of reading, and p.s. a product of speech processing. In most cases p.a. would seem to arise during the subject's school career, whilst p.s. pre-dates reading, which is what we would expect. The hierarchy of difficulty exhibited by p.a. also furnishes evidence for its origins in reading, as argued in the longitudinal study above. The evidence from the partial correlations further supports this concept of links with reading experience/ability. Conversely, p.s. pre-dates learning to read, so it may be reasonably assumed that it taps speech. As we have seen, the hierarchy of difficulty of p.s. differs from that of p.a. - the endings of words are more salient. This is not surprising if p.s. is tapping speech, since in oral English, far more use is made of rhyme than alliteration. Again, rhyme is likely to be used by a child more than alliteration, since it is far easier to articulate. Further support for these observations comes from a study by Shankweiler & Liberman (1972). They analysed young schoolchildren's reading errors, and found that they were usually associated with the vowel (43%) or the final consonant, with the initial letter being accurately read. Conversely, their errors in repeating spoken words were equally divided between word beginnings and endings, with the vowel being accurately repeated. Hence, it would seem that reading places a stronger emphasis on word beginnings than speech does.

Thus, we have further evidence that p.a. is an all or nothing product of reading experience, whilst the data on p.s.'s performance further supports the theory advanced by Bradley & Bryant that their phonic skill arises in speech, and improves with age.

P.a. and p.s.'s relationship with spelling is comparable to that with reading performance. Again, p.a. is a better and more robust predictor of spelling than p.s. As was argued in the introduction, p.s. is likely to play a weak role in spelling because it provides no information that words can be decomposed into phonemes, which is the aspect of phonemic structure which is of most value in the spelling process. Indeed, the stepwise regression analysis totally excludes p.s. from a significant role in spelling. P.a.'s relationship to spelling has already been examined. However, one should note that the p.a.-spelling correlation is weaker here than in the longitudinal study. In the present study, p.a. is defined as the strength of a subject's p.a. at one moment in time. In the longitudinal study, it will be recalled that p.a. was defined as the length of time a subject had possessed p.a., without particular regard to the number of p.a. sub-skills the subject possessed. This suggests that p.a.'s importance to spelling lies not through what the subjects know about the precise nature of phonemic structure, (which is what is measured in this study) but the general realisation that words are built up of letters. To expand on this point. The realisation that words are composed from a discrete set of sub-components is clearly useful in learning to spell, since it should reveal the principle of alphabetic spelling to the child. However, a detailed knowledge of phonemic structure is likely to be of restricted use in spelling, because of the number of irregular spellings in English.

So far, we have looked at p.a. and p.s. in terms of their differences. However, this does not mean that the two skills do not interact. In fact, the total p.a. and p.s. scores correlate at .723, ($t(98)=10.36$, $p<.001$).* As has been argued above, p.s. is probably a necessary prerequisite of p.a., for without tacit sensitivity, the subject has no method of determining if two phonemes which have been partialled out for comparison actually sound the same. The level of p.s. required for this may be very rudimentary, however. A further and greater use of p.a. in p.. may be in judging subtler phonemic distinctions between words, (though in abolute terms, the level of p.s. required is still very basic). The less "obvious" the phonemic similarity between two partialled out words,(e.g.,"cat,bat" are more obviously similar than "cat,bit") the greater the sensitivity required to detect it. This would seem to be indicated by the finding that the subjects scored significantly higher on the input full word lists than on the half word lists,(sign test on

*Though note the figure falls to $r=.41$ ($p<.001$) when age is partialled out.

large sample; z=1.97;p<.024). In other words, the saliency of the word similarities would seem to have an effect. However, it should be noted that proportional to the total scores this effect is not very great.

The results of this experiment are of relevance to the findings of the longitudinal study. It will be recalled that the confounding effect of chronological age could not be excluded from the longitudinal study results. The evidence from the partial correlation analysis performed here indicates that part of the p.a.-reading/spelling correlation may be attributable to the age effect. However, in line with the arguments advanced in the Introduction, (particularly the work of Morais and his co-workers) the effect of age itself is probably small. To recap on the evidence: (a) The p.a.-reading/spelling correlation decreases when age is partialled out. However, since age is confounded with length of schooling, we cannot conclude much from this. A more informative procedure, therefore, is to see if age and p.a. correlate when reading/spelling is partialled out. The correlation in this case dwindles to non-significance. (b) In the multiple regression analysis, p.a. is a more robust predictor of reading/spelling than age. Hence, we can reasonably conclude that chronological age has little influence on the p.a. correlations, both in the longitudinal study and the present one. It would seem that we have good evidence for p.a. being a product of reading, and differing markedly from p.s. However, both tests would seem to play an important role in reading and spelling, and indeed there is some evidence for the two skills interacting.

Having shown that p.a. is strongly related to early reading and spelling, we shall now turn to the question of how it is related. In other words, how does p.a. manifest itself in the processes of reading and spelling? The final two experiments of this thesis address this question.

3.3 The reading style study.

Introduction.

So far we have considered p.a. in terms of its relationship with reading, spelling and p.s.. However, none of this tells us how p.a. interacts with reading. It is reasonable to assume that p.a.'s immediate impact will be upon "graphemic processing", (i.e., letter recognition, "building up" words, etc.) since it is at this level that knowledge of phonemic structure is most useful, (see Introduction). If this is so, then one can make a prediction. Subjects with, (pa+) and without p.a., (pa–) can, (and often do) perform equally well on conventional word recognition tasks. However, might this not be because the pa- subjects are reading by, (for example) recognising the gestalt shape of the word, whilst pa+ subjects are paying attention to graphemic structure? If this is so, then we can predict that pa+ subjects will be much more sensitive to graphemic change within words than pa- subjects, despite the two groups ostensibly having the same level of word recognition skills. In order to investigate this claim, we need first to examine the literature on reading sub-skills with especial emphasis upon studies of graphemic processing.

Studies which concentrate solely upon sensitivity to graphemic structure, as opposed to studies of the role of graphemic processing in overall reading style, (which will be reviewed below) are quite rare. All have found that "graphemic sensitivity" increases with age/ability. Guthrie (1977) examined (U.S.) 1st, 2nd. and 3rd. graders, and found that there was a hierarchy of difficulty in learning grapheme-phoneme correspondences, (e.g., short vowel words learnt before long vowel words, etc.). Massaro & Hestand (1983) again took (U.S.) 1st. to 3rd. graders as subjects. They asked them to pick the item that "looked more like a word" from pairs of letter strings, which had a "legal" or "illegal" structure. The greater the graphemic sensitivity, the more often the subject should pick the "legal" structure. The researchers found that task performance improved with length of schooling, and was positively correlated with reading ability. Williams et al (1970) took (U.S.) kindergarten non-readers, 1st. graders and students as their subjects. The stimuli were nonsense trigrams and quingrams. The subjects were exposed to the stimulus for three seconds, and then asked to choose it from a range of alternatives, the non-targets having been graphemically altered, (i.e., some of their letters had been changed). Williams et al found from an error analysis that the kindergarteners followed no particular strategy. The first graders tended to choose by the first, (more frequent strategy) or last, (less frequent) letter of the word. Adults tended to choose by the central portion of the word.

Dodd (1982) adopted a paradigm, which, like Williams et al, tested sensitivity to graphemic changes within a word. She assessed a group of infant school children's developing ability to perform this task through their first year at school. They were divided into groups of good and poor readers. The subject was given a printed word to memorise. S/he then had to judge if 15 printed letter strings were the same as, or different to, the memorised, (target) word. Four of the letter strings were the target, and eleven were non-targets. By varying the degree of graphemic similarity between the non-targets and the target, it was possible to assess the subjects graphemic sensitivity, (i.e., the subtler the target/non-target difference before the subject is "caught out" the greater the sensitivity). In order to compensate for possible memory effects, the test was re-run, with the subject now being required to match the same letter strings to the printed target placed in front of him/her. Five targets were used, which varied in length. The results of Dodd's study are complex. Basically, she found that test performance improved with age/length of schooling, and that good readers were better than poor readers. Longer words were harder to judge than shorter ones, and seemed to be treated differently. For short words, the hardest transformations to detect were reversals, (e.g., "cow" -> "woc"), whilst for the long words, the graphemically most similar transformations, (i.e., those with the fewest letters altered) were the hardest. This led Dodd to ask "whether the child's real problem in word identification was not so much the initial realisation of the importance of letter identity, but in the child's ability to cope with an increasing number of letters."

Though p.a.'s most direct role in reading is probably through graphemic processing, this does not mean that its effects will not be seen in other aspects of reading style. For example, at the simplest level, p.a.'s acquisition might bring with it an increased emphasis on graphemic/phonemic sub-skills. In order to assess this claim, we need first to consider the literature in reading sub-skills. This is considerable, and what follows is, of necessity, a review of examples of research, rather than the whole field. Let us start at the beginning, and examine those studies which have assessed the role of the different sub-skills in the initial stages of reading acquisition.

Reading sub-skills are usually assessed by analysing oral reading errors. The child is given a prose passage to read out loud, and any deviations between what is written and what s/he reads out are noted and classified. Before 1970, studies of this were frequently unsystematic. Assessing over 30 of these, Weber, (1968) found a wide variance in the classification schemes being used. Often, the same term would be used by different studies for completely different error types. Schale (1966) compared the distribution of error types as assessed by 10 different studies, and found no useful concordance between them.

Goodman & Burke (1972) responded to these criticisms, and devised a clearer taxonomy of errors, which has been used as a basis for measures by subsequent researchers. Goodman & Burke identified four types of "miscues", (a term adopted because "errors" was thought to be too negative):

(a) <u>substitution</u>

- the subject substitutes another word for the to-be-read one.

(b) <u>insertion</u>

- an extra word is inserted into the text being read.

(c) <u>omission</u>

- a word is not read, but "skipped over", with no obvious pause.

(d) <u>reversal</u>

- two words are reversed, (e.g., "cat the" for "the cat"). These errors are rare, and researchers usually classify them as pairs of substitution errors, (this is the policy adopted here).

By judging the graphemic similarity between the miscue and what should have been read, we can gain a measure of the subjects' reliance on graphemic information. Clearly, this can only be done on substitution errors. Measures of graphemic similarity vary from study to study. Reliance upon contextual information is measured by judging if the miscue makes semantic and syntactic sense in the phrase in which it occurs, (e.g., "she ran quietly" for "she ran quickly" might be, but "she ran green" would not be contextually acceptable). As insertion errors are nearly always context-bound, and omission miscues are rare, analysis of contextual miscues too has concentrated on substitution errors. Substitution miscues can thus be classified as graphemic only, (i.e., only making graphemic sense), contextual only, or contextual and graphemic. For example, "the brick dog" for "the black dog" is graphemic only; "the white dog" contextual only; and "the blank dog" both graphemic and contextual.

Biemiller (1970) used these measures to assess the development of (U.S.) 1st. graders' reading in a longitudinal study. He found that across the year, there was initially an emphasis on contextual, then graphemic, then graphemic and contextual information combined. Biemiller also identified a "non response", (NR) miscue. A NR was recorded when the child stopped reading, but unlike an omission miscue, did not attempt to skip the word s/he could not read. Biemiller identified a "NR phase", (where over 50% of miscues were NR) which occurred at the same time as a significant increase in graphemic errors. Prior to the N-R phase, miscues were largely contextual, and in the post-NR phase, miscues were largely contextual and graphemic. This developmental sequence might be explained as follows. At the onset of reading, children's knowledge of graphemic structure is poor, and hence they are forced to rely on contextual cues. When their graphemic skills increase, they can start to use them in reading. However, they will at some time be balanced between using graphemic and contextual cues, and this conflict of strategies is marked in the NR phase. Here the child fails to combine the strategies at his/her disposal, and this results in a failure to recognise the word. As graphemic skills further increase, so the children become able to use graphemic cues more efficiently, until they are able to assimilate contextual information simultaneously, (the graphemic and contextual miscue phase).

Cohen (1975) effectively replicated Biemiller's findings. Dodd (1982), however, did not. She assessed a group of U.K. infant school children through their first year of reading. Most strikingly, she found no evidence for a NR phase. Furthermore, though there was a rise through the year in graphemic miscues, these were graphemic <u>and</u> contextual miscues. "Pure" graphemic miscues were always very low. Good readers' miscues had a significantly higher graphemic content than poor readers'. From this, Dodd concluded that "The ability to use graphic information does, therefore, seem to be important in early reading, although it is impossible to say whether reading achievement is the result of an understanding of the graphic element of words, or vice versa."

The reasons for the disparities in Dodd's and Biemiller's findings could be twofold. First, their subjects were taught by different educational systems. We have already seen from the work of the Morais et al group that teaching methods influence the level of phonic skills. Might this not extend to reading style? Second, as Dodd herself acknowledges, cross-observer reliability in reading style analysis is still low. For example, Hood (1976) found that adequate inter-observer reliability was not attainable in a single test without 30 hours of training. Nonetheless, there is at least an agreement between the researchers that the child starts reading using contextual cues, and within the first year comes to rely heavily upon graphemic cues. We have seen from the work on graphemic sensitivity that good readers are quicker to use graphemic information than poor readers, (as Dodd has observed, it is not clear how far this is attributable to awareness of structure, i.e. p.a.).

The findings of the miscue analysis studies might be crudely summarised thus: in the first year of reading, children at first place stress upon contextual and then upon graphemic information. However, studies of reading after the first year have found a different story. That is, of graphemic or phonemic processing giving way to contextual processing. Let us examine this literature before attempting an explanation of this apparent conflict.

Many studies have sought to identify a pair of reading sub-skills and compare the extent of the usage of each in developing reading. A popular topic for this type of study has been a comparison of the use of phonemic and contextual/semantic information. The general conclusion of this research is that the latter supercedes the former with increasing age/reading experience. For example, Felzen & Ansfield (1970) tested 3rd. and 6th. (U.S.) grade children in a continuous recognition task. They found that false recognition of phonemically related words was more frequent for 3rd. graders, and false recognition of semantically related words was more frequent for 6th. graders. Rice & Divesta (1965) measured the GSR of (U.S.) 3rd. and 5th. graders as they watched a continuous display of words. The 3rd. graders displayed a generalized response to paronyms, whilst the 5th. graders generalized to synonyms. These results do not indicate that phonic skills worsen with age/increasing reading ability. Indeed, many researchers have found that phonic skills improve with age, and are positively correlated with reading ability, (e.g., Ehri & Wilke, 1983; Hogaboam & Perfetti, 1978; Katz & Baldasare, 1983). It seems probable that the better the reader, the more automatic the phonemic processing, and hence the less the emphasis placed upon it. Certainly failure of phonemic processing in adult reading is highly disadvantageous, as we have seen from the work of Byrne & Ledez (1983).

Phonemic processing, (i.e., the attention paid to the phonic structure of words) has also been compared to graphemic processing. Again, phonemic skills seem to become less obtrusive with increasing age/ability. For example, Doctor & Coltheart (1980) asked children, (aged 6:2 to 10:5 years) to decide whether some sentences were meaningful or not. Included in the experiment were some sentences which were phonemically meaningful, but graphemically nonsense, (e.g., "He ran threw the street"). The younger subjects made a greater number of errors, and made relatively more errors with the phonologically meaningful sentences. The researchers concluded that with the development of reading, children gain direct access to an "internal lexicon", and do not need to pass through an intermediate stage of phonological encoding. This is not necessarily the case, however. The older subjects may still be phonemically processing, but have learnt to recognise relevant and irrelevant spellings. Thus, developing reading might be a case of combining visual coding with a pre-existing phonological coding. Indeed, Hulme & Bradley (1984) have argued that it is an inability to combine phonemic and graphemic, and in addition, motor information which hampers many dyslexic children. They found that the best way of teaching new words was to demonstrate the words' phonemic, visual and motor properties in combination. Normal reading age matched controls showed no such advantage. Loveless & Blau (1980) using a smaller group of (U.S.) dyslexics aged 9-12 years found the same using a similar method.

The comparative studies of graphemic and semantic/contextual skills have not been as clear-cut in their findings. For example, Juel (1980) gave her subjects, (U.S. 2nd. and 3rd. graders) target words to read. These varied in decodability, (i.e., the text itself was degraded), frequency, and number of syllables; and appeared in isolation or in text of "poor" or "moderate" context. She found that the poor readers were comparatively reliant upon contextual information, and good readers upon the state of the text. Average readers fluctuated between the two strategies. Using a similar paradigm Simpson visual coding with a pre-existing phonological coding. Indeed, Hulme & Bradley (1984) have argued that it is an inability to combine phonemic and graphemic, and in addition, motor information which hampers many dyslexic children. They found that the best way of teaching new words was to demonstrate the words' phonemic, visual and motor properties in combination. Normal reading age matched controls showed no such advantage. Loveless & Blau (1980) using a smaller group of (U.S.) dyslexics aged 9-12 years found the same using a similar method.

The comparative studies of graphemic and semantic/contextual skills have not been as clear-cut in their findings. For example, Juel (1980) gave her subjects, (U.S. 2nd. and 3rd. graders) target words to read. These varied in decodability, (i.e., the text itself was degraded), frequency, and number of syllables; and appeared in isolation or in text of "poor" or "moderate" context. She found that the poor readers were comparatively reliant upon contextual information, and good readers upon the state of the text. Average readers fluctuated between the two strategies. Using a similar paradigm Simpson et al (1983) found that poor readers were more affected by degraded text, and were more reliant upon context, than good readers, (subjects were 3-6th. graders). For both groups, the contextual benefit was greater with degraded than with normal text.

Other researchers have not considered pairs of skills, but instead have looked at the role of single factors in reading style. For example, Au (1977) considered the oral reading errors of 2nd. grade Hawaiian readers. She found that good readers made more attempts to correct errors than poor readers. Also, good readers' errors tended to be more in context. Schlieper (1978) found similar results in comparing (U.S.) 1st. and 3rd. graders. Adopting a different approach, some researchers have measured the effect of cognitive style upon reading ability. For example, Fontes (1977) in a large-scale study of about 6,000 Irish schoolchildren, found that performance in problem-solving and mathematical tests was poorly correlated with reading performance. Again, Denney (1974) compared 40 normal and 40 poor readers from (U.S.) grades 2 to 5 on three cognitive style batteries, (conceptual styles;

matching familiar figures; and the Fruit Distraction tests). He found no consistent relationship between style and reading ability.

If we dovetail together the miscue analysis studies, which study the first school year, with the reading sub-style studies of the second year upwards just reported, then a curious pattern emerges. The miscue analysis studies show that in the first year, the child initially relies heavily upon contextual information, but becomes progressively more reliant upon graphemic cues. The other studies show that from the second year upwards, contextual information again becomes ascendant! These findings are not conflicting, as I hope to show. Reading is a multi-faceted skill, and we may suppose that we place stress on different sub-skills, depending upon the situation, (indeed, Carver (1977, 1983) has shown that adults do this). In the initial stages of reading, children's phonemic/graphemic skills are likely to be very poor, and hence their basic word attack skills will be similarly impoverished. Their richest source of information is likely to be context. Hence, the high initial rate of contextual errors. However, as the graphemic/phonemic skills improve, their ability to decode individual words should increase. Reading of words is probably now easier and faster by decoding than referring back through the passage to guess the word by contextual cues. Thus, the observed ascendancy of graphemic/phonemic processing. At the same stage, (Dodd would say immediately, Biemiller, later) this graphemic/phonemic processing becomes near-automatic, and/or words are read on sight. This in effect means that the attention the children previously had to direct towards phonemic processing can now be directed towards context. Evidence that children do come to read words effectively "by sight" has been recently furnished by Ehri & Wilke (1983). They assessed the RTs of subjects, (U.S. 1, 2 and 4th. graders) to read familiar and nonsense words, and digits. They argued that a child "sight read" when s/he named a word as quickly as a digit. A digit can only be read by its shape. If a word is read as quickly as this, then it is in effect being read as quickly <u>as if</u> it were a gestalt shape. Ehri & Wilke found that skilled readers of <u>all</u> grades, (but of the unskilled readers, only the 4th graders) read words as quickly as digits. This "sight reading" was probably based upon a phonemic skill, since the skilled 2nd. and 4th. grade readers could, (astonishingly) name nonsense CVC trigrams as quickly as digits. It is interesting to note that the level of reading skill, rather than the age of the subject determined reading speed. This is further evidence against the argument that good reading is dependent upon mental maturation.

To repeat, if graphemic/phonemic processing becomes so near-automatic, then the child is free to concentrate on contextual content. Hence the importance in older readers of contextual cues. This is a curious turn of events: initially contextual processing was dominant because of the impoverishment of phonemic/graphemic skills; now, it is because these skills are complete, and running at near-automaticity. This process of development probably continues up to adolescence, and thus is largely outside the scope of this thesis. Let us now turn to the question of the role of p.a. in these events.

To test p.a.'s relationship with reading sub-skills, the following study was carried out. As has already been discussed, p.a.'s most direct link with reading is probably through graphemic sensitivity. Dodd's test of ability to detect graphemic change was chosen to measure this type of graphemic skill, for two main reasons: (1) Alison Dodd was working in the Department at the time, and the test was in any case the only one readily available; and (2) it is a very elegant test design, and is easy and quick to administer. I was also interested in assessing Dodd's question as to whether the skill in performing her task lay in the "realisation of the importance of letter identity" or, "the ... ability to cope with an increasing number of letters." The effect of p.a. on this skill was to be assessed by comparing the performance of pa+ and pa- subjects who had been matched for reading ability and age.

However, although p.a. might have an effect upon graphemic processing, the effect upon reading style might be non-significant. To assess this, the same matched pairs of subjects used in the graphemic sensitivity study were used in a second experiment. This compared the reading styles, (as measured by miscue analysis) of the pa+ and pa- groups. Using the same subjects for both experiments enabled a direct comparison to be made between reading style and graphemic sensitivity.

Dodd's method of miscue analysis was chosen for this second experiment, partly because of availability, but largely because her system of measurement was easy and convenient to use.

Thus, the purpose of this investigation was to examine the differences in (a) the graphemic sensitivity, and (b) the reading style of groups of subjects with equally effective reading styles, which did or did not use p.a.

Method

Subjects.

The subjects were the entire reception classes of four infant schools in the north-west of England, and had been in school 1-1.5 terms when tested. All the children were native English speaking, and came from a roughly equal mixture of working- and middle-class homes. At the teachers' request, SES data on individual subjects were not recorded. All the schools used an eclectic reading teaching system. In total, about 150 subjects were tested, from whom 20 matched pairs were obtained. Subjects with assessed hearing/speech impediments were automatically excluded.

TABLE M - TARGET WORDS AND TRANSORMATIONS OF TARGET WORDS USED IN DODD's POSTING AND MATCHING TASKS

TARGET :	COW	HEN	MOUSE	DONKEY	ELEPHANT
MIDDLE DOUBLED:	COOW	HEEN	MOUOUSE	DONONKEY	ELEPHAPHANT
REVERSAL:	WOC	NEH	ESUOM	YEKNOD	TNAHPELE
MIDDLE MISSING:	CW	HN	MSE	DOEY	ELANT
END LETTER DIFFERENT:	COM COP	HEC HEP	MOUSN MOUST	DONKEG DONKEW	ELEPHANK ELEPHANS
INITIAL DIFFERENT:	MOW DOW	FEN CEN	COUSE BOUSE	LONKEY SONKEY	OLEPHANT BLEPHANT
INITIAL ONLY SAME:	CUM CUG	HUW HUK	MARIN MANTY	DISBUG DISCAR	EBOGFICK ECOSONIC
JUMBLED:	WCO OCW	NHE ENH	OSMUE SUMEO	DEGNOK KNODEY	PHENATLE PETHLANE

NOTES:

a. All transformations cue intentially non-words

b. The difference between the two words in the presence or absence of an ascender for the changed letter. The first word in each category has a form similar to the target, the second word the opposite.

Materials and procedure.

Six tests were used - the Carver Word Recognition Test, (Carver 1970); the two p.a. tests of my own devising; Dodd's word recognition test; Dodd's word matching test; and the miscue analysis. Details of the Carver and p.a. tests have been given above.

Dodd's word recognition test. The task for the child was to judge if various letter strings were the target word or not. Five target words were used - cow, hen, mouse, donkey, and elephant, ("hen" was substituted for "dog" which was used in Dodd's original experiment, because it was suspected that the subjects were reading "dog" as a "sight" word). There were 11 transformations of each target word, and these are listed in Table M). (The "jumbled" condition replaces a "transformation" condition in Dodd's experiment, which contained meaningless letter strings of the same length as the target). The eleven transformations of each word, plus five copies of each target word, were printed in lower case letters separately on 4 by 6" cards, giving fifteen test cards, and one example card for each target word. Each target was dealt with separately.

The test procedure was as follows. The 11 transformation cards were shuffled, and the 4 target cards folded into the pack, with the provisos that two or more were never inserted together, and a target card did not appear at the top or bottom of the pack. The example of the target, (the fifth card) was placed on top of the pack. A toy postbox, with a picture of the animal concerned, (e.g., if the target word was "cow", a picture of a cow was on the postbox) was put in front of the child. The child was told that it was his/her task to decide which cards were to be posted to the animal, and which were not. Only those cards with the animal's name on were to be posted; the reject cards were to be given to the experimenter. The example target card was given to the child, and s/he was told what it said. S/he was then told to look at the card very carefully, and then post it. The subject then worked through the pack of cards. S/he was not allowed to see the target after it had been posted. This was to impose a memory load upon the child in the hope "that the errors would show more clearly the elements of the word that the child was able to pay attention to", (Dodd,1982,p.62). This procedure was adopted for each of the five target words in turn. The order of presentation of the words was varied from subject to subject by using a latin square design.

Dodd's word matching task. The sets of 15 cards used in the posting task were again used in this test. The subject had to match the cards to a picture of the animal and the target word printed in larger letters than the cards, (to prevent direct matching by word length or size). The 15 cards were distributed as for the word posting task. The subject had to pick out all the cards which gave the animal's name like the bigger printed card. The example card was again used to give the child an idea of the task. In Dodd's task, the target card was then placed in view of the child above the picture. It was decided that this could lead to the child matching by direct visual comparison. Thus, in this experiment, the subject's choices were placed in two face-down piles. The same procedure was adopted for each of the five words. The order of presentation of these words was varied from subject to subject by a latin square design.

Reading style analysis. The measure used here is adapted from Dodd (1982) which in turn is adapted from Goodman & Burke (1972). Each subject read from his/her current reading book on 3 consecutive schooldays for the experimenter. Each child was heard to read at least 300 words over this period. This may seem to be a small amount, but it is, in fact, often the length of a whole early reading book. Given this proviso, reading was terminated when a suitable point had been reached in the story. Errors were recorded in pencil on an identical copy of the book the child was reading. Any deviation in the child's reading away from the presented text was recorded. These errors were marked and classified into the following types:

(*a*) *Substitutions*: where a word was misread. Marked by crossing out the word in the text, and writing the substituted word above it.

(*b*) *Insertions*: where a word is added to the text. Marked by entering a caret, (^) at the point of insertion, and writing the inserted word above it.

(*c*) *Omissions*: where a word is not read, or is partly read, but is then skipped over, with no discernable break in reading. Marked by crossing out the omitted word.

(d) Non-response: where a word is not read, or is partly read, and instead of "skipping over" it, the subject stops. Dodd's criteria for assessing this were used - i.s., a pause of at least 10 seconds, or a statement from the child to the effect that they did not know the word. The experimenter supplied the word, and the child was instructed to carry on reading. A non-response was marked by drawing brackets around the word.

Eccentric pronunciations, pauses and repetitions were not recorded. Except in the case of non-responses, the experimenter did not correct the child unless asked to by the child; or if the subject was constantly misreading a word; or if previous errors were leading to confusion. If the child made an error and then corrected him/herself, this was recorded as a self-correction, (marked by writing "s.c." above the word). These were fairly rare, and were not included in the analysis.

The substitution errors were further

classified into the following types:

(a) Those that were only contextually acceptable, and bore no graphemic similarity to the stimulus word, (e.g., reading "the white cat" for "the black cat").

(b) Those that were only graphemically acceptable, and made no contextual sense, (e.g., "the cat was blue" for "the cat was big"). A substitution was held to be graphemically similar if it began with the same letter as the stimulus word. This apparently crude measure was devised by Biemiller, who in justification cited Weber's (1970) finding that the first letter mistake was strongly associated with other similarities between the substitution and target words. Dodd has pointed out that Weber placed a strong weighting on initial letter correspondence in drawing up her similarity index. However, there are two points in favour of Biemiller's measure. The first is that it is simple, easy to use and unambiguous. The second is that it would seem to be a good measure. In this present study I out of interest also calculated the number of substitution errors which began/ended with the same sound and also the number which ended with the same grapheme. The difference between the scores registered by this more comprehensive measure and Biemiller's are negligable.

(c) Those that were contextually and graphemically acceptable, (e.g., "the brave boy" for "the big boy").

(d) Those errors which were neither graphemically nor contextually acceptable, (e.g., "the pink rhinocerous" for "the grey rhinocerous").

Design

All subjects were tested individually. An assistant first tested the subjects on the Carver and p.a. tests. Subjects were judged as not having p.a. if they scored zero on all sections of both tests. Subjects were held to have p.a. if they scored above zero on an alliteration and a rhyme section of at least one of the two tests, (in fact, all subjects scored on every section of the two tests, with the exception of two, who failed the output rhyme task). Subjects were then matched, (one with p.a., one without) on the basis of their Carver scores, (subjects had to score within two points of each other). Fortunately, these initial pairings also matched very well for chronological age, so no further "manouevering" was required. Pairs were always drawn from the same school, to control for different environmental experiences. Twenty pairs were drawn from 150 pupils of 4 schools, (1 school provided 6 pairs, another provided 4, whilst the other 2 provided 5 each). Limitations of time prevented testing in more schools.

The matched pairs were then tested by myself within a week of their pairing. The children were blind tested to avoid possible biasing effects in the reading style analysis. The subjects were tested on four consecutive schooldays, and one day one week later. The first three days were spent on the reading style analysis, and the fourth on the posting task. A week later, they were tested on the matching task. Dodd's tasks always followed the reading style analysis, because it was felt, (correctly as it transpired) that they might prove to be an accurate pointer to possession/non-possession of p.a. Thus, experimenter bias might have been introduced had the order of testing been varied.

Scoring

Scoring on the Carver and p.a. tests was as detailed before. One point was given for each error on the reading style analysis. Each error on Dodd's posting and matching tasks was also given one point. In order to compensate for there being two letter strings for some transformations but not for others, scores for the "single letter string" transformations, (middle doubled, reversal and middle missing) were doubled.

Results

Pairing of subjects. The mean ages of the two groups, (in months) were; pa+, 66.0 (S.D.=2.57); pa-, 66.1 (S.D.=2.38). As far as possible, subjects were paired by sex. There were 9 all-male, 6 all-female, and 5 mixed pairs. The mean scores of the pa+ subjects on the four p.a. sub-tests were; input rhyme, 17.55 (S.D.=2.5); input alliteration, 17.55 (S.D.=1.85); output rhyme, 4.11 (S.D.=0.87); output alliteration, 4.6 (S.D.=0.63). The pa- subjects did, of course, score zero on all these tests. The mean Carver scores of the two groups were; pa+, 17.4 (S.D.=7.76); pa-, 16.4 (S.D.=8.02). This

Scoring

Scoring on the Carver and p.a. tests was as detailed before. One point was given for each error on the reading style analysis. Each error on Dodd's posting and matching tasks was also given one point. In order to compensate for there being two letter strings for some transformations but not for others, scores for the "single letter string" transformations, (middle doubled, reversal and middle missing) were doubled.

Results

Pairing of subjects. The mean ages of the two groups, (in months) were; pa+, 66.0 (S.D.=2.57); pa-, 66.1 (S.D.=2.38). As far as possible, subjects were paired by sex. There were 9 all-male, 6 all-female, and 5 mixed pairs. The mean scores of the pa+ subjects on the four p.a. sub-tests were; input rhyme, 17.55 (S.D.=2.5); input alliteration, 17.55 (S.D.=1.85); output rhyme, 4.11 (S.D.=0.87); output alliteration, 4.6 (S.D.=0.63). The pa- subjects did, of course, score zero on all these tests. The mean Carver scores of the two groups were; pa+, 17.4 (S.D.=7.76); pa-, 16.4 (S.D.=8.02). This

TABLE N(i) - MEAN NUMBER OF NON-TARGETS INCORRECTLY POSTED AND MATCHED BY Pa+ and Pa- GROUPS (WITH STANDARD DEVIATIONS*, CLASSIFIED BY TYPE OF TRANSFORMATION **

		Middle Doubled	Reversal	Middle Missing	End Different	Initial Different	Initial Only Same	Jumbled
POSTING TASK (Error scores/10)	Pa+	1.45 (1.27)	0.75 (1.06)	0.45 (1.09)	1.1 (1.14)	0.17 (0.4)	0.5 (0.93)	0.5 (0.45)
	Pa-	2.55 (1.39)	2.45 (2.03)	1.25 (1.4)	2.4 (1.63)	1.4 (1.5)	1.6 (1.69)	2.22 (1.72)
MATCHING TASK (Error scores/10)	Pa+	1.2 (1.05)	0.45 (0.68)	0.05 (0.22)	0.65 (0.77)	0.15 (0.28)	0.05 (0.15)	0.2 (0.37)
	Pa-	1.7 (1.41)	1.17 (1.16)	0.5 (0.94)	1.05 (0.93)	0.7 (0.75)	0.42 (0.63)	0.62 (0.87)

* In brackets
** See text

TABLE N(ii) - MEAN NUMBER OF NON-TARGETS INCORRECTLY POSTED OR MATCHED BY Pa+ AND Pa- GROUPS, WITH STANDARD DEVIATIONS* CLASSIFIED BY ANIMAL NAME**

		COW	HEN	MOUSE	DONKEY	ELEPHANT
POSTING TASK (Error scores/11)	Pa+	0.6 (1.14)	0.7 (0.95)	0.95 (1.08)	1.42 (1.37)	1.25 (0.8)
	Pa-	2.82 (2.22)	2.42 (2.15)	2.52 (1.8)	3.12 (2.41)	3.07 (3.07)
MATCHING TASK (Error scores/11)	Pa+	0.35 (0.58)	0.12 (0.39)	0.72 (0.73)	0.72 (0.73)	0.82 (0.69)
	Pa-	1.12 (1.56)	0.75 (1.16)	1.25 (1.29)	1.43 (1.41)	1.82 (1.43)

* In brackets
** See text

difference was not significant, (paired t test; $t(19)=0.98$, $p>.05$).* In addition, teacher ratings of reading ability were obtained on a scale of 1 to 5, (1=well below average; 2=below average; 3=average; 4=above average; 5=well above average). Pa+ subjects had a mean rating of 3.43, compared with the pa- subjects' 2.83. This was not a significant difference, (paired t test; $t(19)=1.98$, $p>.05$).

Posting and matching tasks. The mean number of non-targets incorrectly posted and matched by the two groups are shown in Table N. A three way ANOVA of the posting task, with factors; group, animal names, and error type, showed highly significant effects of all three factors. There was also a significant name-error type interaction. However, there was no significant interaction between group and error type and/or animal name, (see Table O). This absence of a group interaction suggests that the pa+ and pa- subjects were using the same strategy to perform

*According to the Carver scoring tables, these scores give the subjects a reading age of 4:3-4:6. However, Carver's test has not been standardised on this age group. The test was standardised on a group of 7+ year olds, and "reading ages" below this were calculated by extrapolating a straight line back from the test sample's results, (Carver,1970).

TABLE O - 3-WAY ANOVA RESULTS WITH FACTORS POSSESSION/NON-POSSESSION OF P.A., TYPE OF TRANSFORMATION AND ANIMAL NAME, FOR POSTING AND MATCHING TASKS

	Source of Variance	d.f.	m.s.	F	P
POSTING	pa+/pa- ("A")	1	99.9	13.99	.0006
	animal ("B")	4	2.12	5.26	.0005
	A x B	4	0.40	0.98	.4188
	transformation ("C")	6	6.18	12.13	<.0001
	A x C	6	0.91	1.78	.1042
	B x C	24	0.78	2.27	.0005
	A x B x C	24	0.44	1.29	.1612
MATCHING	pa+/pa- ("A")	1	14.2	7.21	.0107
	animal ("B")	4	2.21	6.92	<.0001
	A x B	4	0.17	0.52	.7237
	transformation ("C")	6	5.17	17.18	<.0001
	A x C	6	0.23	0.76	.6051
	B x C	24	1.27	4.62	.0001
	A x B x C	24	0.31	1.13	.3001

the task, but that the p.a.-possessors were far more adept at using it. The patterning of errors was equivalent to that found by Dodd. That is, the longer words were harder than the shorter ones, and reversal errors were especially prevelent in the shorter words. The same pattern of results was found in a three-way ANOVA of the matching task, (see Table O). Note, however, that the F of the group difference is reduced in the matching task, (from 13.99 in the posting task to 7.21). This suggests that part of the group difference may be due to a mnemonic factor. A small number of errors occurred with targets which were not posted/matched. The pattern of these results was very similar to that of the non-target errors, but their frequency was too low to permit statistical analysis.

The mean errors, collapsed across groups, were for the posting task, 17.33, and for the matching task 7.15. The subjects were tested towards the end of the spring term. The results are roughly comparable to Dodd's subjects' at their second test session in the summer term of their first year, (17.2 and 7.1 respectively). Overall, there would seem to be a high degree of

TABLE P - MEAN ERROR SCORES OF Pa+ and Pa- GROUPS IN MISCUE ANALYSIS, WITH STANDARD DEVIATIONS *

	MEAN NO. WORDS READ	SUBSTITUTION	INSERTION	OMMISSION	NON-RESPONSE
Pa+	426 (17.8)	19.25 (6.75)	2.35 (2.92)	4.1 (7.07)	5.4 (4.22)
Pa-	394 (21.4)	29.75 (14.25)	2.9 (4.01)	3.6 (6.81)	9.95 (9.38)

* In brackets

TABLE P - MEAN ERROR SCORES OF Pa+ and Pa- GROUPS IN MISCUE ANALYSIS, WITH STANDARD DEVIATIONS *

	MEAN NO. WORDS READ	SUBSTITUTION	INSERTION	OMMISSION	NON-RESPONSE
Pa+	426 (17.8)	19.25 (6.75)	2.35 (2.92)	4.1 (7.07)	5.4 (4.22)
Pa-	394 (21.4)	29.75 (14.25)	2.9 (4.01)	3.6 (6.81)	9.95 (9.38)

* In brackets

TABLE Q - MEAN NUMBER OF SUB-TYPES OF SUBSTITUTION ERROR BY Pa+ and Pa- GROUPS WITH STANDARD DEVIATIONS*

	Total No. Substitution Miscues	Pure Graphemic	Pure Semantic	Graphemic & Semantic	Nonsense
Pa+	19.25 (6.75)	5.5 (3.17)	4.4 (2.41)	4.85 (3.73)	4.5 (3.01)
Pa-	29.75 (14.25)	6.6 (5.54)	10.3 (7.63)	5.05 (5.18)	8.3 (4.21)

* In brackets.

consistency between Dodd's and this study's findings.

<u>Reading style analysis</u>. The mean numbers of words read by the two groups were; pa+, 426 (S.D.=17.8); pa-, 394 (S.D.=21.4). This difference was not significant, (paired t test; $t(19)=0.01$, $p=0.33$). The mean error scores are shown in Table P. The results were subjected to a 2-way ANOVA, the factors being group and error type. The analysis found a significant group ($F(1,19)=10.66$, $p<.01$)); error type ($F(3,19)=66.23$, $p<.001$); and interaction effects ($F(1,57)=4.05$, $p<.01$). Thus, the pa+ group were not only superior to the pa- group, but also appeared to be adopting a different reading style. Attention was then turned to the substitution errors. There was no significant group difference in the ratio of substitution to total errors, (paired t test; $t(19)=0.42$; $p>.05$). However, there is a significant group difference in the distribution of <u>types</u> of substitution errors, (see Table Q). A two way ANOVA of these results found a significant group difference ($F(3,19)=10.04$, $p<.01$) but no significant difference between error types, ($F(3,19)=2.09$, $p>.05$). However, there was a

significant group-error type interaction, (F(3,57)=3.6, p<.025).

Thus, as for the Dodd tasks, pa+ subjects exhibited superior performance to pa- subjects. However, unlike the Dodd task, there are interactions. Hence the group difference is probably attributable to the two groups employing different reading styles.

Discussion.

Posting and matching tasks. It will be recalled that Dodd asked if ability at these tasks reflected "realisation of the importance of letter identity" or the, "ability to cope with an increasing number of letters". The results of this study indicate that p.a., and hence the realisation of what graphemes represent, is important in improving ability at this task. However, the absence of an interaction suggests that pa+ and pa- subjects are attending to the same aspects of word structure.

What aspect of word structure are the subjects attending to? One possibility is that the subjects judge the words by what they sound like read out loud. However, this seems highly unlikely because all the non-targets very obviously "don't sound right" when read out loud, or are unpronouncable. Neither can the children be attending purely to the visual shape of the words, since although in the longer words the most visually similar transformations are the hardest to detect, in the shorter words the visually dissimilar "reversals" are the most difficult to spot. Thus, the subjects are not adopting a simple phonemic or visual strategy.

The next most parsimonious explanation is that the subjects look for transformations in individual letters. If subjects are making a letter-by-letter search, then logically, the longer the word, the greater the probability they will miss an alteration. Hence, the observed increased number of errors with word length. However, why the reversal errors in the shorter words? Dodd argues that they reflect a failure to always read from left to right. This might be aided by two factors. (1) Most short words spelt backwards are still pronounceable. (2) In scanning a word letter by letter, the child may scan the word "backwards" as well as "forwards". Scanning backwards, s/he might temporarily forget the left to right rule, and identify the reversal non-target as the target. The probability of this happening is greater in short than long words, since in backwards reading a long word, the child has greater time in which to realise his/her mistake. We saw in the Introduction that in learning to read, the child encounters for possibly the first time items, (words) which can only be correctly interpreted in one orientation. Possibly it is the conflict between his/her established perceptual "rules" and the newly-acquired left-to-right rule which causes the reversal errors. The teaching of the left-to-right rule has long been a concern of educationalists, yet has remained largely unconsidered by psychologists. The results of this and Dodd's study indicate that it may be a fruitful area of research.

How might the effect of p.a. be explained by this letter search theory? It was argued in the Introduction that graphemes are largely meaningless without an awareness of the phonemes they represent. Thus, the acquisition of p.a. should cause the child to become aware of the purpose of graphemic structure. From this, it follows that s/he should also realise the importance of graphemic structure. This could have three effects. (1) Pa+ subjects should realise that any alteration of graphemic structure alters the word, and thus be vigilant in searching for changes. Pa- subjects, lacking this realisation, should be more lax. (2) The pa+ subjects are probably more used to using graphemic cues in reading, and therefore are more familiar with letter-by-letter processing than pa- subjects. (3) It is possible that pa- subjects might detect a graphemic change, but, because they do not realise its importance, accept the changed word as a close enough resemblance to the target and classify it as such. There is some evidence for this from the verbal protocols of the pa- subjects. Some of them made utterances such as, "this will do", or, "it's near enough" when posting/matching a non-target.

It would seem from this that whilst pa- subjects can examine words letter by letter, their criterion for word identity is not the grapheme. Thus, an effect of the acquisition of p.a. is to make word identification more stringent. In time, this added stringency should create a more accurate word recognition process.

Two qualifications need to be made to these conclusions. (1) The target words were all new or unfamiliar to all or most of the subjects. This was intentional: we were interested in seeing what would happen when the children were forced to read on a letter by letter basis. It would be interesting to see what would happen if the children were given familiar words which they could read "by sight". If the pa+ and pa- groups both read by sight, would their overall error scores be the same? Again, would performance improve on familiar words? These questions can only be answered empirically. (2) All the subjects in the present study had been taught eclectically, and had thus received training in reading letter by letter. How this performance would be altered in a completely whole word or phonics group remains to be seen.

The acquisition of p.a. seems to result in a general increase in sensitivity to graphemic structure. The decreased F ratio for group difference from the posting to the matching task possibly indicates that the acquisition of p.a. also results in a mnemonic change*. Since the posting task is harder than the matching task the difference in F ratios might arise from differences in test sensitivity or ceiling effects. However, the "memory" explanation fits more plausibly in line with the evidence to be presented in Experiment 4. Further discussion of p.a.'s role in memory will be made then. All we can say as yet is that p.a. seems to cause a general improvement in memory of graphemic structure.

We have seen from this section of the experiment that p.a. can very strongly affect sensitivity to graphemic structure. The manner in which it does this seems to involve increasing awareness of the importance of letters. Certainly this is very effective. The mean error rates for the pa+ group were 4.92/55 for the posting, and 2.73/55 for the matching task, (compared with the pa- groups' figures of 13.95 and 6.37 respectively). The acquisition of p.a. seems to cause a change in the criterion of what makes a word a correct spelling. Pa- subjects seem to accept a criterion of "it looks near enough the same". Pa+ subjects realise the importance of exact spelling. The implications of this changed awareness are considerable. Spelling should obviously benefit from this newly-acquired knowledge. If the child realises that every letter of a word has to be correct, then s/he will try for greater accuracy. Reading too should benefit. The child should make fewer errors if his/her judgement of word identity is based upon precise spelling rather than what the word "looks like". This will have a "domino" effect. If the child's word identification strategy gets more efficient, then s/he will read more fluently. If s/he does this, then his/her extraction of meaning will improve. If this improves, then the reader will have more contextual cues at his/her disposal to speed up word recognition, etc, etc. Thus, the effect of the acquisition of p.a. may spread beyond its initial bounds. There is support for this argument from the findings of Experiments 1 and 2 of this thesis, which showed that p.a. is strongly correlated with reading ability.

Reading style analysis. Given the possible "diluting" of p.a.'s influence in "normal" reading described above, the finding of a group difference in miscues of 8 versus 13% is considerable. (It should be stressed that many of these errors were not "serious" - i.e., normally demanding correction). We shall look briefly at each miscue type, before attempting to create an overall picture of p.a.'s effect upon reading style.

The groups showed little difference in the number of insertion miscues made. It may be suspected that they reflect the loquaciousness of the subject, rather than a reading-specific trait. Nearly all the insertions made contextual sense and probably represented a desire to inject some zest into the story, (it often needed it). Dodd found insertion errors to be prevelant only in initial reading, and attributed them to a desire to "tell a story", coupled with an incomplete concept that printed words tell all of the story, (c.f., Ehri, 1979). There was also little difference between groups in the omission miscues. The slightly higher pa+ group's score may be a side effect of faster reading.

More substantial is the group difference in N-R miscues, which is statistically significant, (t test; $t(19)=2.10$, $p<.05$). Two explanations for the pa- group's larger number of errors spring to mind. (1) That they were unable to make use of the contextual information to have a guess at a word's identity. This is highly unlikely, given the evidence discussed above showing that beginning reading is characterised by use of contextual cues. (2) That pa- subjects could not use graphemic/phonemic cues to "build up" a word, and thus gave up. This may partially explain the N-R miscues. Certainly pa- subjects seem to "build up" fewer words than pa+ subjects. Out of curiosity, I noted down subjects' attempts to verbally build up words. I found that 16/20 pa+ subjects built up, compared with 6/20 pa- subjects. If only attempts to build up words encountered for the first time on a reading scheme, (ascertained using the teacher's handbook; though note we cannot know if the subjects have read the words before in other books) are taken, then the figures are, pa+, 11; pa-, 1. This is not a foolproof measure. Some "building up" could represent false starts of pronunciation, whilst other children may build up silently. Nonetheless, it may be a useful general guide. It is reasonable to assume that some of the N-R errors may be due to a failure to utilise graphemic/phonemic skills. However, this cannot be the complete explanation, or we would expect pa+ subjects' N-R errors not just to be lower than pa- subjects', but virtually non-existent. The most prosaic explanation is that a N-R miscue is due to the child being unable to read the word by any method at his/her disposal. Pa+ readers make fewer N-R miscues simply because they have more skills.

No evidence was found for Biemiller's N-R phase, (i.e., a child with over 50% N-R miscues) though given that the children were only seen at one point in time, this may not be surprising. However, Biemiller's explanation that N-R is due to a "combat" between graphemic and contextual cues seems unlikely given the evidence presented here. As we have seen, the rise in graphemic skills with p.a. produces a fall, not a rise in N-R miscues.

As we saw above, there is no group difference in the proportion of gross substitution miscues, but there is a significant difference in the distribution of sub-types. If we consult Table P, then we can see that the pa+ subjects' miscues are roughly equally distributed across the four sub-types, whilst the pa- errors are more unequally distributed. Perhaps the easiest way to interpret these results is to divide the substitution miscues into those with some graphemic content, (the pure graphemic and the graphemic and semantic) and those with none, (the pure semantic and meaningless). By this reckoning, the pa+ miscues are 54% graphemic, 46% non-graphemic, and the pa- are 39% graphemic, 61% non-graphemic. The pa- subjects' results seem to reflect their lack of graphemic skills. We have already seen that they lack sensitivity to graphemic change in novel words. We now have evidence that they pay less attention to graphemic structure in normal reading than pa+ subjects. Although the acquisition of p.a. brings with it a shift in graphemic processing, it is interesting to note that the change is not to a reading style totally dominated by it; 50% of pa+ substitutions are non-graphemic. Effects of p.a. may be limited in at least three ways: (1) The pa+ subjects' knowledge of, and ability to utilise, graphemic/phonemic information is not, of course, made perfect by their acquisition of p.a., and they still have to learn the seemingly myriad number of irregular spellings. (2) Although a child has p.a., that does not mean that s/he will use it, (see Introduction). The pa+ subjects tested here had probably only possessed p.a. for a short while. They possibly had not acquired the habit of always using it in everyday reading, and thus occasionally read words without attention to phonemic/graphemic structure. Hence, some of the observed non-graphemic miscues. (3) It is possible that the children were failing to co-ordinate separate cues, and were judging word identity by individual cues. That is, the children might read some words by what the context dictated, disregarding the graphemic cues, and vice versa. This failure to integrate accords with Biemiller's and Dodd's observations of early reading.

General Discussion.

The reading style analysis clearly shows a superior performance by the pa+ subjects, which seems to be derived from better graphemic processing. The groups showed virtually no difference in the "neutral" insertion and omission miscues. That p.a. should influence graphemic processing is of course what we have argued throughout. The results clearly indicate that the group differences in the posting and matching tasks were not task specific, but generalize to normal reading. But the influence of p.a. is not just confined to a general sharpening up of graphemic skills; there are signs from this study that it has an effect upon other aspects of reading performance. Most clearly, we can see that pa+ subjects had a lower miscue rate. This was due to superior graphemic skills, as we have seen. However, note that the pa+ subjects also made fewer errors which failed to convey any meaning - that is, N-R and meaningless substitution miscues. Thus, even when misreading, they were less likely to disrupt the "flow" of the story. Furthermore, the fact that they seemed able to process novel words better, should enable pa+ readers to assimilate new words into their vocabularies more easily. This should result in swifter processing of text. Furthermore, if the child can develop the skill of building up new words for him/herself, then s/he should spend more time reading to him/herself, and less time queuing to see the teacher for the meaning of a new word. At the risk of being repetitive, the acquisition of p.a. means that lack of awareness of graphemic/phonemic structure is no longer a problem. The child has another skill to use in reading, to back up his/her existing skills.

The above advantages of p.a. are likely to be felt by all subjects no matter what age they acquire it. However, as we have seen in the longitudinal study, the strength of the advantage depends upon the age of acquisition. How can we explain this? We argued in the longitudinal study that the difference was due to one of "cataloguing" of reading vocabulary. From the present evidence, it would seem that the effect is exacerbated by the pa- readers also having a generally poorer reading style. Their less effective ability to process text can only further retard them.

It thus appears that p.a. plays an important role in graphemic processing, which in turn influences general reading style. However, it should be remembered that to all intent and purposes, the pa+ and pa- groups were matched for reading ability by an established reading test and also by teacher ratings. The effects we have observed do not lead to glaringly obvious differences from a casual observation of reading performance. The point to be made here is that although the two groups are ostensibly the same now, in time, the difference in group performance will probably become very apparent. The results of the longitudinal study show very clearly the effects of early acquisition of p.a. It should be noted that many of the pa- subjects made graphemic substitution miscues and built up words. Thus, they must have been employing some kind of graphemic strategy. However, whatever strategy was employed, it was one without insight into phonemic structure. This implies that the behaviour of the pa- readers was in effect being performed by rote. Such findings as this question the usefulness of teaching word attack skills to beginning readers without first ensuring that they know why they are being done. Judging "elephank" to be "near enough" hardly bodes well for phonics teaching.

This study has uncovered several new facets to p.a. We have seen that it greatly improves graphemic sensitivity, both in letter-by-letter searches of isolated novel words, and in the graphemic processing of "normal" text. We have seen how this in turn, leads to pa+ subjects having a better reading style than pa- subjects. This difference is not only confined to graphemic processing, but also probably generally improves reading. Though these differences are not apparent upon a casual observation, they probably are the first indicators of the much more apparent differences which we have already observed in the longitudinal and p.a.-p.s. studies. The main purpose of this study has been to show not that p.a. is important for reading, (which we have already shown) but <u>how</u> it is important.

3.4 The phonemic confusability effect in short-term serial recall.

Introduction.

Many researchers have observed that young poor readers have inferior short-term recall, especially of verbal material, (e.g., Katz et al, 1981; Mann et al, 1980; Moore et al, 1982; Spring & Perry, 1983). This effect remains after matching reading retardates and normal readers for chronological age and intelligence, (cf, Jorm, 1983c). Studies have concentrated particularly upon the recall of phonologically confusing material. For example, suppose the subjects are given a serial recall task in which the items are either similar-sounding words, (paronyms*) or dissimilar-sounding words, (non-paronyms). Good readers' recall of both list types is superior to poor readers. However, whilst the poor readers show no difference in recall between list types, the good readers find the paronymous list comparatively harder to recall. This "phonemic confusability effect", ("p.c.e.") has been shown

*Researchers have frequently erroneously classified these words as "homophones". Homophones are words such as "sole" and "soul", which sound the same, but have different meanings.

by several researchers, (e.g.; Byrne & Shea, 1979; Mark et al, 1980; Shankweiler et al, 1979). The difference in the strength of the p.c.e. between good and poor readers is probably confined to young readers. Hall et al (1981), for example, have shown that adult dyslexics show the p.c.e. to the same degree as matched normal readers aged 8-9 years.

Thus, the p.c.e. discriminates between good and poor young readers. However, is this effect due to a failure of memory or of phonological encoding? Jorm, (1983b; 1983c) in two very lengthy reviews of the literature, concluded that there is no consistent evidence for poor readers suffering from STM deficits in anything but phonologically-encodable items. Further evidence for the deficit being one of phonological encoding comes from the finding that the p.c.e. is not confined to STM. For example, Byrne & Shea(1979) found a p.c.e. in a continuous recognition task. Similarly, Mark et al (1980) found the effect when the subjects were given a recognition task, (without warning) on a list of words they had just read. Both these tasks stretch beyond the bounds of short-term/"working" memory, both in terms of interval between first encountering an item and being asked to recall it, and in terms of workload, which greatly exceeds the theoretical limit of the articulatory loop, (cf, Baddeley & Hitch, 1974; Jorm, 1983c). The p.c.e. is thus not peculiar to one type of memory. Jorm concluded that, "It seems likely that the results of these studies reflect the availability of phonological codes in long-term memory."(Jorm, 1983c; p 319). This conclusion ties in well with the oft-repeated observation made in this thesis that a principal deficit of retarded young readers is lack of a phonological strategy. If the p.c.e. is attributable to level of phonic skill, then it should also follow a developmental trend. That is, the young children, who show fewer phonic skills, should have a lower p.c.e. than older children. This has been found to be the case, (e.g., Conrad, 1972; Halliday & Hitch, in preparation).

If the p.c.e. is assumed to be due to phonic processing, then what is the phonological strategy involved? As we have seen, phonic skills can be broadly divided into phonemic sensitivity and p.a. Phonemic sensitivity is unlikely to be responsible for the p.c.e. since most 4-5 year old children show a reasonable degree of p.s. at an age when they show no p.c.e. Perhaps, however, the p.c.e. may be related to the acquisition of p.a. This seems plausible for a number of reasons. The earliest age at which the p.c.e. has been observed is 5 years; this, as we have seen, is the age at which most children begin to acquire p.a. However, the link cannot be a simple equation of "pa+ = p.c.e., pa- = no p.c.e.". As has been seen, the p.c.e. is lacking in some children above the age of 7 years. Yet we have seen that every child so far tested has displayed p.a. by 7 years of age. In order to link p.a. with the p.c.e. we will have to introduce a new argument: viz, that although p.a. can be displayed by all readers after 7 years of age, they do not all <u>use</u> it to the same degree. We have already seen from the reading style studies that poor readers are less adept at utilising phonemic information than good readers. Why should this not also apply to the use of p.a.? Again, we have seen from Byrne & Ledez's (1983) paper that dyslexic adults, whilst all presumably having p.a., were less <u>efficient</u> at using it than normal readers. Thus, for successful reading, the subject might not only have to acquire p.a., but also learn to use it efficiently, (see

Introduction). Hence, it would appear that post-7 year old subjects who fail to display the p.c.e. might do so, not through lack of p.a., but through failure to use it efficiently. If this is so, then there is a still a plausible case for p.a. influencing the p.c.e.

Having determined that the acquisition of p.a. and the appearance of the p.c.e. might be related to one another, let us now examine how p.a. might influence the p.c.e. The following suggestion, I stress, is tentative. P.a. gives the subject insight into phonic structure. Let us assume that this insight is used by the subject to organise in some manner his/her internal "lexicon", (the precise nature of this need not concern us). This organisation of the lexicon by phonemic structure enables the subject to classify words by their phonemic characteristics, something which a pa- store cannot do, (presumably it stores by syllabic or morphemic structure). If this is so, then we can make two predictions: (a) Pa-subjects should not display the p.c.e. Since they do not make use of phonological features in storage, they should not be confused by phonological similarities. (b) Subjects with only "alliteration p.a." should display the p.c.e. on alliterating lists of words, but not rhyming lists. Since they can only identify the phonemes at the start of words, they should not be confused by similarities at the end of words.

These arguments are based upon a great deal of conjecture, and very little hard evidence. It was thus decided to perform an experiment to test these assumptions. That is, if at a broad level, a phonological skill correlated with the p.c.e., (as Jorm and others have conjectured, but have never tested). And also, if p.a. is specifically related to the p.c.e. If so, then it should fulfill the predictions outlined above. The experimental method chosen was the standard memory span procedure. Subjects were asked to repeat word lists of increasing length until the maximum list length was found. Two sets of lists were used. Conrad's (1972) lists of paronyms and non-paronyms were used to provide reference to other experiments taking place in the Department at that time. The second list was comprised of separate lists of rhyming, alliterating, and non-paronymous lists of my own devising. This was partly to assess the prediction that "partial p.a." subjects would only show the p.c.e. on alliterating lists, but I was also interested in seeing if the source of the similarity in paronymous lists affected recall in general, (previous researchers had not addressed this problem). It was decided to use a "normal" cross-section of 5 year olds as subjects. This had been found to be the age at which the greatest variety of p.a. skills was shown. Subjects were also given the EPVT test of verbal intelligence.

Method.

Subjects.

The subjects were the entire middle year of an infant school, (mean age 5:5 yrs). 45 children, (20 girls, 25 boys) were tested. A further three subjects dropped out through ill health. The children came from two school classes, (they were assigned to them by age). All were native English speakers from English-speaking homes. The school's catchment area was a mixture of working- and middle class homes. At the request of the teaching staff, detailed SES data were not collected.

TABLE R - WORD LISTS USED IN R.A. AND CONRAD TASKS

R.A.

	1.	bee, key, knee, sea, tea, we
RHYME	2.	kill, mill, will, hill, till, pill
	3.	not, lot, hot, dot, pot, cot
	1.	seed, seal, seem, seat, sea, seek
ALLITERATION	2.	hit, hill, hid, him, his, hip
	3.	gave, gale, game, gate, gay, gaze
	1.	nod, big, has, man, let, sip
CONTROL	2.	sit, top, ham, red, pig, fly
	3.	wet, pea, hid, can, fill, leg

CONRAD

SIMILAR	hat, bat, man, tap, rat, bag, cat, mat
CONTROL	bus, train, horse, fish, span, hand, girl, clock

Materials and Procedure

Rhyme and alliteration task For the sake of convenience, this shall be termed the RA task. The subject was tested on his/her recall of rhyming, alliterating and control, (non-paronymous) words. There were three lists of each word type, and these are shown in Table R. The lists were composed of words likely to be known to the child, and an attempt was made, (using the Thorndike-Lorge list) to match the mean frequencies of the lists of each word type. Taking "A" words as having a nominal frequency of 50/million, and "AA" words of being 100/million, then the mean frequencies of the three word type lists were, rhyme, 72.6 (per million); alliteration, 73.4; control, 71.8.

The order of presentation of the three word types was decided using a latin square design, as was the order of presentation of the three lists of each type. Words from each list were presented randomly. Each word was written on a separate playing card, and the cards comprising one list were shuffled together. The required number of cards were then drawn from this pack and read, at a rate of approximately one per second, (the experimenter practiced reading the words at this speed). The subject was tested on his/her recall of all the word lists, the lists comprising each group always being presented together. Recall of each list was tested as follows. The subject was first asked to repeat each item of the list singly as it was read to him/her. This was to ensure that there were no errors of mispronunciation,etc. Then, the subject was read two words from the list and asked to repeat them in sequence. S/he was then asked to repeat another two word sequence, (the cards were shuffled between each questioning). The child was then asked to repeat two three word sequences, etc. Testing on a particular list stopped when the subject incorrectly repeated two lists of the same length. His/her memory span was then scored as being the terminal length minus 1. For example, if a subject failed both four word sequences on a particular list, then his/her memory span for that list was counted as being three. This procedure was repeated for each list. The subject was allowed a slight rest between lists of each word type, and was given 3-4 minutes rest between word types, to avoid possible interference. The recall task in general was introduced to the child by his/her being asked to recall two digit strings. .

<u>The Conrad recall task</u>

- two lists of words, one paronymous and one non-paronymous, were used. These are shown in Table R. The procedure was the same as for the RA task described above, except that in this instance, the subjects were tested on their recall of the each list three times.

<u>The EPVT</u>

- the material is a book of simple line drawings. Each page of the manual contains four of these. The subject's task is to point to the picture which represents the word spoken by the experimenter. Three practice examples are given. The testing session is terminated when the subject makes five incorrect responses within eight consecutive pages.

<u>The p.a. tests</u> These have already been described above.

<u>Design</u>

Because of potential experimenter biasing effects, the order of testing was always the same. Each subject was tested individually. The first test session was of recall of the rhyming,alliterating and control word lists. A week later, the subject was assessed for his/her level of p.a., and then his/her recall of the Conrad word lists was tested. Approximately 2 weeks later, s/he was administered the English Picture Vocabulary Test, (E.P.V.T.). It was felt that it would be much easier for the experimenter to retain knowledge of p.a. test performance than of memory test performance, and thus the memory test was administered first to avoid experimenter bias. The Conrad test was being administered as a checking measure, and an additional test session solely for its administration was not available. Consequently, the results from the Conrad test might be contaminated by some experimenter bias. It was felt that the EPVT scores might act as a biasing factor if the test was administered at any time before the other tests, and thus it was left until last. The procedure involved leaves little scope for experimenter bias.

Scoring

For the RA and Conrad tests, the mean of the three scores for each of the word types was taken. The raw EPVT scores, (i.e., the total number of

TEST SCORE

	12	13	14	15	16	17	18	19	20
n	1	0	0	0	2	4	6	5	8

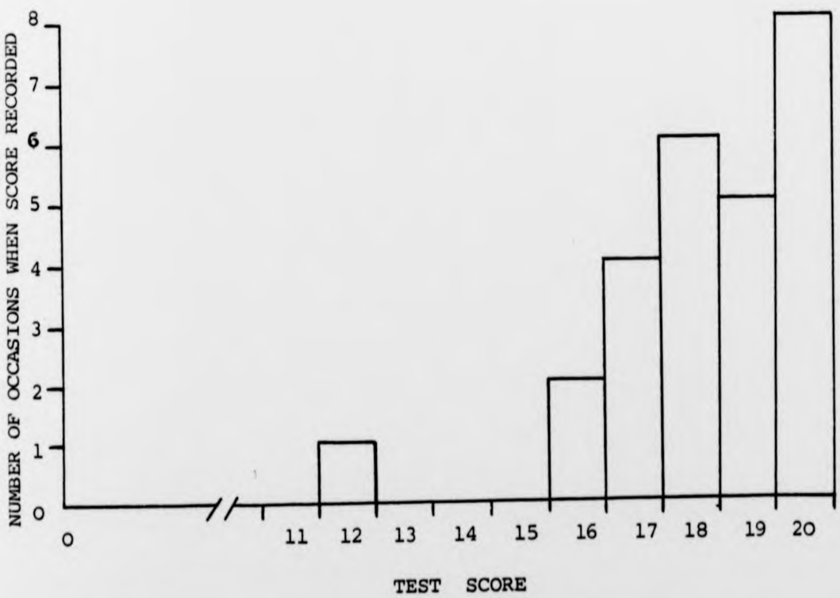


FIG.4.(i) DISTRIBUTION OF INPUT ALLITERATION SCORES OF SUBJECTS IN MEMORY STUDY

TEST SCORE

	14	15	16	17	18	19	20
n	3	1	1	4	6	2	1

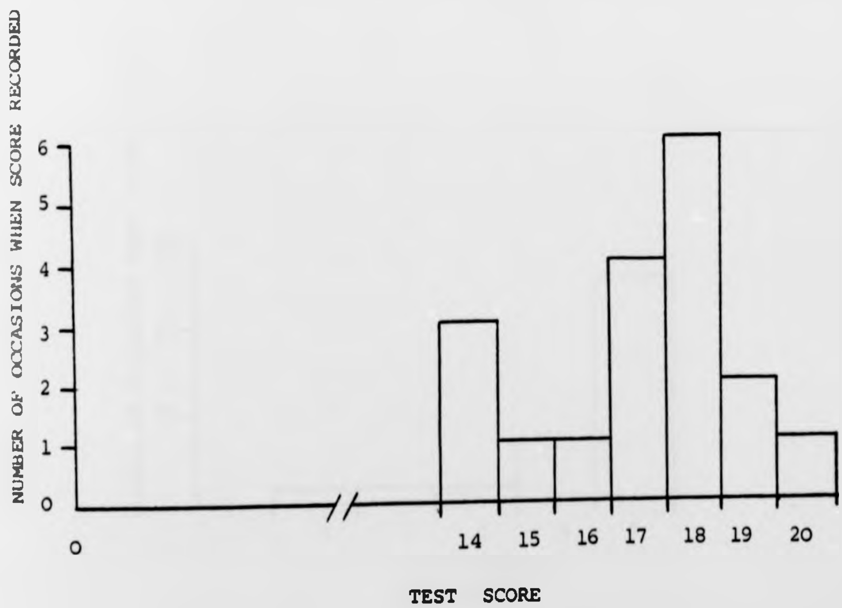


FIG.4.(ii) DISTRIBUTION OF INPUT RHYME SCORES OF SUBJECTS IN MEMORY STUDY

TEST SCORE

	1	2	3	4	5
n	1	1	1	6	25

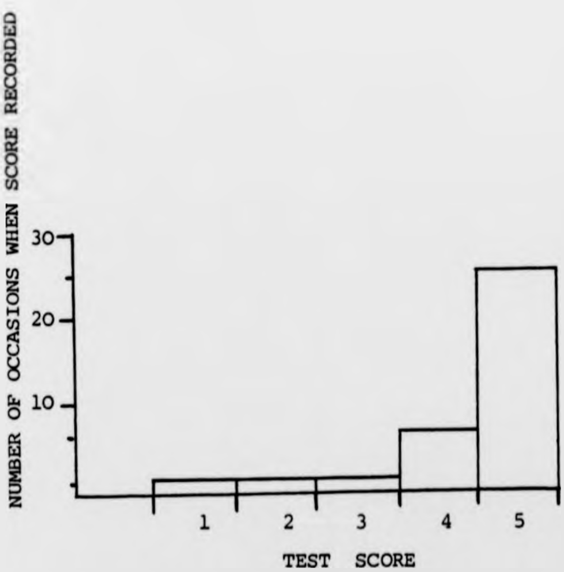


FIG.4.(iii) DISTRIBUTION OF OUTPUT ALLITERATION SCORES OF SUBJECTS IN MEMORY STUDY

	TEST SCORE				
	1	2	3	4	5
n	0	1	2	3	5

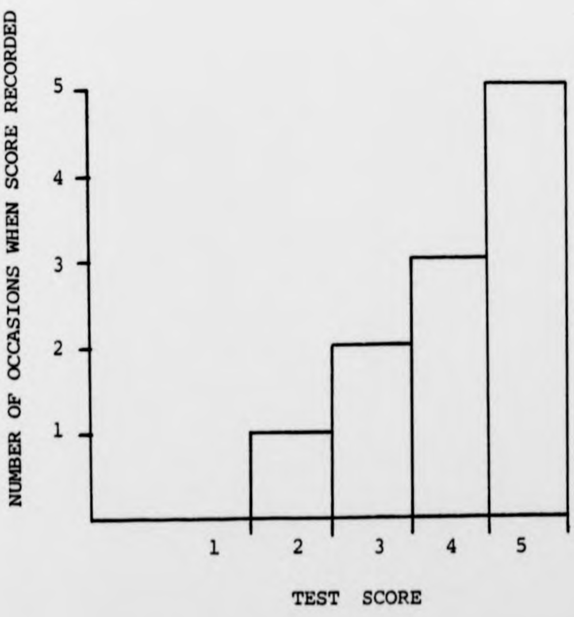


FIG.4.(iv) DISTRIBUTION OF OUTPUT RHYME SCORES OF SUBJECTS IN MEMORY STUDY

TABLE S - MEAN RECALL (WITH STANDARD DEVIATIONS) OF SUBJECTS DIVIDED BY LEVEL OF P.A.

P.A. * GROUP	n	R.A. EXPT. Rhyme	R.A. EXPT. Allit.	R.A. EXPT. Control	CONRAD EXPT. Paronymous	CONRAD EXPT. Control
0	9	2.48 (0.58)	2.41 (0.49)	2.78 (0.71)	2.52 (0.38)	2.67 (0.47)
1	9	2.67 (0.47)	2.44 (0.33)	3.26 (0.85)	2.56 (0.50)	3.30 (0.72)
2	8	3.25 (0.61)	2.96 (0.28)	3.67 (0.36)	2.79 (0.50)	3.96 (0.42)
3	6	2.89 (0.34)	2.89 (0.27)	3.15 (0.67)	2.83 (0.35)	3.89 (0.46)
4	13	3.67 (0.65)	3.15 (0.63)	3.97 (0.46)	3.21 (0.55)	4.44 (0.66)

correct responses) taken. Scoring on the p.a. tests was as described above.

Results

The subjects again scored in an "all or none" fashion on the p.a. lists, and so were divided into the usual 5 groups, (no subjects fell outside this grouping). The distribution of scores on the p.a. sub-tests is shown in fig. 4. The mean number of words recalled by the groups, grouped by "strength of possession" of p.a., are shown in Table S. As can be seen, recall improves with the level of p.a. The results of the RA and Conrad tasks were subjected to 2-Way ANOVAs, the results of which can be seen in Table T(i). These analyses confirmed that level of p.a. had a critical effect upon level of recall, and again, that there is a significant difference in list difficulty. However, although there is a strongly significant interaction between level of p.a. and the Conrad lists, the RA list type interaction with level of p.a. is not significant. The results were also analysed in terms of simple possession or no-possession of p.a. The subjects were pooled into those with no p.a., and those with any form of p.a., (i.e., groups 1-4). These results were again

TABLE T(i) - 2-WAY ANOVA RESULTS WITH FACTORS LEVEL OF P.A. AND LIST TYPES, FOR R.A. AND CONRAD EXPERIMENTS

SOURCE OF VARIANCE	d.f.	m.s.	F	P
Level of p.a.	4	5.37	9.15	<.0001
List type (R.A. Expt.)	2	6.56	39.7	<.0001
Level of p.a. x list type	8	0.29	1.75	.0985
Level of p.a.	4	4.64	9.97	<.0001
List Type (Conrad Expt.)	1	15.92	165.25	<.0001
Level of p.a. x list type	4	0.93	9.63	<.0001

TABLE T(ii) - 2-WAY ANOVA RESULTS WITH FACTORS POSSESSION/NON-POSSESSION OF P.A. AND LIST TYPES FOR R.A. AND CONRAD EXPERIMENTS

SOURCE OF VARIENCE	d.f.	m.s.	F	P
p.a.+/p.a.-	1	12.05	15.72	.0003
List Type (R.A. Experiment)	2	2.24	13.26	<.0001
p.a.+/p.a.- x list type	2	0.51	2.99	.0556
p.a.+/p.a.-	1	9.93	15.66	.0003
List Type (Conrad Experiment)	1	4.25	40.84	<.0001
p.a.+/p.a.- x list type	1	3.09	29.69	<.0001

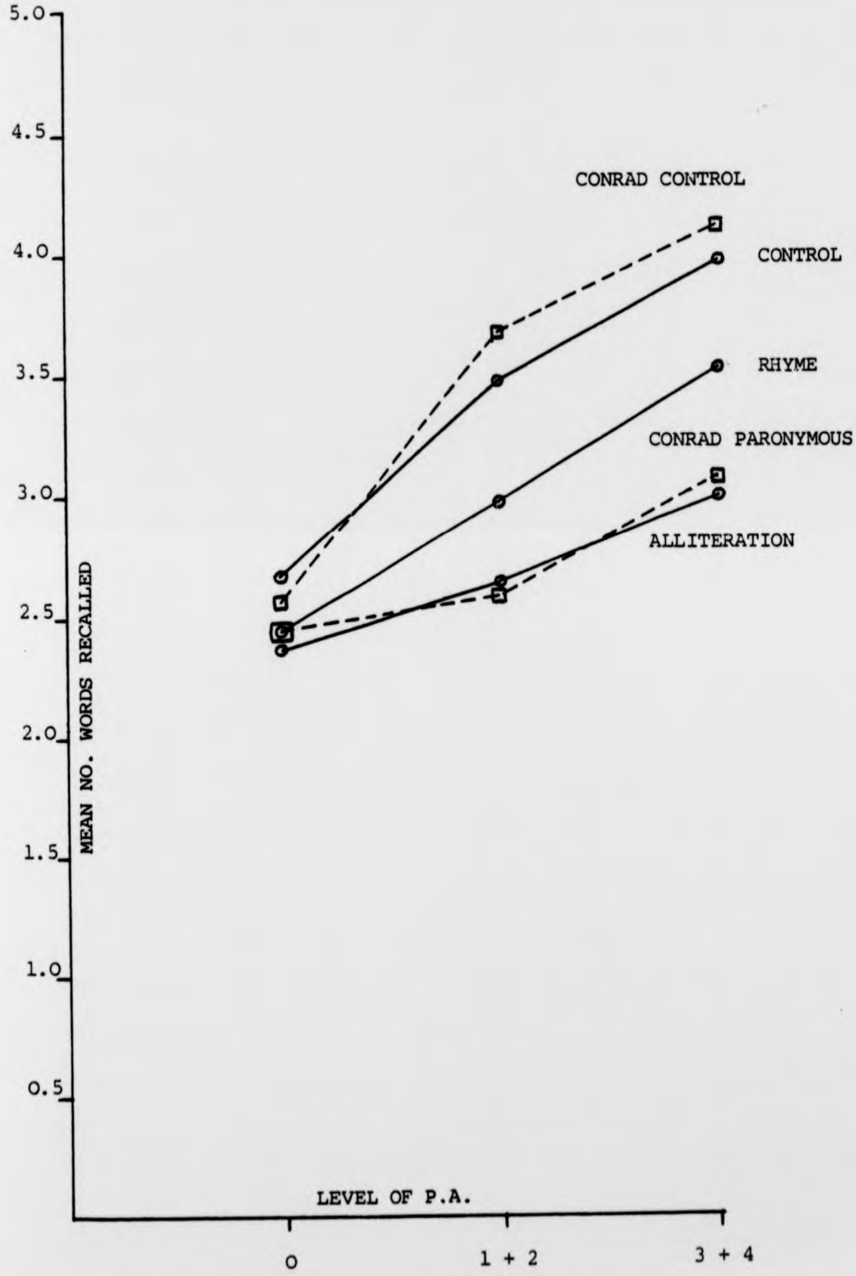


FIG.5. MEAN RECALL OF LIST TYPES OF SUBJECTS DIVIDED BY LEVEL OF P.A.

subjected to 2-way ANOVAs, which are shown in Table T(ii). As can be seen, the same pattern of results emerges, although the interaction between the RA lists and level of p.a. almost reaches significance.

The pattern of these results is perhaps best seen in graphical form, (see fig. 5 - note that for the sake of clarity the subjects have been divided into subjects with no p.a., rhyme and alliteration p.a., or alliteration-only p.a.). As can be seen, there is little difference between list types in the pa- group. In the pa+ groups,(in this instance, the full and alliteration-only p.a. subjects), recall of rhyming lists is easier than recall of the alliterating lists. Note that this effect is just as strong for the partial as for the full p.a. groups, (proportion of rhyming words recalled to control words = partial, 0.85; full, 0.86; proportion of alliterating words = partial, 0.78; full, 0.77). Performance on the Conrad control list is roughly synonymous with performance on the RA control list, whilst paronymous recall is seems to be identical to recall of alliterating words.

The effect of verbal intelligence would

appear to be negligable. The correlation of EPVT score with memory span for the control list of the RA experiment was small and non-significant, (r(43)=0.16, p<.20) as was its correlation with level of p.a., (r(43)=0.24, p<.20). Therefore, further analysis of the role of verbal intelligence was not performed*.

Discussion.

The results of this study have provided firm empirical support for the arguments of Jorm and others that the p.c.e. is attributable to phonological skills. Indeed, we have gone further, and shown that the p.c.e. would appear to be critically related to the level of p.a. The results of the Conrad experiment show a significant interaction between level of p.a. and level of recall, whilst the interaction in the RA task, although not quite reaching significance, "falls" in the right direction. These effects cannot be attributed to the verbal intelligence of the subjects. However, the link between the p.c.e. and p.a. is not a simple one. For example, why

*The above 2-way ANOVAs were re-run with mental age partialled out in 2-way ANCOVAs. The mental age score failed to significantly alter the results.

should subjects with only alliteration p.a. show the same relative strength of p.c.e. for both alliterating and rhyming lists? From the arguments advanced in the Introduction, one would suppose that the partial p.a. subjects should only show the p.c.e. on the alliterating lists. Again, why should the rhyming lists be easier to recall than the alliterating lists? The explanation I offer, is, I stress, tentative. I make no predictions about where in the child's chain of mental mechanisms the described process occurs; only that somewhere analogous processes to the ones described take place. Furthermore, it is doubtful if all sections of the model would stand closer empirical scrutiny. However, it is the most plausible model which fits the observed facts, and I offer it here as a working hypothesis as a spur for further research.

Let us take the case of a subject asked to memorise a single spoken word. The subject, at some point after hearing the word, segments it into the smallest units s/he is capable of consciously detecting. Let us suppose that this process is controlled by p.a. Thus, the subject with full p.a. will segment the word into its constituent phonemes, (e.g., "cat" -> "c", "a", "t"). The subject with only initial p.a. will segment into the initial phoneme and a syllabic chunk, ("c", "at"). The pa- subject cannot segment into phonemes, and thus the word may enter whole or as a syllable, (for convenience's sake, we will presume it enters as a morpheme). The word, (in whatever form) has to be identified, and sent to the articulatory loop. The race to identify the word is now on. There are very many more morphemes than syllables, and considerably more syllables than phonemes. So the search for a stored morpheme which matches the input will take longer than than the matching of syllables, which in turn will take longer than a phoneme matching. Now of course, a phoneme search has to take place for every phoneme in a word, compared with only one search for a morpheme. However, given that there are only some 40 or so phonemes, compared with several thousand morphemes, this process will still be faster than a morpheme search. By this reckoning, full p.a. subjects, (purely phonemic search) will codify input faster than partial p.a. subjects, (phonemic and syllabic search) who in turn will codify faster than the pa- subjects, (morphemic search). Once the word is encoded, it can be sent to the articulatory loop. The faster the encoding, the more items can be placed on the loop before the trace fades. Therefore, the greater the level of p.a., the greater the storage on the articulatory loop, and hence the greater the overall recall.

The disadvantage of the phonemic and syllabic encoding system is that if the subject is asked to encode a series of paronyms, then repeated use of the same phonemic/syllabic stores within a short space of time exhausts them. This fatigue may lead to a delay in processing to allow the particular store time to "recover". This will in turn lower the number of items entering the loop. Thus, subjects encoding syllabically or phonemically, (i.e., full and partial p.a.) should show the p.c.e. Pa- subjects should not show the effect because each morpheme store is used only once in each memorisation. The p.c.e. should be as strong for partial p.a. subjects on rhyming as alliterating words. Suppose a subject with only alliterating p.a. were asked to memorise "cat, cup, cod". S/he would encode these as "c/at, c/up, c/od". In recall, a p.c.e. would result from the exhaustion of, or confusion in retreival from the "c" phoneme store. If s/he were asked to encode "cat, rat, bat", s/he would encode them as "c/at, r/at, b/at". Confusion upon recall would result from exhaustion of the "at" syllable store. Thus, the partial p.a. subjects should display the p.c.e. on both rhyming and alliterating lists.

The articulatory loop also probably plays a role in the p.c.e. Alliterating words are harder to pronounce than rhyming words, which in turn are harder than non-paronyms. Thus, the subjects may recall more rhyming words than alliterating words because they can say more of them before the loop contents "fade".

This model, however speculative, would account for the results of the RA experiment; that the greater the level of p.a., the greater the recall; that full and partial p.a. subjects showed the same relative strength of the p.c.e.; that rhyming words were easier to recall than alliterating words; and, that pa- subjects displayed no p.c.e. However, how well does the model explain the results of the Conrad experiment? The Conrad results again show that the greater the level of p.a., the greater the recall, and that pa subjects display the p.c.e., whilst pa- subjects do not. However, there is a discrepancy. The paronymous list in the Conrad task is comprised of words which rhyme or alliterate. For any two words picked at random from this list, there is a 13/56 probability that they rhyme, a 3/56 probability that they alliterate, and a 40/56 probability that they neither rhyme nor alliterate. One would therefore expect that the pa+ subjects recall of this list would fall somewhere between the level of recall for the rhyming and control lists of the RA experiment. In fact, recall is as low as for the alliterating list. Why should the pa+ subjects have found recall of the paronymous list so difficult?

There are several explanations for this result. (1)It is reasonable to assume that the pa+ subjects were monitoring the words they were asked to recall. When given all rhyming, all alliterating, or non-paronymous lists to recall, presumably they quickly realised the nature of the lists, (e.g., that they all began the same, etc.). However, the paronymous list is not as easily categorisable. On one trial the child could be asked to recall "cat, bat" and on the next, "bag, man". Thus, part of his/her attention may be diverted away from memorising to trying to classify the words. The Conrad task was always preceded by the p.a. test. The pa+ subjects were possibly still monitoring words for similarities, which may have exacerbated this effect. This is speculative. However, I noted that several pa+ subjects, when incorrectly recalling, produced (error) words which rhymed with a list word. For example, the child might be asked to recall, "cat, bat, bag, man". What s/he then recalled was "cat, bat, fat, sat". Thus, it is possible that pa+ children were detecting some but not all of the similarities in the paronymous list, and were misled accordingly. (2)If the subjects found the p.a. test tiring, it is possible that fatigue exagerrated the p.c.e. (3)As mentioned above, the Conrad test could be subject to experimenter bias, (though its "objective" nature makes this highly unlikely).

Whatever the reason for the Conrad results, it is important to note that there would seem to be different patterns of response for paronymous and purely rhyming and alliterating lists. This indicates the need for future researchers in this field to take care in selection of lists for use in verbal recall tasks. Only using paronymous lists may be masking a variety of other processes.

What can we conclude from this study? From the viewpoint of memory research, there are three principal findings. First, that there is strong empirical support for the largely theoretical arguments of Jorm and others that the p.c.e. is an effect of phonemic processing, rather than memory per se. Second, we have further narrowed down this field, and shown that this "phonemic processing" is probably p.a., and we have created a model to explain how p.a. might cause the p.c.e. Third, we have found that recall of rhyming, alliterating, and paronymous lists differ, which indicates the need for future researchers to take care in their choice of materials in a verbal memory task.

From the viewpoint of p.a. research, these findings are of considerable importance. Regardless of the manner in which p.a. and working memory interact, the results indicate that p.a.'s role is not just to improve the reading of alphabetic script, but also to alter the manner in which we process spoken language. In order for p.a. to exert an influence on verbal recall, the pa+ subject must be using p.a. near-automatically. Thus p.a. not only provides a child with a knowledge of word structure - it also alters the manner in which these words are processed. The results reported here indicate some of the importance of this shift, but this is just one small sample study. However, it points the way towards further studies in what should be an exciting area of research. This study has shown that the acquisition of p.a. is not just relevant to reading research. However, this does not mean that the results are without relevance to reading. Any increase in verbal memory cannot be disadvantageous to the development of learning, reading included. Furthermore, if the child's working memory is expanded, this should mean that s/he can encode larger chunks of prose in reading This in turn should improve the his/her semantic/syntactic processing of text. Thus, p.a. may further improve reading in this incidental manner. We began this chapter with a study assessing p.a.'s "basic credentials": that is, as a predictor of reading and spelling. We have since then seen that p.a. is a phonic skill distinct from tacit recognition of similarity of sound, and that its specific role in reading is to improve graphemic processing. With this final study, we have seen that p.a. has a critical role in working memory and the p.c.e. We have thus not not only shown that p.a. has an important role in learning to read and to spell, but also that it has a relevance to the wider field of cognitive development. I therefore close this chapter on a note of optimism. P.a. is not just another way of looking at phonics in reading. It has real value, and the discovery of its role in working memory indicates a field of research still rich in possibilities.

Chapter 4 ~ Conclusions.

We began this thesis by considering in a fairly broad sweep the role of phonological processing in all aspects of reading. We then narrowed our sights upon the role of p.a.. First, we asked what it was. Second, how best it could be tested, and third, of what use it was. We have spent this thesis examining these three basic questions. What follows in this final chapter is a summation and overview of these findings. We shall begin by considering issues particular to p.a., before once again spreading out to examine the importance of p.a. across a wider span of mental processes.

4.1 Testing p.a.

We defined p.a. as "the realisation that words can be decomposed into a limited set of subcomponents, (phonemes) and that words have phonemes in common". The skill assessed by this test seems to accord with this definition. Certainly we have shown that there are two types of "p.a." test, which have different "natures" and predictive powers. This should not be taken to imply that one of the test types is rendered redundant by the other. Rather, that we should regard the two tests as complementary. An interesting possibility is the creation of a phonics "supertest" which would combine features of a p.a. and a p.s. test, (e.g., the present p.a. test, but with phonemic similarities varying in "subtlety").

However, though the p.a. test devised here may be a valid one, does it test p.a. to its limits? The p.a. test only assesses awareness of initial and final word sounds. This might cause five major problems. (1) We have no knowledge of the child's awareness of medial sounds. There has been a tacit assumption throughout this thesis that if the child is aware of initial and final sounds, then s/he is fully aware of all aspects of phonemic structure. There are two major justifications for this approach. The first is that there are practical problems of testing medial p.a.. There is a far greater processing load attached to it than to initial or final p.a. testing. In searching for the initial or final sound of a word, the "pa+" child knows unambiguously where it is. In searching for the medial sound, s/he has to first identify the final and initial portions of the word before s/he can identify the medial portion. This places a greater processing load upon the child. Furthermore, the terminology might be harder for the child to comprehend. In other words, the testing of p.a. might run foul of the criticisms of cognitive/mnemonic overload to which the Bruce-type studies are prone. (2) A measure of medial awareness would probably not add much to our picture of p.a.. As we just argued, medial p.a. is probably dependent upon the child being able to identify initial and final word sounds. It would seem highly unlikely that a child capable of identifying the beginning and end of a word would regard the medial sound as an unidentifiable sound. Indeed, from the evidence of pa+ children "building up" words in the reading style study, it would seem highly unlikely that they do not recognise the medial portion as containing letters identical to ones they have perceived at the beginnings or ends of words. A study of medial p.a. should be undertaken for the sake of completeness, but I seriously doubt if (a), it could be tested unambiguously, or (b), would yield any new information. (3) A further limitation of the p.a. test is that it only assesses CVC words. However, as has already been stated, this was intentional. The use of longer words would not alter the child's p.a., but it might overtax his/her mnemonic capacities, thus forcing him/her into errors. It might be fruitful to test for this effect - it would give us a useful measure of the limitations of the child's "processing capacity" in phonological tasks. (4) A more problematic criticism of the test is that it may not distinguish between "reading p.a." and "speech p.a.". This requires some explanation. We have seen that p.a. is strongly linked with reading experience, so one might therefore wonder if the child's concept of phonological structure is demarked by graphemic structure. In other words, his/her concept of "sat" is not represented by the phonetic symbols for /s/, /a/, and /t/, but by the letters, "s", "a", and "t". This would lead the child astray if asked such a question as "do `once' and `ooze' start with the same sound?" If the child's p.a. is based upon graphemic representation, then s/he should erroneously answer "yes" to this question. The p.a. test deliberately avoided such a speech-writing conflict. Nonetheless, it would be interesting to see if this conflict does take place, and furthermore, if there was a developmental pattern to it. A study of this kind would also indicate a child's relative dependence upon phonological and graphemic representation in early reading.

(5) The final problem is one which has vexed me throughout my work on p.a.. If children cannot display awareness of initial word sounds, how can they play "I-Spy"? Not all reception class children can play this game, but the majority can. In pilot testing, I tried to use the "I-Spy" game to coax the pa- child into the right line of thinking, but to no avail. Do most children therefore have p.a., but this test is too insensitive to test it? The only conclusion I can reach is that this is a case of Piagetian decalage. The pa- child who can play "I-Spy" has yet to gain a clear idea of phonemic structure. His/her knowledge of phonemic structure is too encapsulated to be of any use to reading. Certainly the differences between pa+ and pa- readers reported here fully support this argument.

4.2. P.a. and reading. The original impetus for this research was to investigate p.a.'s relationship with reading, and the thesis has been largely presented in these terms. The study has made three major findings, which are summarised below:

(a) P.a. usually arises after the onset of reading experience. This accords with the arguments of Morais et al and others that insight into phonemic structure is possible through contemplation of speech alone, but is most likely to be prompted by graphemic structure.

(b) The age of onset of p.a. is strongly correlated with early reading and spelling ability. This indicatees that p.a. is not only an insight resulting from the contemplation of word structure, but that it is also a realisation whose acquisition seems to be a pre-requisite for good early reading. That acquisition is not dependent upon reaching a particular level of reading/spelling skill makes this finding all the more remarkable. P.a. seems to be an insight whose attainment is largely serendipidous, and yet has an enormous impact once it is attained.

(c) The principal impact of p.a. on reading would seem to be through graphemic processing. This manifests itself very clearly in sensitivity to graphemic change. As was argued in the discussion of Experiment 3, the method used to test this only employed novel words, to try to force errors, which might not appear in the use of well-known words. It would be interesting to see if errors do decrease with increased familiarity of words, and whether this also decreases the difference between pa+ and pa- subjects. If so, then we gain valuable information on the development of reading style. P.a.'s influence on graphemic processing is also reflected in miscue analysis of "normal" reading. However, p.a.'s influence is not purely at the level of the letter. It also seems to generally "tighten up" the efficiency of the child's reading. Furthermore, p.a. may have an influence through its effect on working memory.

How does this work add to the body of knowledge about p.a. and reading development? The finding that p.a. is strongly correlated with early reading ability is in one sense uninteresting: nearly every p.a. researcher has seen it as his/her mission to prove just this same point. Here I think is the major criticism of p.a. research. Everyone seems to have asked, "how well is p.a. related to reading?" Few have wondered, "how is p.a. related to reading?" Researchers have contented themselves with asking the same question time and time again, and always getting the same answer: p.a. is strongly related to reading ability. However, as we have seen, a failure to critically examine the nature of the p.a. tests they have used, or to ask how p.a. is related to reading, has led to the masking of a great deal of interesting and useful information. Hopefully this thesis, and Snowling & Perin's and Morais et al's work have shown that there is life for p.a. beyond the correlation with reading scores.

4.3 P.a. and spelling. It has been observed that p.a. is correlated with spelling ability, though usually at a slightly lower level than with reading. This, it has been argued, is at first sight surprising, because one would expect a knowledge of correct ordering of phonological components to be very important in the spelling process. However, it has also been observed that spelling also requires the subject to remember the motor actions for writing words, and also to remember, (rather than simply recognise, as in reading) irregular spellings. Thus, there is probably comparatively less stress on phonological processes in spelling than in reading. However, all we have so far examined is the correlation; no-one has yet examined how p.a. and spelling interact. Clearly this needs to be examined. One possible approach to this problem has been suggested by the findings of these studies. It will be recalled that in Experiment 3, I observed some partial p.a. subjects who could not remember how to write a letter at the beginning of a word, yet who quite readily, (and seemingly unwittingly) would write the same letter at the end of a word. I suggested then that learning to spell might involve a transition from a primarilly motor-guided to phonologically-guided strategy, and that p.a. may play a part in this transition. One way in which this could be tested would be compare matched groups of pa+ and pa- children on the following task. The subjects would learn to spell new words, either writing them, or using letter cards. The children would then be tested at a later date in the same or the other modality. It is predicted that the pa- subjects, who are likely to be more reliant upon a motor strategy, would display comparatively more difference between modalities, (i.e., they should perform less well on the card task, since it lacks a motor component) and should be comparatively worse in the transfer condition, (because they lack the phonological skills which are in this case context-free) than the pa+ subjects. One would also expect the pa+/pa- difference to decrease if irregularly-spelt words were used, (since a phonological strategy is of less use). Again, it would be interesting to see if the use of syllabic cards, (e.g., "ing" instead of "i", "n", "g") affects performance. It might be predicted that a child with partial p.a. would find syllabic cards comparatively easier to use at word endings than single letters.

Certainly much still needs to be discovered about the role of p.a. in spelling. Though we have observed that p.a.'s role is smaller than in reading, the fact remains that it still is a major role, and one which has been neglected by researchers for too long.

4.4 p.a. and speech processing. Although the test was not devised to test this, p.a. does appear to have an effect upon speech processing. In any case, p.a. is assessed through the child's analysis of the spoken word. Although we have considered this information first and foremost in terms of its relationship to reading, a child's p.a. should make him/her aware of the phonemic structure of language, regardless of the form it is presented in. This is not to say that access to the phonemic structure is equally easy across mediums. As has been argued, the written word is a far better source for learning about word structure than speech. The spoken word lasts a few milliseconds; the written word endures, and can be analysed time and time again. It is therefore not surprising that p.a. has usually been found to arise from reading rather than from speech. We have evidence from the experiment on working memory that p.a. may have an effect upon speech perception: there are indications that p.a. enables the child to process verbal inputs by their phonological structure, and possibly at a faster speed too. However, these are not yet cast-iron conclusions, and work still needs to be performed in this area. One simple test of the effectiveness of p.a. in speech would be to see if matched pa+ and pa- subjects differed in their response latencies for recognising spoken words. A further amendment to this study would be to see if latency of response is affected by word length. It would be expected that pa- subjects, who may process morphemically, should be less affected by length than pa+ subjects, who possibly process phonologically. Again, the work suggested above to test for "written p.a." versus "spoken p.a." would be of relevance here.

4.5 P.a. and memory. The results of the working memory experiment described here suggest that p.a.'s role in memory is secondary, its effect being felt through speech processing. This does not mean that p.a.'s role is unimportant. Very surprisingly, p.a. seems to be a far better predictor of recall than verbal intelligence, (surprisingly, because tests of digit span are often used as part of a general intelligence test package, so there should be quite a strong link between memory and verbal intelligence). P.a.'s probable role in working memory has already been described in detail above. Work still needs to be performed in this area to determine where in the memory process p.a. exerts its influence. The most probable site, as has already been posited, is in the stage where speech is being encoded. It would be interesting and constructive to see if training in p.a. skills in turn brought about a change in working memory span and the creation of the p.c.e.. This would give a clear indication that p.a. was a prime mover of the p.c.e.. It would also be informative to see if such a change also resulted in changes in the span of non-verbal memory, (e.g., memory for shapes, etc.). This would give an indication of a role for an intermediary phonological process in developing memory, if one exists.

4.5 P.a. and teaching. The thesis was not devised to examine the educational relevance of p.a. However, the results clearly have relevance to the teaching of reading to young children. Most importantly, we have seen that the earlier the child attains p.a., the better his/her reading. Yet there would appear to be no clear reasons why some children attain p.a. earlier than others, and in the absence of any other explanation, one must assume that the initial acquisition of p.a. is often a matter of happenstance. If this is the case, then there would appear to be no grounds for not teaching p.a. to infant school children, and every advantage in doing so. The advantages of p.a. we have already seen repeatedly: it is strongly linked to reading and spelling, it is particularly well correlated with graphemic processing, and also with improves speech processing and working memory. In addition, it would seem somewhat foolhardy for a teacher to instruct a young child to use word attack skills if s/he lacks p.a.. The child cannot have any concept of the usefulness of what is being taught. In effect, s/he is learning a more sophisticated method of barking at print. Teaching the child p.a. should be a relatively simple task. Given the arguments above, it would probably be easiest to teach a pa- child when s/he had begun to read, so that s/he could be taught from examples from print, which are probably more tangible than spoken examples. Some informal and pilot work I have performed indicates that it is possible to teach a child p.a. in a relatively short space of time, (2-3 half-hour sessions). Content, (personal communication) has found that it is possible to teach 4-5 year olds to successfully perform Bruce's elision task, given a couple of hours' practice. This augurs well for training in the considerably less complex p.a. test.

It is not possible to summarise the findings of this thesis in a few neat paragraphs. Although the basic aim of this study was simple enough - what is p.a., how do we test it, what use is it? - each study in this work has generated its own side issues, and is particularly concerned with one aspect of reading research. What has been written above hopefully summarises the issues raised by each study, and also points to fresh fields to explore. Certainly p.a. would not seem to be a "dead" area of research, with so much work still to be performed. P.a. is not just a skill of parochial interest to reading researchers. If nothing else, I hope that this thesis has shown that there is still much work to be done, and it and other works like it will encourage other researchers to look "beyond the correlation".

Bibliography.

Adams, M.J. (1979). Models of word recognition. Cognitive Psychology 11, 133-176.

Alegria, J. & Content, A. (1983). Explicit analysis of speech and learning to read: some experimental studies. Paper presented at 3rd. Language & Language Acquisition Conference on Pragmatics & Education, Gent, 21-25 March, 1983.

Alegria, J.; Morais, J.; Alimonte, G. & Shikel, R. (in preparation). Speech analysis at the beginning of whole-word instruction. Cited in Alegria & Content (1983).

Alegria, J.; Pignot, E. & Morais, J. (1982). Phonetic analysis of speech and memory codes in beginning readers. Memory & Cognition 10, 451-456.

Au, K.H. (1977). Analysing oral reading errors to improve instruction. The Reading Teacher 31, 46-49.

Baddeley, A.D. (1978). The trouble with levels: A reexamination of Craik & Lockharts' framework for memory research. Psychological Review 85, 139-152.

Baddeley, A.D. & Hitch, G. (1974). Working memory. In G.H. Bower (ed.). The Psychology of Learning and Motivation 8, New York: Academic Press.

Baron, J. & Mckillop, B.J. (1975). Individual differences in speed of phonemic analysis, visual analysis, and reading. Acta Psychologia 39, 91-96.

Baron, J. & Thurston, I. (1973). An analysis of the word superiority effect. Cognitive Psychology 4, 207-228.

Bee, H.L.; Van Egeren, L.F.; Streiss-Guth, A.P.; Nyman, B.A. & Leckie, M.S. (1969). Social class differences in maternal teaching strategies and speech patterns. Developmental Psychology 1, 726-734.

Biemiller, A. (1970). The development of the use of graphic and contextual information as children learn to read. Reading Research Quarterly 5, 75-96.

Blau, H. & Loveless, E.J. (1983). If they can speak, why can't they read? And spell? They may now! Hemispheric `routing' and `vision bypass' to teach spelling to dyslexics. Reading 17, 23-30.

Bradley, L. (1980). Assessing Reading Difficulties. A diagnostic and remedial approach. London: Macmillan Education.

Bradley, L. & Bryant, P.E. (1978). Difficulties in auditory organisation as a possible cause of reading backwardness. Nature 271, 746-747.

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

Brekke, B. & Williams, J.D. (1975). Reversibility preceding conservation and reading readiness. Journal of Psychology 90, 191-196.

Brewer, W.F. (1972). Is reading a Letter-by-Letter Process? In: J.F. Kavanagh & I.G. Mattingly (Eds.) Language by Ear and by Eye. Cambridge, Mass.: MIT Press, 359-367.

Bruce, L.J. (1964). The analysis of word sounds by young children. British Journal of Educational Psychology 34, 158-170.

Bryant, P.E. & Bradley, L. (1980). Why children sometimes write words which they do not read. In: U. Frith (Ed.) Cognitive Processes In Spelling. London: Academic Press, 355-370.

Burke, E. (1976). A developmental study of children's reading strategies. Education Review 29, 30-46.

Byrne, B. (1981). Deficient syntactic control in poor readers: is a weak phonetic memory code responsible? Applied Psycholinguistics 2, 201-212.

Byrne, B. & Ledez, J. (1983). Phonological awareness in reading-disabled adults. Australian

Journal of Psychology 35, 185-197.

Byrne, B. & Shea, P. (1979). Semantic and phonetic memory codes in beginning readers. Memory & Cognition 7, 333-338.

Calfee, R.C.; Chapman, R.S. & Venezky, R.L. (1972). How a child needs to think to learn to read. In: L. Gregg (Ed.), Cognition in Learning and Memory. New York: Wiley.

Calfee, R.C.; Lindamood, P.; and Lindamood, C. (1973). Acoustic phonetic skills and reading - kindergarten through twelfth grade. Journal of Educational Psychology 64, 293-298.

Carpenter, P.A. & Daneman, M. (1981). Lexical retrieval and error recovery in reading: A model based on eye fixation. Journal of Verbal Learning and Verbal Behaviour 20, 137-160.

Carver, C. (1970). A Group or Individual Word Recognition Test. London: Hodder & Stoughton.

Carver, R.P. (1977). Towards a theory of reading comprehension and rauding. [sic] Reading Research Quarterly 13, 8-63.

Carver, R.P. (1983). Is reading rate constant or flexible? Reading Research Quarterly 18, 190-215.

Cattell, J. McK. (1886). The time taken up by cerebral operations. III. The perception time. Mind 11, 377-392.

Claxton, G. (1975). Sources of information in word perception. Canadian Journal of Psychology 29, 292-301.

Claxton, G. (1979). Cognitive Psychology - New Directions. London: Routledge & Kegan Paul.

Cohen, A.S. (1975). Oral reading of first grade children taught by a code emphasis approach. Reading Research Quarterly 10, 615-651.

Conrad, R. (1972). Speech and Reading. In: J.F. Kavanagh & I.G. Mattingly (Eds.), Language by Ear and by Eye. Cambridge, Mass.: MIT Press, 205-241.

Content, A.; Morais, J.; Alegria, J. & Bertelson, P. (1982). Accelerating the development of phonetic segmentation skills in kindergarteners. Cahiers do Psychologie Cognitive 2, 259-269.

Cosky, M.J. (1976). The role of letter recognition in word recognition. Memory & Cognition 4, 207-214.

Crowder, R.G. (1982). The Psychology of Reading. An Introduction. New York: Oxford University Press.

Denney, D.R. (1974). Relationships of three cognitive style dimensions to elementary reading abilities. Journal of Educational Psychology 66, 702-709.

Dimitrovsky, L. & Almy, M. (1975). Early conservation as a predictor of later reading. Journal of Psychology 90, 11-18.

Doctor, E.A. & Coltheart, M. (1980). Children's use of phonological encoding when reading for meaning. Memory & Cognition 8, 195-209.

Dodd, A. (1982). Emerging word knowledge in the first year of school. M.A. thesis, University of Manchester.

Downing, J. (1967). Evaluating the Initial Teaching Alphabet. London: Cassell.

Downing, J. (1970a). Children's concepts of language in learning to read. Education Research 12, 106-112.

Downing, J. (1970b). The development of linguistic concepts in children's thinking. Research in the Teaching of English 4, 5-19.

Downing, J.; Ayers, D. & Schafer, B. (1984). Linguistic Awareness in Reading Readiness. Windsor: NFER-Nelson.

Downing, J. & Leong, C. (1982). Psychology of Reading. New York: Macmillan.

Downing, J. & Oliver, P. (1974). The child's concept of a `word'. Reading Research Quarterly 9, 568-582.

Downing, J. & Thackray, D.V. (1975). Reading Readiness, (2nd. edition). U.K.R.A. London: Hodder & Stoughton.

Drewnowski, A. (1978). Detection errors on the word the: Evidence for the acquisition of reading levels. Memory & Cognition 6, 403-409.

Drummond, D. & Wignell, E. (1979) In: D. Drummond & E. Wignell (Eds.), Reading - A Source Book. London: Heinemann.

SEE FOOTNOTE

Ehri, L.C. (1975). Word consciousness in readers and prereaders. Journal of Educational Psychology 67, 204-212.

Ehri, L.C. (1976). Word learning in beginning readers and prereaders: effects of form class and defining contexts. Journal of Educational Psychology 68, 832-842.

Ehri, L.C. (1979). Linguistic insight: Threshold of reading acquisition. In M. Coltheart (Ed.), Reading Research: Advances in Theory and Practice 1, 63-114.

Ehri, L.C. & Wilke, L.S. (1983). Development of word identification speed in skilled and less skilled beginning readers. Journal of Educational Psychology 75, 3-18.

Felzen, E. & Ansfield, M. (1970). Semantic and phonetic relations in the false recognition of words by third- and sixth grade children. Developmental Psychology 3, 163-168.

Fontes, P.J. (1979). Reading, ability and mathematics. In: V. Greaney (Ed.), Studies in Reading. Dublin: the Educational Co., 112-127.

Frazier, L. & Rayner, K. (1982). Making and correcting errors during sentence comprehension: Eyemovements in the analysis of structurally ambiguous sentences. Cognitive Psychology 14, 178-210.

Frith, U. (1980). Unexpected spelling

ADDITIONAL REFERENCES:

Durkin, D. (1961). Children who learned to read at home. Elementary School Journal 62, 14-18.

Durkin, D. (1963). Children who read before Grade 1: a second study. Elementary School Journal 64, 52-56.

problems. In: U. Frith, (Ed.), Cognitive Processes in Spelling. London: Academic Press.

Fry, P. (1977). Homo Loquens. Cambridge: Cambridge University Press, 101-124.

Garnica, O.K. (1973). The development of phonemic speech perception. In: E. Moore (Ed.), Cognitive Development and the Acquisition of Language. London: Academic Press, 215-222.

Gleitman, L. & Rozin, P. (1973). Teaching reading by use of a syllabary. Reading Research Quarterly 8, 447-483.

Goodman, Y.M. & Burke, C.L. (1972). Reading Miscue Inventory Manual: Procedures for Diagnosis and Evaluation. New York: Macmillan.

Groff, P. (1974). Sight words: the Humpty Dumpty of reading instruction. Reading (U.K.R.A.) 8, 11-16.

Guthrie, J.T. (1973). Models of reading and reading disability. Journal of Educational Psychology 65, 9-18.

Guthrie, J.T. (1977). Letter sound complexity in learning and identifying words. Journal of Educational Psychology 69, 686-696.

Hall, J.W.; Ewing, A.; Tinzman, M.B. & Wilson, K.P. (1981). Phonetic coding in dyslexics and normal readers. Bulletin of the Psychonomic Society 17, 177-178.

Halliday, M.S. & Hitch, G. (personal communication).

Henderson, L. (1982) Orthography in Word Recognition. London: Academic Press

Hochberg, J. (1970). Components of literacy: speculations and exploratory research. In: H. Levin & J.P. Williams (Eds.), Basic Studies on Reading. New York: Basic Books, 57-73.

Hogaboam, T.W. & Perfetti, C.A. (1978). Reading skill and the role of verbal experience in decoding. Journal of Educational Psychology 70, 717-729.

Hood, J. (1976). Qualitative analysis of oral reading errors: the inter-judge reliability of scores. Reading Research Quarterly 11, 577-598.

Hulme, C. & Bradley, L. (1984). An experimental study of multi-sensory teaching with normal and retarded readers. In R.N. Malatesha & H.A. Whitaker (Eds.), Dyslexia: A Global Issue. The Hague: Martinus Nijhoff.

Jorm, A.F. (1983a). The Psychology of Reading and Spelling Difficulties. London; Routledge & Kegan Paul.

Jorm, A.F. (1983b). Determinants of individual differences by reading achievement. Australian Journal of Psychology 35, 163-174.

Jorm, A.F. (1983c). Specific reading retardation and working memory: A review. British Journal of Psychology 74, 311-342.

Juel, C. (1980). Comparison of word identification strategies with varying context, word type, and reader skill. Reading Research Quarterly 15, 358-376.

Katz, L & Baldasare, J. (1983). Syllable coding in printed-word recognition by children and adults. Journal of Educational Psychology 75, 245-256.

Katz, R.B.; Shankweiler, D. & Liberman, I.Y. (1981). Memory for item order and phonetic recoding in the beginning reader. Journal of Experimental Child Psychology 32, 474-484.

Lewcowicz, N.K. (1980). Phonemic awareness training: What it is and how to teach it. Journal of Educational Psychology 72, 686-700.

Lewcowicz, N.K. & Low, L.Y. (1979). Effects of visual aids and word structure on phonemic segmentation. Contemporary Educational Psychology 4, 238-252.

Liberman, I.Y.; Shankweiler, D.; Fischer, F.W. & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. Journal of Experimental Child Psychology 18, 201-212.

Locke, J.L. (1971). Phonemic processing in silent reading. Perceptual and Motor Skills 32.

905-906.

Lomax, C.M. (1977). Interest in books and stories at nursery school. Education Research 19, 100-112.

Loveless, E. & Blau, H. (1980). Multisensory techniques updated: Fernald and Gillingham to Hemispheric Routing. Presented at: 17th. Annual International Conference of the Association of Children With Learning Disabilities. Milwauka, February-March 1983. Quoted in Blau & Loveless (1983).

Lyons, J. (1968). Introduction to Theoretical Linguistics. Cambridge: Cambridge University Press.

Makite, K. (1968). The rarity of reading disability in Japanese children. American Journal of Opthalmology 38,

Mann, V.A.; Libermann, I.Y. & Shankweiler, D. (1980). Children's memory for sentences and word strings in relation to reading ability. Memory & Cognition 8, 329-335.

Mark, L.S.; Shankweiler, D.; Liberman, I.Y. & Fowler, C.A. (1980). Phonetic recoding and reading difficulty in beginning readers. Memory & Cognition 5, 623-629.

Mason, J.M. (1977). Suggested relationships between the acquisition of beginning reading skills and cognitive development. Journal of Education Research 70, 195-199.

Massaro, D.W. & Hestand, J. (1983). Developmental relations between reading ability and knowledge of orthographic structure. Contemporary Educational Psychology 8, 174-180.

Moore, M.J.; Kagan, J.; Sahl, M. & Grant,S. (1982). Cognitive profiles in reading disability. Genetic Psychology Monographs 105, 41-93.

Moore, R.S.; Moore, D.N.; Willey, T.J.; Moore, D.R. & Kordenbrock, D.K. (1979). School Can Wait. Brigham: Brigham University Press.

Morais, J.; Caryl, L.; Alegria, J. &

Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? Cognition 7, 323-331.

Morais, J.; Cluytens, M. & Alegria, J. (in press). Segmentation abilities of dyslexics and normal readers. To appear in: Perceptual & Motor Skills.

Morris, J.M. (1983). Focus on phonics. Background to the perennial debate. Reading 17, 131-138.

Ollila, L.O. & Chamberlain, L. (1979). The learning and retention of two classes of graphic words: high-frequency nouns and non-noun words among kindergarten children. Journal of Educational Research 72, 58-62

Patterson, K.E. (1978). Phonemic dyslexia: errors of meaning and the meaning of errors. Q.J.E.P. 30, 587-601.

Polke, C.L.H. & Goldstein, D. (1980). Early reading and concrete operations. Journal of Psychology 106, 111-116.

Reid, J.F. (1966). Learning to think about reading. Educational Research 9, 56-62.

Rice, U.M. & Divesta, F.J. (1965). A developmental study of semantic and phonetic generalization in paired-associate learning. Child Development 36, 721-730.

Roberts, T. (1975). Skills of analysis and synthesis in the early stages of reading. British Journal of Educational Psychology 45, 3-9.

Rosner, J. & Simon, D.P. (1971). The auditory analysis test: an initial report. Journal of Learning Disabilities 4, 384-392.

Rozin, P. & Gleitman, L.R. (1977). the structure and acquisition of reading II: The reading process and the acquisition of the alphabetic principle. In A.S. Reber and D.L. Scarborough (Eds.), Toward a Psychology of Reading: The Procedings of the CUNY Conferences. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Rozin, P.; Poritsky, S. & Sotsky, R. (1971). American children with reading problems can easily learn to read English represented by Chinese characters. Science 71, 1264-1267.

Saffran, E.M. & Marin, O.S. (1977). Reading without phonology: evidence from aphasia. Q.J.E.P. 29, 515-525.

Savin, H.B. (1972). What the child knows about speech when he starts to learn to read. In: J.F.Kavanagh & I. Mattingly (Eds.), Language by Ear and by Eye. Cambridge, Mass.: MIT Press.

Schale, F.C. (1966). Changes in oral reading errors at elementary and secondary levels. Unpublished doctoral dissertation, University of Chicago. Summarised in Academic Therapy Quarterly 1, 225-229.

Schank, R.C. & Abelson, R.P. (1977). Scripts, plans, goals, and understanding. Hillsdale, New Jersey: Lawrence Erlbaum.

Schlieper, A. (1978). Oral reading errors in relation to grade and level of skill. The Reading Teacher 31, 283-287.

Schonell, F.J. (1932) Essentials in Teaching and Testing Spelling. London: Macmillan

Scribner, S. & Cole, M. (1981) The Psychology of Literacy. Cambridge, Mass: Harvard University Press.

Seidenberg, M.S. & Tanenhaus, M.K. (1979). Orthographic effects on rhyme monitoring. Journal of Experimental Psychology: Human Learning & Memory 5, 546-554.

Shankweiler,D. & Liberman, I.Y. (1972). Misreading: a search for causes. In J.F. Kavanagh & I. Mattingly (Eds.), Language by Ear and by Eye. Cambridge, Mass.: MIT Press.

Shankweiler, D.; Liberman, I.Y.; Mark, L.S.; Fowler, C.A. & Fischer, F.W. (1979). The speech code and learning to read. Journal of Experimental Psychology: Human Learning and Memory 5, 531-545.

Simpson, G.B.; Lorsbach, T.C. & Whitehouse, D. (1983). Encoding and contextual components of word recognition in good and poor readers. Journal of Experimental Child Psychology 35, 161-

171.

Skjelfjord, V. (1976). Teaching children to segment spoken words as an aid in learning to read. Journal of Learning Disabilities 9, 297-306.

Smith, F. (1971). Understanding Reading: a psycholinguistic analysis of reading and learning to read. New York: Holt, Rinehart & Winston.

Snowling, M. & Perin, D. (in press). The development of phoneme segmentation skills in young children. To be published in: J. Sloboda (Ed.), The Acquisition of Symbolic Skills. Plenum Press.

Spring, C. & Perry, L. (1983). Naming speed and serial recall in poor and adequate readers. Contemporary Educational Psychology 8, 141-145.

Stevenson, H.W.; Stigler, J.H.; Lucker, G.W. & Lee, S.Y. (1982). Reading disabilities: the case of Chinese, Japanese and English. Child Development 53, 1164-1181.

Sticht, T.G.; Caylor, J.S.; Kern, R.P. & Fox, L.C. (1972). Project REALISTIC: Determination of adult functional literacy skill levels. Reading Research Quarterly 7, 424-465.

Tunmer, W.E. & Bowey, J.A. (1984). Metalinguistic awareness and reading acquisition. Ch. 3.2 of W.E. Tunmer, C. Pratt & M.L. Herriman (Eds.), Metalinguistic Awareness In Children. Berlin: Springer-Verlag, 144-169.

Venezky, D.L. (1976). Reading acquisition: the occult and the obscure. In F.B. Murray & J.J. Pilulski (Eds.). The acquisition of reading: cognitive, linguistic and perceptual prerequisites. Baltimore: University Park Press.

Weaver, P. & Shankoff, P. (1978). Research within research: A research-guided response to concerns of reading education. Cited: Tunmer & Bowey (1984).

Weber, R.M. (1968). The study of oral reading errors: a survey of the literature. Reading Research Quarterly 4, 96-119.

Weber, R.M. (1970). A linguistic analysis of first-grade reading errors. Reading Research Quarterly 5, 427-451.

Williams, J.P. (1980). Teaching decoding with an emphasis on phoneme analysis and phoneme blending. Journal of Educational Psychology 72, 1-15.

Williams, J.P.; Blumberg, E.L. Williams, D.V. (1970). Cues used in visual word recognition. Journal of Educational Psychology 62 310-315.

Zhurova, L.E. (1971). The development of sound analysis or words in pre-school children. Early Child Development and Care 1, 53-66.

Zifcak, M. (1981). Phonological awareness and reading acquisition. Contemporary Educational Psychology 105, 117-126.

APPENDIX A - RESULTS OF THE MULTIPLE REGRESSION ANALYSIS

	P.A. = TOTAL P.A.						P.A. = TOTAL P.A.					
	F	M.R.	R.SQ	R.SQ CH	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH	S.R.	O.F.
1. P.A.	174	.8	.64	.64	.8	174	137	.76	.58	.58	.76	137
2. P.S.	24	.84	.71	.07	.76	119	12	.79	.63	.05	.7	82
3. C.A.	21	.87	.76	.05	.77	103	2.1*	.8	.64	.01	.64	56
1. P.A.	174	.8	.64	.64	.8	174	137	.76	.58	.58	.76	137
2. C.A.	41	.86	.75	.11	.77	143	8.4	.79	.62	.03	.64	78
3. P.S.	6.4	.87	.76	.02	.76	103	5.7	.8	.64	.02	.7	56
1. P.S.	137	.76	.58	.58	.76	138	95	.7	.49	.49	.7	95
2. P.A.	43	.84	.71	.13	.8	119	36	.79	.63	.14	.76	82
3. C.A.	21	.87	.76	.05	.77	103	2.1	.8	.64	.01	.64	56
1. P.S.	137	.76	.58	.58	.76	138	95	.7	.49	.49	.7	95
2. C.A.	30	.83	.68	.1	.77	104	7.1	.73	.53	.04	.64	54
3. P.A.	32	.87	.76	.1	.8	103	29	.8	.64	.11	.76	56
1. C.A.	142	.77	.59	.59	.77	142	67	.64	.41	.41	.64	67
2. P.S.	28	.83	.68	.09	.76	104	25	.73	.53	.12	.7	54
3. P.A.	32	.87	.76	.08	.8	103	29	.8	.64	.11	.76	56
1. C.A.	142	.77	.59	.59	.77	142	67	.64	.41	.41	.64	67
2. P.A.	59	.86	.75	.16	.8	143	53	.79	.62	.21	.76	78
3. P.S.	6.4	.87	.76	.02	.76	103	5.7	.8	.64	.02	.7	56

CONTINUED ON NEXT PAGE.........

KEY:

F = F ratio significant at p = .05 or better, unless marked by an asterisk (e.g. 0.3*)

M.R. = Multiple regression

R.SQ = Multiple regression squared

R.SQ CH = Change in R.SQ due to the inclusion of variable

S.R. = Simple regression

O.F. = Overall F ratio

P.A. = Phonemic awareness test score (p.a. tests included in analysis printed above the table see text)

P.S. = Bradley test score (total score unless indicated otherwise above the table)

C.A. = Chronological age (in months)

Dependent variable for each analysis indicated below each table.

APPENDIX A - RESULTS OF THE MULTIPLE REGRESSION ANALYSIS (CONTINUED)

	P.A. = INPUT ALLIT.						P.A. = INPUT RHYME						P.A. = OUTPUT ALLIT						P.A. = OUTPUT RHYME					
ORDER OF ENTRY	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.
1. P.A.	82	.68	.46	.46	.68	82	151	.78	.61	.61	.78	151	34	.51	.26	.26	.51	34	147	.78	.6	.6	.78	148
2. P.S.	29	.76	.58	.12	.7	67	12	.8	.65	.04	.7	90	56	.73	.53	.27	.7	55	13	.81	.65	.05	.7	90
3. C.A.	5	.78	.6	.02	.64	48	5	.82	.67	.02	.64	65	5	.74	.55	.02	.64	40	1.2*	.81	.65	.01	.64	60
1. P.A.	82	.68	.46	.46	.68	82	151	.78	.61	.16	.78	151	34	.51	.26	.26	.51	34	147	.78	.6	.6	.78	148
2. C.A.	23	.75	.56	.1	.64	62	15	.81	.66	.05	.64	94	36	.68	.46	.2	.64	41	6.9	.79	.63	.03	.64	82
3. P.S.	10	.78	.6	.04	.7	48	3.1*	.82	.67	.01	.7	65	20	.74	.55	.09	.7	40	7.1	.81	.65	.03	.7	60
1. P.S.	95	.7	.49	.49	.7	95	95	.7	.49	.49	.7	95	95	.7	.49	.49	.7	95	95	.7	.49	.49	.7	95
2. P.A.	20	.76	.58	.09	.68	67	44	.81	.65	.16	.78	90	7.6	.73	.53	.04	.51	55	43	.81	.65	.16	.78	90
3. C.A.	5	.78	.6	.07	.64	48	5.3	.82	.67	.02	.64	65	4.8	.74	.55	.02	.64	40	1.2*	.81	.65	.01	.64	60
1. P.S.	95	.7	.49	.49	.7	95	95	.7	.49	.49	.7	95	95	.7	.49	.49	.7	95	97	.7	.49	.49	.7	95
2. C.A.	7.1	.73	.53	.04	.64	54	7.1	.73	.53	.04	.64	54	7.1	.73	.53	.04	.64	54	7.1	.73	.53	.04	.64	54
3. P.A.	17	.78	.6	.07	.68	48	41	.82	.67	.14	.78	65	5.3	.74	.55	.03	.51	40	34.7	.81	.65	.12	.78	60
1. C.A.	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67
2. P.S.	25	.73	.53	.12	.7	54	25	.73	.53	.12	.7	54	25	.73	.53	.13	.7	54	25	.73	.53	.12	.7	54
3. P.A.	17	.78	.6	.07	.68	48	41	.82	.67	.14	.78	65	5.3	.74	.55	.03	.51	40	35	.81	.65	.13	.78	60
1. C.A.	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67
2. P.A.	34	.75	.56	.16	.68	62	72	.81	.66	.25	.78	94	10	.68	.46	.05	.51	41	58	.79	.63	.22	.78	82
3. P.S.	10	.78	.6	.04	.7	48	3.1*	.82	.67	.01	.7	65	20	.74	.55	.09	.7	40	7	.81	.65	.03	.7	60

DEPENDENT VARIABLE = SCHONELL SCORE

DEPENDENT VARIABLE = SCHONELL SCORE

APPENDIX A - RESULTS OF THE MULTIPLE REGRESSION ANALYSIS (CONTINEUD)

ORDER OF ENTRY	P.A. = INPUT ALLIT.						P.A. = INPUT RHYME						P.A. = OUTPUT ALLIT.						P.A. = OUTPUT RHYME					
	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.R.	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.
1. P.A.	96	.7	.5	.5	.7	96	139	.77	.59	.59	.77	139	45	.56	.31	.31	.56	45	168	.8	.63	.63	.8	168
2. P.S.	48	.81	.66	.17	.76	95	30	.83	.68	.09	.76	105	84	.8	.63	.32	.76	83	28	.85	.71	.08	.76	121
3. C.A.	28	.86	.74	.08	.77	90	30	.87	.76	.08	.77	101	25	.84	.71	.08	.77	77	18	.87	.76	.05	.77	101
1. P.A.	96	.7	.5	.5	.7	96	139	.76	.59	.59	.76	139	45	.56	.31	.31	.56	45	168	.79	.63	.63	.80	168
2. C.A.	71	.84	.71	.21	.77	118	61	.86	.75	.16	.77	143	88	.8	.64	.33	.77	87	39	.86	.76	.1	.77	136
3. P.S.	11	.86	.74	.03	.76	90	5	.87	.76	.01	.76	101	22	.84	.71	.07	.76	77	9	.87	.76	.02	.76	101
1. P.S.	137	.76	.58	.58	.76	137	137	.76	.58	.58	.76	137	137	.76	.58	.58	.76	137	137	.76	.58	.58	.76	137
2. P.A.	22	.81	.66	.08	.71	95	31	.83	.68	.1	.77	105	13	.8	.63	.05	.56	83	44	.85	.71	.13	.8	121
3. C.A.	28	.86	.74	.07	.77	90	30	.87	.76	.08	.77	101	25	.84	.61	.08	.77	77	18	.87	.76	.05	.77	101
1. P.S.	137	.76	.58	.58	.76	137	137	.76	.58	.58	.76	.37	137	.76	.58	.58	.76	137	137	.76	.58	.58	.76	137
2. C.A.	30	.83	.68	.09	.77	104	31	.83	.68	.09	.77	104	30	.83	.68	.09	.77	104	30	.83	.68	.09	.77	104
3. P.A.	20	.86	.74	.06	.7	90	31	.87	.76	.08	.77	101	8	.84	.7	.02	.56	77	31	.87	.76	.08	.8	101
1. C.A.	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142
2. P.S.	28	.83	.68	.09	.76	104	28	.83	.68	.09	.76	104	28	.83	.68	.09	.76	104	28	.83	.68	.09	.76	104
3. P.A.	20	.86	.74	.06	.7	90	30	.87	.76	.08	.77	101	8	.84	.71	.02	.56	77	31	.87	.76	.08	.8	101
1. C.A.	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142
2. P.A.	39	.84	.71	.12	.7	118	59	.86	.75	.16	.77	143	13	.8	.64	.05	.56	87	53	.86	.77	.15	.8	136
3. P.S.	11	.86	.74	.03	.76	90	5	.87	.76	.01	.76	101	22	.84	.71	.07	.76	77	9	.87	.76	.02	.76	101

DEPENDENT VARIABLE = CARVER SCORE

DEPENDENT VARIABLE = CARVER SCORE

APPENDIX A - RESULTS OF THE MULTIPLE REGRESSION ANALYSIS (CONTINUED)

DEPENDENT VARIABLE = CARVER SCORE

ORDER OF ENTRY	P.A. = INPUT ALLIT. P.S. = INITIAL CONDITION						P.A. = INPUT RHYME P.S. = FINAL CONDITION					
	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH	S.R.	O.F.
1. P.A.	96	.7	.5	.5	.7	96	139	.77	.59	.59	.77	139
2. P.S.	35	.79	.63	.14	.71	82	17	.81	.65	.06	.73	90
3. C.A.	34	.85	.73	.1	.77	85	41	.87	.75	.11	.77	98
1. P.A.	96	.7	.5	.5	.7	96	139	.77	.59	.59	.77	139
2. C.A.	71	.84	.71	.21	.77	118	61	.86	.75	.16	.77	143
3. P.S.	6.3	.85	.73	.02	.71	85	2.9*	.87	.75	.01	.73	98
1. P.S.	98	.70	.5	.5	.71	97	112	.73	.53	.53	.73	112
2. P.A.	34	.79	.63	.13	.7	82	32	.81	.65	.12	.77	90
3. C.A.	34	.85	.73	.1	.77	85	41	.87	.75	.11	.77	98
1. P.S.	98	.71	.5	.5	.71	97	112	.73	.53	.53	.73	112
2. C.A.	42	.81	.65	.15	.77	90	44	.82	.68	.15	.77	103
3. P.A.	27	.85	.73	.08	.7	85	29	.87	.75	.08	.77	98
1. C.A.	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142
2. P.S.	16	.81	.65	.06	.7	90	26	.82	.68	.09	.73	103
3. P.A.	27	.85	.73	.08	.7	85	29	.87	.75	.08	.77	98
1. C.A.	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142
2. P.A.	39	.84	.71	.12	.7	118	59	.86	.75	.16	.77	143
3. P.S.	6.3	.85	.73	.02	.71	85	2.9	.87	.75	.01	.73	98

DEPENDENT VARIABLE = SCHONELL SCORE

ORDER OF ENTRY	P.A. = INPUT ALLIT. P.S. = INITIAL CONDITION						P.A. = INPUT RHYME P.S. = FINAL CONDITION					
	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH.	O.F.	
1. P.A.	82	.68	.46	.46	.68	82	151	.78	.61	.61	.78	151
2. P.S.	16	.73	.53	.08	.62	55	7.4	.82	.64	.03	.68	84
3. C.A.	9.5	.76	.57	.04	.64	43	8.5	.82	.66	.03	.64	63
1. P.A.	82	.68	.46	.46	.68	82	151	.78	.61	.61	.78	151
2. C.A.	23	.75	.56	.1	.64	62	15	.81	.66	.05	.64	94
3. P.S.	3.0*	.76	.57	.01	.62	43	1.7*	.82	.66	.01	.68	63
1. P.S.	60	.62	.38	.38	.62	60	86	.68	.47	.47	.68	86
2. P.A.	32	.73	.53	.15	.68	55	44	.8	.64	.17	.78	84
3. C.A.	9.5	.76	.57	.04	.64	43	8.5	.82	.66	.03	.64	63
1. P.S.	60	.62	.38	.38	.62	60	86	.68	.47	.47	.68	86
2. C.A.	15	.68	.46	.09	.64	42	12	.72	.53	.06	.64	54
3. P.A.	25	.76	.57	.11	.68	43	39	.82	.66	.14	.78	63
1. C.A.	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67
2. P.S.	11	.68	.46	.06	.62	42	25	.73	.53	.12	.68	54
3. P.A.	25	.76	.57	.11	.68	43	39	.82	.66	.14	.78	63
1. C.A.	67	.64	.41	.41	.64	67	57	.64	.41	.41	.64	67
2. P.A.	34	.75	.6	.16	.68	62	72	.81	.66	.25	.78	94
3. P.S.	3.0*	.76	.57	.01	.62	43	1.7*	.82	.66	.01	.68	63

APPENDIX A - RESULTS OF THE MULTIPLE REGRESSION ANALYSIS (CONTINUED)

DEPENDENT VARIABLE = CARVER SCORE

ORDER OF ENTRY	P.A. = INPUT ALLIT. P.S. = INITIAL CONDITION						P.A. = INPUT RHYME P.S. = FINAL CONDITION					
	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH	S.R.	O.F.
1. P.A.	96	.7	.5	.5	.7	96	139	.77	.59	.59	.77	139
2. P.S.	35	.79	.63	.14	.71	82	17	.81	.65	.06	.73	90
3. C.A.	34	.85	.73	.1	.77	85	41	.87	.75	.11	.77	98
1. P.A.	96	.7	.5	.5	.7	96	139	.77	.59	.59	.77	139
2. C.A.	71	.84	.71	.21	.77	118	61	.86	.75	.16	.77	143
3. P.S.	6.3	.85	.73	.02	.71	85	2.9*	.87	.75	.01	.73	98
1. P.S.	98	.70	.5	.5	.71	97	112	.73	.53	.53	.73	112
2. P.A.	34	.79	.63	.13	.7	82	32	.81	.65	.12	.77	90
3. C.A.	34	.85	.73	.1	.77	85	41	.87	.75	.11	.77	98
1. P.S.	98	.71	.5	.5	.71	97	112	.73	.53	.53	.73	112
2. C.A.	42	.81	.65	.15	.77	90	44	.82	.68	.15	.77	103
3. P.A.	27	.85	.73	.08	.7	85	29	.87	.75	.08	.77	98
1. C.A.	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142
2. P.S.	16	.81	.65	.06	.7	90	26	.82	.68	.09	.73	103
3. P.A.	27	.85	.73	.08	.7	85	29	.87	.75	.08	.77	98
1. C.A.	142	.77	.59	.59	.77	142	142	.77	.59	.59	.77	142
2. P.A.	39	.84	.71	.12	.7	118	59	.86	.75	.16	.77	143
3. P.S.	6.3	.85	.73	.02	.71	85	2.9	.87	.75	.01	.73	98

DEPENDENT VARIABLE = SCHONELL SCORE

ORDER OF ENTRY	P.A. = INPUT ALLIT. P.S. = INITIAL CONDITION						P.A. = INPUT RHYME P.S. = FINAL CONDITION					
	F	M.R.	R.SQ	R.SQ CH.	S.R.	O.F.	F	M.R.	R.SQ	R.SQ CH.	O.F.	
1. P.A.	82	.68	.46	.46	.68	82	151	.78	.61	.61	.78	151
2. P.S.	16	.73	.53	.08	.62	55	7.4	.82	.64	.03	.68	84
3. C.A.	9.5	.76	.57	.04	.64	43	8.5	.82	.66	.03	.64	63
1. P.A.	82	.68	.46	.46	.68	82	151	.78	.61	.61	.78	151
2. C.A.	23	.75	.56	.1	.64	62	15	.81	.66	.05	.64	94
3. P.S.	3.0*	.76	.57	.01	.62	43	1.7*	.82	.66	.01	.68	63
1. P.S.	60	.62	.38	.38	.62	60	86	.68	.47	.47	.68	86
2. P.A.	32	.73	.53	.15	.68	55	44	.8	.64	.17	.78	84
3. C.A.	9.5	.76	.57	.04	.64	43	8.5	.82	.66	.03	.64	63
1. P.S.	60	.62	.38	.38	.62	60	86	.68	.47	.47	.68	86
2. C.A.	15	.68	.46	.09	.64	42	12	.72	.53	.06	.64	54
3. P.A.	25	.76	.57	.11	.68	43	39	.82	.66	.14	.78	63
1. C.A.	67	.64	.41	.41	.64	67	67	.64	.41	.41	.64	67
2. P.S.	11	.68	.46	.06	.62	42	25	.73	.53	.12	.68	54
3. P.A.	25	.76	.57	.11	.68	43	39	.82	.66	.14	.78	63
1. C.A.	67	.64	.41	.41	.64	67	57	.64	.41	.41	.64	67
2. P.A.	34	.75	.6	.16	.68	62	72	.81	.66	.25	.78	94
3. P.S.	3.0*	.76	.57	.01	.62	43	1.7*	.82	.66	.01	.68	63