THE PERFORMANCE OF AVERAGE READERS ON A BATTERY OF PSYCHOLINGUISTIC TESTS

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DECLARATION

I hereby declare that the research report is my own unaided work. It has been submitted for the degree of Master of Education (Educational Psychology) to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university.

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ABSTRACT

This study of the performance of a sample of average readers on a battery of psycholinguistic tests, was conducted in order to provide norms for these tests. The sample was drawn from two private schools in Johannesburg and was selected on the basis of age-appropriate performance on the Schonell Graded Word Reading Test. Scores on the Psycholinguistic Tests were expected to conform to predictions of an Information Processing Model which identifies two reading strategies: a direct strategy for reading, which depends on the recognition of the visual appearance of the whole word; and a second indirect or phonological strategy, which is dependent on the use of grapheme-phoneme correspondence. This functional model of adult language processing has been applied in the present study to the development of reading abilities in children. Research has shown that children use dual routes in reading as well, and that, while younger readers are more dependent on the indirect or phonological route, more proficient older readers rely predominantly on the lexical or direct route. It was expected therefore that different reading strategies would be used for different word types at different ages. As the means for the tests supplied by this study conform to predictions of the Dual Processing Model and support the proposition of developmental changes in reading strategies, these means may be used as an indication of normal processing strategies in children, thereby permitting the identification of deviant reading strategies in children of different ages.

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1. INTRODUCTION

The term dyslexia describes the impaired acquisition of reading despite conventional instruction, adequate intelligence, and sociocultural opportunity. (Critchley, 1975) Children who are slow to read are referred to as developmental dyslexics as they have failed to attain an expected level of reading ability.

Traditionally standardized tests have been used to identify developmental dyslexia. Such tests diagnose whether an individual's ability to acquire reading is impaired, usually by furnishing a reading age, which is then compared with the individual's chronological age. As reading is a complex cognitive skill it requires the integration of numerous sub-skills necessary for the successful processing of the written language. These tests may therefore diagnose a difficulty but are not able to identify the specific area or skill which is impaired.

A conceptual model of reading is required to elucidate the specific areas of difficulty. The information processing approach, proposed by cognitive neuropsychologists, is a functional model of normal adult processing, based largely on evidence from patients with acquired language disorders. (Coltheart, 1987; Ellis and Young, 1987) This approach models the subskills which are necessary for reading and consequently clarifies how a breakdown in any one of these subskills can result in a specific language disability.

According to this model every reader has a stored semantic representation of each word in his/her mental lexicon (dictionary) in the long term memory. This internal lexicon stores phonological and visual representations of the words known by an individual. The scunds, appearance and meaning of the words may be accessed and held in the short term storage buffers while further processing takes place. (Harris and Coltheart, 1986) Fluent reading requires access to all the information stored in the lexicon.

As can be seen from the diagram (see Appendix 1) the model allows for access to the word by two main routes.

1. **The Lexical Route:** This route is also known as the visual (orthographic) whole word or direct route. The strategy depends on visual access to the word-specific information retained in the internal lexicon and is used for the reading of familiar words, as it allows for access to the abstract visual representation of the whole word. Therefore the route permits reading of regular words, which follow the rules of letter to sound correspondence, and irregular words as long as they are familiar. In reading, therefore, lexical access involves using information from a printed word to gain access to that word's entry in the mental lexicon. (Harris and Coltheart, 1986)

2. The Non-lexical Route: This route is known as the phonological or indirect route. The strategy functions by translating the word's visual representation into a phonological code. This is an indirect procedure in the sense that print is linked to pronunciation via an intermediate step, the use of spelling to sound rules. As the route does not rely on previously learned direct correspondences between individual printed words and their spoken forms, it permits reading of unfamiliar regular words, i.e. novel letter strings that do not already exist in the internal lexicon. Non-words can be read by this route as they do not have a representation in the visual input lexicon. Irregular words cannot be read correctly by this indirect strategy as they do not conform to the rules of grapheme-phoneme conversion.

Skilled reading requires that both routes function effectively as any impairment of functioning on either route leads to dependence on the other. If this happens familiar and unfamiliar words cannot be processed efficiently. Although familiar regular words can be read by either route, unfamiliar words need a phonological strategy. Irregular words which do not obey spelling to sound rules require a lexical strategy. Therefore reading cannot be efficiently mediated solely by either route. This is the rationale behind the dual-route models of reading.

Studies of cases where either the lexical or the non-lexical strategy is impaired have provided evidence that the two strategies exist. In English, failure to develop both strategies is particularly significant owing to the highly variant correspondence between English orthography and phonology. e.g. There is frequently more than one way to spell the same sound, and the same letter combination can represent more than one sound.

An inability to follow the non-lexical route is termed Phonological Dyslexia. As individuals who suffer from this difficulty have problems applying grapheme-phoneme conversion rules (Beauvois and Derouesne, 1979) they read by using the lexical route only. As a consequence they have difficulties reading unfamiliar words. Their phonological deficits are particularly evident if they are required to read non-words as they tend to use the visual appearance of words and/or orthographic sequences instead of analysis into phonological segments.

Surface Dyslexia is characterised by difficulty in reading words as wholes. The individual may have intact phonological skills but is unable to follow the lexical route. (Patterson 1986, Harris & Coltheart, 1986) As the surface dyslexics read by using the phonological route, they frequently make errors with irregular words. These words are read therefore according to the grapheme-phoneme conversion rules to which they do not conform. e.g. " wand" is read as in "band". The errors are therefore errors of

regularisation as they are phonologically plausible.

The investigation of an individual's specific reading difficulty is therefore facilitated by using information processing indicators. While the selection of a conceptual model provides the rationale for a qualitative assessment, the diagnosis of reading difficulties in children is made more complex by the addition of a further component. Although reading is not a biologically-evolved skill (Ellis 1984) children's cognitive development is constantly changing. While research has related this dual-process model primarily to skilled adult reading, (Mitterer 1982, Seymour and MacGregor, 1984), Coltheart, Masterson, Byng, Prior and Riddoch (1983) and others have used it to draw parallels between the established syndromes of acquired dyslexia and those of developmental dyslexia. (Broom 1990)

These parallels indicate that children use dual routes in reading as well. As the normal adult skilled reader primarily makes use of the lexical route, reverting only to the non-lexical route when confronted by unfamiliar words, so as the child becomes a more proficient reader, the use of the lexical route becomes more predominant. i.e. Reliance on phonological encoding decreases with the age of the child (Doctor and Coltheart 1980) This hypothesis that the relative importance of the lexical and non-lexical routes changes as reading ability develops is supported by research. (Bradley and Bryant, 1983; Doctor and Coltheart, 1980; Harris and

Coltheart, 1986; Marsh, Friedman, Welch and Desberg, 1981; Seymour and MacGregor, 1984)

The following sequence of how reading is normally acquired is described by Coltheart (1986) based on ideas proposed by Marsh, Friedman, Welch and Desberg (1981), Seymour and MacGregor (1984), Frith (1985) and Seymour and Elder (1985).

1. The Sight-Vocabulary Phase

   At =/- 4 years of age , the child has a small sight vocabulary as a few words are recognised as wholes through the acquisition of visual word recognition units. The child lacks any phonic skills. Words in this "logographic lexicon" (Seymour and Elder (1986) and Seymour (1987) are read using the direct route. Unfamiliar words in context may elicit a guess based on the preceding context which bears no visual resemblance to the word on the page (Ellis, 1984). The direct procedure appears to operate by recognizing words as particular sequences of letters, even though the procedure does not involve translating these letters into sounds. (Harris and Coltheart, 1986) These authors assert that the direct procedure used during this stage involves analysing the words into their constituent letters in order that the words be recognised and therefore they believe that it would be misleading to refer to the procedure as being one of 'whole-word' recognition.

2. The Discrimination-Net Phase

At +/- 5-6 years of age recognition is still visual without any phonics, but guesses now come to be drawn from within the set of words the child has encountered in print before, (Ellis, 1984) and the word chosen is most likely the one which bears a close visual resemble to the target word.

At this stage, therefore, fragmentary cues become responsible for the increases in the number of words which the child can read aloud. The term discrimination-net refers to this reading method as the child collects sufficient information from the printed word by using salient features of letter strings (words) to select the most plausible response from amongst a specific set of words, this set being the collection of words they know they have been taught to read. (Harris and Coltheart, 1986)

3. The Phonological-Recoding Phase

Reading in the discrimination net phase becomes complicated and cumbersome as the child's reading vocabulary expands. As the child finds it more and more difficult to identify fragmentary features of new words which distinguish it from other words in the increasing reading vocabulary, s/he is prompted to move into the next phase of reading development. The child begins to acquire simple letter-to-sound correspondences so may now attempt to decode or sound out a

new word. The first sign that this stage is reached is the beginning of an ability to read non-words or untaught words and a consequent rapid expansion in the total number of words which can be correctly read.

The phase three child is a far more versatile and independent reader because s/he now has a chance of being able to decode a new word (Ellis, 1984) Ellis emphasizes that decoding will always remain just an option for the normal reader. New words, phonologically decoded will soon join the expanding set of familiar words identified visually.

> "What the acquisition of phonic skills does is to add a second, and valuable strategy for coping with alphabetic writing." (Ellis, 1984)

During the phonological recoding phase the child continues to find difficulty discriminating between homophones, e.g. sail and sale. In addition s/he is unable to sound out irregular words.

4. The Orthographic Phase

Reliance on the phonics phase may be an appropriate way to acquire reading, but cannot be sufficient as a way of becoming skilled in reading. (Harris and Coltheart, 1986) In other words the direct rather than the phonics route becomes more dominant in the orthographic phase. Doctor and Coltheart (1980) proposed that progress from being an effective

beginning reader towards being a skilled reader involves a progressive increase in reliance upon orthographic (visual) recoding.

It is therefore evident that the information processing approach to the acquisition of reading provides a conceptual model upon which methods of assessment of reading disabilities can be based.

Several psycholinguistic tests, based on the principles of the information processing model have been derived for adult subjects. (Coltheart, 1981). Some of them assess the individual's difficulties in the areas of orthography and phonology. The main feature which distinguishes these tests from other single word tests is that their aim is to establish whether a particular processing strategy is available or not, while most other single word tests aim to provide a reading age without taking particular skills into account. Consequently, words in tests such as those in the Coltheart battery are matched for frequency, orthographic regularity, number of letters and syllables, part of speech and imageability, and can give a more specific diagnosis of a reading difficulty in an adult suffering from acquired dyslexia. One limitation of these tests, insofar as the present study is concerned, is that they are all based on word frequencies for adult subjects. Using the same principles, Broom (1990) designed a series of tests for children using the frequency count of Carroll, Davies, and Richman, (1971) which are more appropriate for

children. In addition the words are graded according to complexity, that is letter and syllable length, part of speech and abstractness.

While tests such as the Schonell, Burt, Neale etc., permit the calculation of a reading age, they do not provide a specific test of the child's orthographic knowledge or the child's ability to use phonology, and they take no account of recent developments, which plot the development of reading through the stages described above. There is in these tests, for example, no regular progression from one to one grapheme correspondences to many to one correspondences. Neither are the tests graded according to frequency or imageability. It is therefore doubtful if tests such as these are useful for assessing whether a child is developing appropriate lexical decision strategies for regular and irregular words, and words of different frequencies. Measures which probe these processes directly are required.

The pathology of developmental dyslexia must be seen in the light of a developmental model and these tests need to be standardized for children, as their reading strategies appear to change with age. The individual child's performance needs to be judged against a normal/ average child's performance.

In order to be able to do this a standardization procedure i.e. the processes and procedures of establishing a set of norms for the

tests (Reber, 1985), is necessary. A selected group of subjects that is presumed to represent the population under consideration is used as the standardization group. The sample should be large enough to provide stable values.

In this study a battery of psycholinguistic tests were administered to normal readers in standards 1,2,3,4 and 5 in order to investigate the develcpment of phonological and lexical decision abilities and to provide a set of norms with which the scores of retarded readers can be compared.

To summarize: the earliest readers in the sight-vocabulary stage, would be able to read a few words recognized as wholes and therefore performance on regular and irregular words would not be different. By the discrimination-net stage, recognition of words is still visual without the use of phonics, but when the child encounters new words the child is able to select a guess, on the basis of minimal cues, of a word chosen from the words the child has been taught to read. At this stage as well performance on regular and irregular words would not be likely to be different. This stage is inadequate as the child reading vocabulary expands and the method of accessing new words becomes too cumbersome. The child then moves into the phonological stage of reading and is able to decode and sound out words. At this stage therefore children should be beginning to be able to read non-words as well as regular words by using their phonological skills, along with some familiar

irregular words, already learned in the sight-vocabulary stage. As unfamiliar or low frequency words are not accessible via this route, performance on these words would be noticeably weaker than performance on regular words, non-words and high frequency irregular words. In order to access the exception words, the direct or lexical route needs to develop. As reliance upon orthographic recoding becomes more predominant, ability to read irregular low frequency words is likely to increase and differences between the ability to read regular words, non-words and high frequency irregular words, and the ability to read low frequency irregular words would become less noticeable. As children become older and develop the visual lexicon, non-words (derived from irregular words) are likely to be read more by analogy to the irregular words, as more irregular words become available to provide analogies for the non-words. Younger children would therefore be more likely to regularise.

While it has been shown therefore that reading strategies change with age, and consequently that children's ability to read regular and irregular words of high and low frequency, and to read non-words, depends on their phonological and orthographic development, the ages that these changes take place need to be identified. As this study uses a sample of average readers, it is suggested that, if the trends which are reflected in the study conform to predictions of the information processing model, they will provide means which should identify changes in orthographic strategies and

locate these changes at specific standard levels. Consequently the following aims and hypotheses were formulated:

AIMS

1. To provide developmental norms for a series of psycholinguistic reading tests (Broom 1990) by testing a sample of average readers.

2. To analyze developmental trends in performance on these psycholinguistic tests.

HYPOTHESES

Experimental Hypothesis 1: The performance of the subjects on the various phonological tests will differ according to age.

Experimental Hypothesis 1a: The performance of the subjects on the phonological tests will differ with respect to word frequency and regularity.

Experimental Hypothesis 1b: The performance of the subjects on the phonological tests will differ depending on whether the stimulus is a word or a non-word.

Experimental Hypothesis 1c:	The performance of the subjects on thebsilent test of phonology will be different from the performance on the matched reading aloud test.
Experimental Hypothesis 2:	The performance of the subjects on the tests of lexical decision will differ according to age.
Experimental Hypothesis 2a:	The performance of the subjects on the lexical decision tests will differ with respect to word frequency.
Experimental Hypothesis 2b:	The performance of the subjects on the lexical decision tests will differ depending on whether the stimulus is a word or a non-word.
Experimental Hypothesis 2c:	The performance of the subjects on the lexical decision tests will differ depending on whether the stimulus is visual or auditory.

2. METHODOLOGY

2.1 DESIGN

A between groups design was used in order to investigate the variation between groups of subjects on the dimensions of the independent variables and the different stimuli used i.e.

- different word items (regular and irregular words of high and low frequency, and non-words)
- mode of presentation (visual or auditory)
- mode of response (silent/written or oral/reading aloud)

In this study, the independent variables are the tests developed for this research (Broom 1990) along with the school standards of the subjects. The dependent variables are the scores achieved by the subjects on the tests.

2.2 SUBJECTS

Pupils from standards 1,2,3,4 and 5 were selected from one English medium private girls' school and one English medium private boys' school. Selection procedure was as follows:

1. The Schonell Graded Word Reading Test (R1) was administered to 125 boys from Pridwin Preparatory School and 151 girls from Kingsmead College.

2. Subjects with reading ages appropriate to their chronological ages were selected. Those with reading ages more than 9 months above or below their chronological ages were excluded from the sample.

3. Pupils whose home language was not English and/or those who were new to English medium schools were excluded from the sample.

4. Pupils previously identified as having reading difficulties were exclude from the study.

5. Pupils more than 12 months above or below the standard average age were excluded from the study.

The selection procedure yielded a sample of 135 "normal" pupils of average reading ability (Standard 1 = 26 pupils; Standard 2 = 25 pupils; Standard 3 = 22 pupils; Standard 4 = 26 pupils; Standard 5 = 36 pupils). (See Table 1)

TABLE OF AGE NORMS

SCHOOL STANDARD		AGE: Chronological Age (years)	AGE: Reading Age (years)
Standard 1 (n=25)	Mean	8.34	8.48
	S.D.	.35	.47
Standard 2 (n=25)	Mean	9.27	9.22
	S.D.	.29	.47
Standard 3 (n=22)	Mean	10.28	10.36
	S.D.	.42	.52
Standard 4 (n=26)	Mean	11.49	11.3
	S.D.	.32	.56
Standard 5 (n=36)	Mean	12.32	12.13 + *
	S.D.	.34	.45

* Schonell Graded Word Reading Test only scores to 12 years 6 months. Some individual scores for the standard 5 sample were above the raw score required for a reading age of 12 years 6 months.

2.3 MATERIALS

2.3.1 The Schonell: Graded Word Reading Test (R1) is used as a screening test and is in no way part of this study, but is used only to obtain a sample of subjects with average reading ages. The Schonell test consists of 100 unrelated words graded in difficulty, i.e. starting with easy words and progressing gradually to more difficult words. (see Appendix 2)

2.3.2 Test 1: Reading Aloud Test of Phonology - Words

Eighty words, 40 regular and 40 irregular, were chosen according to their frequency of occurrence. (Carroll, Davies & Richman, 1973) (see Appendix 3) Frequency means are shown in number of words per million. Twenty of the regular words have high frequencies (mean: 182; S.D. 151) and the other 20 words have low frequencies (mean: 3,5; S.D.: 1,73). For each regular word an irregular word of similar frequency was chosen. Twenty of the irregular words have high frequencies (mean: 182; S.D.: 153) while the remaining 20 have low frequencies (mean: 3,58; S.D.:1,69) In order to control for other potential confounding variables, the regular and irregular words were matched for letter and syllable length,

and for part of speech as well.

The words were randomly arranged to produce the order on the scoring sheet (see Appendix 4)

Test 2: Reading Aloud Test of Phonology - Non-words

A list of 40 non-words was constructed. These words were derived from the words in Test 1, by changing the first letter of each irregular word. e.g. Blood - plood. (see Appendix 3)

As the non-words were specifically derived from irregular words, they could be pronounced either by analogy to an already known irregular word (e.g. "plood" pronounced like "blood") or by simple phonology (e.g. as in the word "mood").

The non-words were then randomly arranged producing the order on the scoring sheet . (see Appendix 4)

Cards: Each regular, irregular word and non-word was printed on a card using the "Printmaster" program (Typestyle "office")

Practice Words: Six practice words for test 1 (3 regular and 3 irregular words) and 3 for test 2 (derived from the irregular practice words) were likewise printed on cards.

2.3.3 Test 3: Silent Test of Phonology - Visual

Ten pairs of regular homophones (matched pairs of words sounding the same, but spelt differently) (Frequency 2,969) and 10 pairs of regular non-homophones (matched pairs of words sounding different) (Frequency 2,981) were selected (see Appendix 5). The 20 pairs of words were randomly arranged to form 2 lists of 10 pairs of regular homophones and non-homophones. On each list there were 20 "filler" pairs which were not scored. (see Appendix 6)

Ten pairs of irregular homophones (Frequency 2,997) and 10 pairs of irregular non-homophones (Frequency 2,973) were selected (see Appendix 5). The 20 pairs of words were randomly arranged to form 2 lists of 10 pairs of irregular homophones and nonhomophones. On each list there were an additional 20 "filler" pairs which were not scored. (see Appendix 7)

Ten pairs of non-word homophones and 10 pairs of non-word non-homophones were randomly arranged to form 2 lists of 10 pairs of non-words. On each of these lists there were 20 "filler" pairs of non-words which were not scored. (see Appendix 8)

Test 4: Reading Aloud of words used in the Silent Test of Phonology

Twenty of the regular words (from appendix 6), 20 of the irregular words (from appendix 7) and 20 of the non-words (from appendix 8) were each printed on a card. (see score sheet - Appendix 9)

2.3.4 Lexical Decision Tests

Test 5: Visual Presentation

Sixteen high frequency words (mean:= 2,196; S.D.: = 1,66) and 16 non-words, formed by changing the first letter of the 16 words, and sixteen low frequency words (mean: = 0,236; S.D. = -0,04) and 16 non-words, formed by changing the first letter of the 16 words were selected (see Appendix 10). These words and non-words were randomly arranged to form 4 lists. There were 14 filler words on each list which were not scored. (see Appendices 11 and 11.1)

Test 6: Auditory Presentation

Sixteen high frequency words, matched for frequency, letter length, syllable length, abstractness and regularity with the list of high frequency words in Test 5 (mean: = 2,196; S.D. = 1,631), and 16 non-words, formed from these high frequency words by changing the first letter, were used.

Sixteen low frequency words, matched for frequency, letter length , syllable length, abstractness and regularity with the low frequency words in Test 4 (mean: = 0,238; S.D.: = -0,016) , and 16 non-words formed from these low frequency words, were used. All 64 words were arranged randomly to form a list (see Appendix 12).

2.4 PROCEDURE

Each subject was seen individually on three occasions. In addition each subject completed three group tests

2.4.1 The Schonell Graded Word Reading Test was administered according to instructions (see Appendix 2.1). The reading age for the total number of words was calculated according to the table. (see Appendix 2.1)

2.4.2 Each of the subjects selected was then seen again. On this occasion Test 1 and Test 2 were administered to each subject. The stimulus items (regular and irregular words, and non-words) were presented on the cards and the subjects were required to read each word aloud. The tester recorded the pronunciation of the responses and credit was given for each correct word. Non-words were scored correct whether they were pronounced by analogy to a regular word or by analogy to an irregular word, but regular and irregular pronunciation was scored separately. The subjects were given a standard set of instructions (see Appendix 4.1)

2.4.3 Test 3 was then presented as a group test. For each pair of words or non-words the subjects had to decide whether the 2 words sounded the same or not. They had to record

their response in the appropriate column by marking a tick. In order to ensure that the subjects worked as quickly as possible a stop watch was used and the group was stopped once it was noted that each child had completed the 10 pairs of words or non-words on each list. Those who worked more quickly continued on to the filler pairs. Instructions which were given are shown on the top of the answer sheet in Appendix 6, along with the practice examples for regular, words irregular words and non-words. Tests were collected and scored by the tester.

2.4.4. Subjects were then seen individually again and Test 4 was administered. Subjects were required to read the regular and irregular words and the non-words on the cards aloud and the time taken on each test was recorded.

2.4.5 Test 5 was then administered as a group test. Lists of the regular, irregular and non-words were presented to the subjects. Subjects had to decide whether each word/non-word was a word or non-word by recording their response in the appropriate column with a tick. As with Test 3 a stop watch was used to encourage the subjects to work as quickly as possible. Testing was discontinued once each subject had completed the 16 test words. Subjects who worked more quickly continued with the

filler words. Instructions which were given are shown on the answer sheet along with the 6 practice examples for the regular words irregular words and the non-words in Appendix 10.1 The test sheets were collected and scored by the tester, according to the score sheet. (see Appendix 11.2)

2.4.6 Test 6 was administered. Subjects were given an answer sheet (see Appendix 12) and the list of words was read to the group. The test sheets were collected and scored by the tester, acording to the score sheet. (see Appendix 12.1)

3. RESULTS

The data obtained for each test are summarised in Tables 2,5,8,11, 14,19,22,25,28,31,34,37 and 40. In each table the means and standard deviations of each standard for each word type are shown.

Phonological Tests

Regular Words, Irregular Words and Non-Words Analysis

Table 2 shows the norm tables for regular and irregular words and non-words and gives the mean and standard deviation for each standard of each word type pronounced correctly on Test 1 and Test 2.

TABLE 2

MEANS FOR REGULAR AND IRREGULAR WORDS, AND NON-WORDS:PHONOLOGICAL TESTS:1 & 2

		STANDARDS				
		1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
WORDS						
REGULAR (n=40)	MEAN	35.68	37.44	39.14	39.81	39.56
	S.D.	2.89	1.72	1.06	0.72	0.6
IRREGULAR (n=40)	MEAN	27.48	29.88	33.59	34.27	36.81
	S.D.	5.04	3.05	2.33	1.91	1.78
NON-WORDS (n=40)	MEAN	32.12	33.88	37.14	36.81	37.89
	S.D.	4.98	3.89	2.03	1.64	2.22

From this table differences between means are apparent. In order to ascertain whether these means were significant a 2-way ANOVA (analysis of variance) with repeated measures per cell was computed. The results are shown in Table 3. The 2-way ANOVA enabled the relationship of the 2 or more independent variables to the dependent variable, where each factor has two or more variables, to be investigated. In this study the 2-way ANOVA was used to conduct separate tests of the main effect of Standard, the main effect of Word Type, and also the interaction of Standard and Word Type on the dependent variable (scores on the tests). The main effect of standard provided a direct test of the developmental hypothesis of children's use of phonological and lexical decision skills in learning to read.

The 2-way between subjects ANOVA compared the subjects' performance with respect to Standard (1,2,3,4 and 5) and Word Type, (regular words, irregular words and non-words) and yielded the results which are shown on Table 3. There was a significant main effect of Standard ($F(4,387) = 76.33$; $p < 0.01$), Word Type ($F(2,387) = 159.54$; $p < 0.01$) and a significant interaction between Standard and Word Type ($F(8,387) = 4.42$; $p < 0.01$)

TABLE 3:

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (Regular Words, Irregular Words, Non-Words) x STANDARD (stds 1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr >F
Standard	4	2185.92	546.48	76.33	0.0001
Word Type	2	2284.54	1142.27	159.54	0.0001
Standard x Type	8	253.13	31.64	4.42	0.0001
Within Cell Error	387	2770.87	MSE = 7.16		
Total	401	7494.46			

A further examnination of the trends, which allowed for the separation of regular words, irregular words and non-words, was then carried out. The results are shown in Table 4. Unrelated 2-tailed t-tests were used to analyse the LSD's between means. Where differences were significant older children were always better than younger children.

Looking first at regular words the only significant differences were between means were between standard 1 and standard 2 ($t = 3.08$, $df = 387$, $p < .01$) and between Standard 2 and Standard 3. ($t = 2.77$, $df = 387$, $p < .01$). There were no differences for older children between standards 4 and 5.

For Irregular words there were differences between means for all consecutive standards, apart from between standard 3 and standard 4. Between standards 1 and 2 ($t = 4.9$, $df = 387$, $p < 0.01$) standards 2 and 3 ($t = 6.08$, $df = 387$, $p < 0.01$) and standards 4 and 5 ($t = 4.02$, df 387, $p < 0.01$). Although there was no difference between standards 3 and 4, there was a significant difference betweeen standards 3 and 5 ($t = 5.48$, $df = 387$).

Similar results were evident for non-words as there were differences between the means for standards 1 and 2 ($t = 3.23$ df $= 387$, $p < 0.01$), for standards 2 and 3 ($t = 5.62$, $df = 387$, $p < 0.01$) and standards 4 and 5 ($t = 2.34$, $df = 387$, $p < 0.05$). Although there was no difference between standards 3 and 4, there was a difference between tandards 3 and 5 ($t = 2.63$, $df = 387$, $p < 0.01$). For irregular words and non-words therefore there were significant differences between consecutive standards at all levels, but these differences became less significant as the subjects grew older.

Comparing regular versus irregular words performance on regular words was consistently better than performance on irregular words. There were significant differences for standard 1 ($t = 11.3$, df 387, $p < 0.01$), for standard 2 ($= 9.95$, $df = 387$, $p < 0.01$), for standard 3 ($t + 6.85$, $df = 387$, $p < 0.01$), for standard 4 ($= 6.81$, $df = 387$, $p < 0.01$) and for standard 5 ($t + 5.48$,$df = 387$, $p < 0.01$). Although performance was significantly better on regular

words for all standards, this difference became less as the children grew older.

Similarly comparing performance on non-words versus irregular words, performance on non-words was consistently better than performance on irregular words. There were significant differences for standard 1 ($t = 6.53$, df 387, $p < 0.01$), for standard 2 ($t = 5.26$, df 387, $p < 0.01$), for standard 3 ($t = 4.38$, df 387, $p < 0.01$), for standard 4 ($t = 3.43$, df 387, $p < 0.01$) and for standard 5 ($t = 2.82$, df 387, $p < 0.01$). Although performance was significantly better on non-words than on irregular words, these differences became less significant as the children grew older.

Comparing performance on non-words versus regular words, performance on regular words was better than on non-words. There were significant differences for standard 1 ($t = 4.79$, df 387, $p < 0.01$), for standard 2 ($t = 4.68$, df 387, $p < 0.01$), for standard 3 ($t = 2.46$, df = 387, $p < 0.05$), for standard 4 ($t = 3.38$, df 387, $p < 0.01$) and for standard 5 ($t = 2.65$, df 387, $p < 0.01$). Differences in performance between regular and non-words became less significant as the children became older.

TABLE 4

RESULTS OF LEAST SIGNIFICANT DIFFERENCES (LSD) ANALYSES: REGULAR WORDS, IRREGULAR WORDS AND NON-WORDS: PHONOLOGICAL TESTS 1 & 2

Regular Words

Between	Std 1 & Std 2	p <.01
	Std 2 & Std 3	p <.01
Between	Std 3 & Std 4	n.s.
	Std 4 & Std 5	n.s.
	Std 3 & Std 5	n.s.

Irregular Words

Between	Std 1 & Std 2	p < .01
	Std 2 & Std 3	p < .01
	Std 4 & Std 5	p < .01
	Std 3 & Std 5	p < .01
Between	Std 3 & Std 4	n.s.

Non-Words

Between	Std 1 & Std 2	p < .01
	Std 2 & Std 5	p < .01
	Std 4 & Std 5	p < .05
	Std 3 & Std 5	p < .01
Between	Std 3 & Std 4	n.s.

Regular vs Irregular Words

For	Std 1 p < .01
	Std 2 p < .01
	Std 3 p < .01
	Std 4 p < .01
	Std 5 p < .01

Non-Words vs Irregular Words

For	Std 1 p < .01
	Std 2 p < .01
	Std 3 p < .01
	Std 4 p < .01
	Std 5 p < .01

Regular Words vs Non-Words

For	Std 1 p < .01
	Std 2 p < .01
	Std 3 p < .05
	Std 4 p < .01
	Std 5 p < .01

Phonological Tests 1 & 2

Analysis of Regular Words (High and Low Frequency) and Irregular Words (High and Low Frequency)

In order to ascertain whether there were any differences due to frequency and regularity across standards, the mean number of correct responses per standard to high and low frequency regular and irregular words was calculated. These means as well as standard deviations are shown in Table 5.

TABLE 5

TABLE 5: MEANS FOR REGULAR WORDS (HIGH AND LOW FREQUENCY), IRREGULAR WORDS (HIGH AND LOW FREQUENCY)

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
REGULAR WORDS					
MEAN	18.96	19.44	19.91	19.92	20.00
HIGH FREQUENCY (n=20)					
S.D.	2.20	0.70	0.42	0.55	0
REGULAR WORDS					
MEAN	16.72	18.00	19.23	19.38	19.56
LOW FREQUENCY (n=20)					
S.D.	2.15	1.57	0.85	0.62	0.6
IRREGULAR WORDS					
MEAN	17.76	19.60	19.68	19.69	19.97
HIGH FREQUENCY (n=20)					
S.D.	2.98	1.47	0.55	1.43	0.16
IRREGULAR WORDS					
MEAN	9.72	10.28	13.91	14.58	16.14
LOW FREQUENCY (n=20)					
S.D.	2.81	2.66	2.17	1.74	1.78

To assess whether the differences between the means were significant, the data were analysed using a 2 way ANOVA. The

results of the ANOVA are shown in Table 6. The 2-way ANOVA yielded the following results:

there was a significant main effect of Standard ($F(4,516) = 67.18$; $p < 0.01$), of Word Type $F(3,516) = 438.05$; $p < 0.01$) and a significant interaction between Standard and Word Type ($F(12,516) = 4.42$; $p < 0.01$).

TABLE 6

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (Regular Words/High & Low Frequency, Irregular Words/ High & Low Frequency) x STANDARD (stds 1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr >F
Standard	4	739.84	184.96	67.18	0.0001
Word Type	3	3618.05	1206.02	438.05	0.0001
Standard x Type	12	437.48	36.46	13.24	0.0001
Within Cell Error	516	1420.62	MSE = 2.75		
Total	535	6215.99			

Post hoc analyses shown in Table 7 allowed for the separation of regular high frequency words, regular low frequency words, irregular high frequency words and irregular low frequency words. As with Table 4 where differences were significant, older children were always better than younger children.

Observation of the results for high frequency regular words shows that none of the means obtained by the children of different standards differed for this type.

For high frequency irregular words the only significant difference occurred between the means for children in standard 1 and standard

2 ($t = 3.9$, $df = 516$, $p < 0.01$). Older children did not differ for this word type.

The means obtained on low frequency regular words differed between standards 1 and 2 ($t = 2.72$, $df = 516$, $p < 0.01$) and between standards 2 and 3 ($t = 2.56$, $df = 516$, $p < 0.05$) but there were no differences between older subjects.

For low frequency irregular words all comparisons differed significantly except between means for children in standards 1 and 2. There was, however, a difference between standards 1 and 3 ($t = 8.72$, $df = 516$, $p < .01$), along with the differences between standards 2 and 3 ($t = 7.79$, $df = 516$, $p < .01$), between standards 3 and 4 ($t = 2.21$, $df = 516$, $p < .05$) and between standards 4 and 5 ($t = 3.00$, df 516, $p < .01$).

Comparison of performance on the word types for each standard shows no significant differences between high frequency regular words and high frequency irregular words for any standard.

There were significant differences in performance between high frequency regular words and low frequency regular words for standard 1 ($t = 4.87$, $df = 516$, $p < 0.01$), for standard 2 ($t = 3.13$, $df = 516$, $p < 0.01$) with performance on high frequency regular words being better than on low frequency regular words. There were no significant differences between these word types for standards 3, 4 and 5 showing that children in standard 3 upwards

were equally able to read low frequency regular words as they are to read high frequency regular words

Results comparing performance on low frequency regular with low frequency irregular words was significantly better for all standards on the low frequency regular words; for standard 1 ($t = 15.22$, $df = 516$, $p < 0.01$), for standard 2 ($t = 16.52$, $df = 516$, $p < 0.01$), for standard 3 ($t = 10.86$, $df = 516$, $p < 0.01$), for standard 4 ($t = 9.82$, $df = 516$, $P < 0.01$) and for standard 5 ($t = 8.79$, $df = 516$, $p < 0.01$) revealing a decrease in significance as the subjects became older and improved on the low frequency irregular words.

A similar trend was evident for performance on high frequency irregular words and low frequency irregular words where results yielded significant differences for all standards. Performance on high frequency irregular words was significantly better than for low frequency irregular words for standard 1 ($t = 17.48$, $df = 516$, $p < 0.01$), for standard 2 ($t = 20.00$, $df = 516$, $p < 0.01$), for standard 3 ($t = 11.78$, $df = 516$ $p < 0.01$), for standard 4 ($t = 10.51$, $df = 516$, $p < 0.01$) and for standard 5 ($t = 9.87$, $df = 516$, $p < 0.01$) revealing a decrease in significance as the subjects became older. It should be noted that comparisons between low frequency regular and low frequency irregular words, and between high frequency irregular and low frequency irregular words showed a noticeable decrease in significance at the standard 3 level.

TABLE 7

RESULTS OF LEAST SIGNIFICANT DIFFERENCE ANALYSES: REGULAR (HIGH AND LOW FREQUENCY), IRREGULAR (HIGH AND LOW FREQUENCY)

High Frequency Regular Words
Between Std 1 & Std 2 n.s.
Between Std 2 & Std 3 n.s.
Between Std 3 & Std 4 n.s.
Between Std 4 & Std 5 n.s.

Low Frequency Regular Words
Between Std 1 & Std 2 $p < .01$
Between Std 2 & Std 3 $p < .05$
Between Std 3 & Std 4 n.s.
Between Std 4 & Std 5 n.s.

High Frequency Irregular Words
Between Std 1 & Std 2 $p < .01$
Between Std 2 & Std 3 n.s.
Between Std 3 & Std 4 n.s.
Between Std 4 & Std 5 n.s.

Low Frequency Irregular Words
Between Std 1 & Std 3 $p < .01$
Between Std 2 & Std 3 $p < .01$
Between Std 3 & Std 4 $p < .05$
Between Std 4 & Std 5 $p < .01$
Between Std 1 & Std 2 n.s.

High Frequency Regular vs High Frequency Irregular Words
No significant differences

High Frequency Regular vs Low Frequency Regular Words
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 n.s.
For Std 4 n.s.
For Std 5 n.s.

Low Frequency Regular vs Low Frequency Irregular
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 $p < .01$

High Frequency Irregular vs Low Frequency Irregular
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 $p < .01$

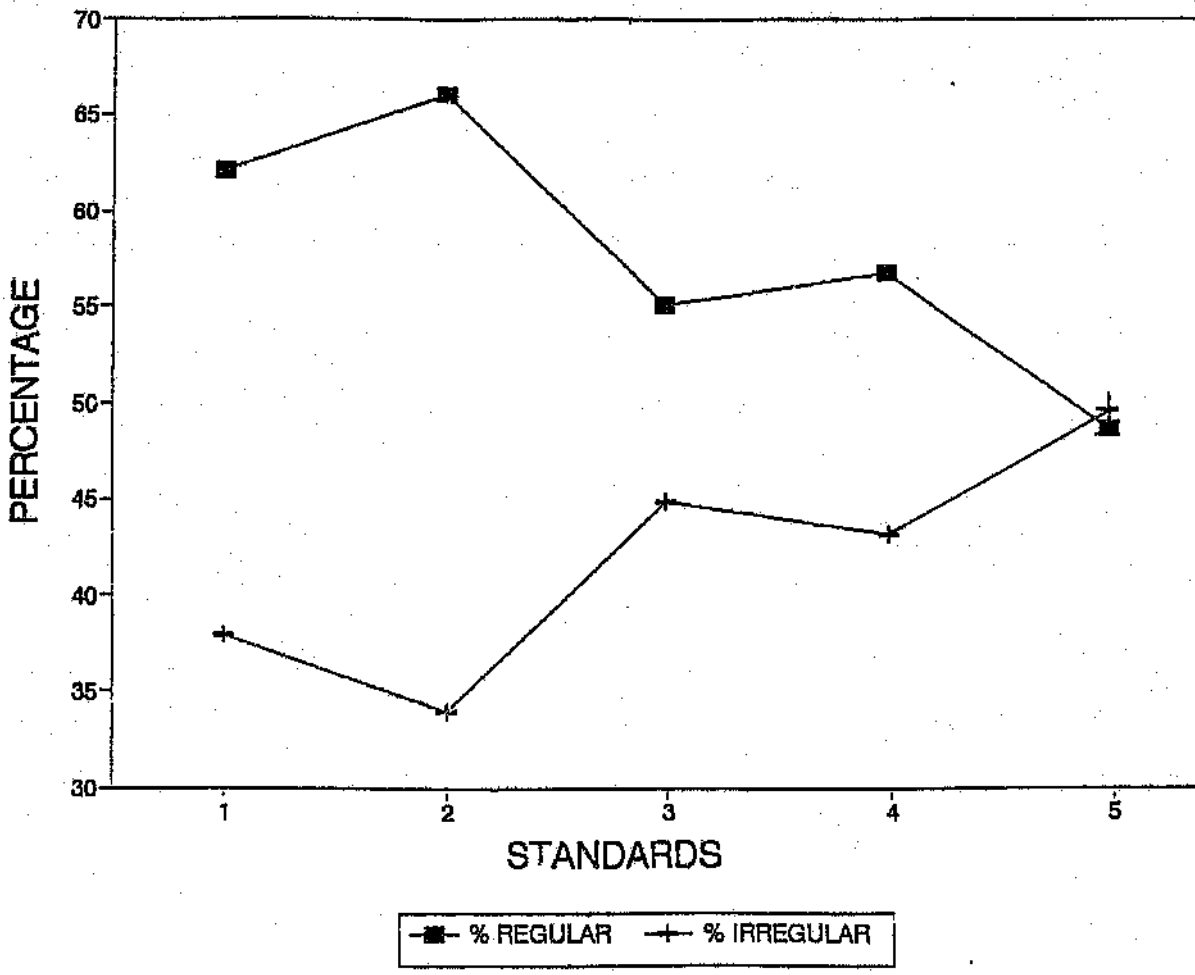
Data obtained on Test 2, describing the subjects' correct responses to the non-word list, and showing the percentage of non-words pronounced by analogy to regular or irregular words, is reported in Table 8 in order to elucidate the reading strategy employed by the children. The mean percentage read by analogy to regular words and the mean percentage read by analogy to irregular words respectively were plotted for each of standards 1,2,3,4 and 5, yielding Figure 1. Both Table 8 and Figure 1 indicate that the 2 patterns (i.e. analogy to regular words and analogy to irregular words) do in fact vary.

TABLE 8

% OF NON-WORDS PRONOUNCED BY ANALOGY TO REGULAR OR IRREGULAR WORDS

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
NON-WORDS					
% REGULAR PRONUNCIATION MEAN	62.03	66.1	55.05	56.8	48.65
% REGULAR PRONUNCIATION S.D.	10.39	10.92	7.51	11.34	11.08
% IRREGULAR PRONUNCIATION MEAN	37.97	33.9	44.95	43.2	51.35
% IRREGULAR PRONUNCIATION S.D.	10.39	10.92	7.51	11.34	11.08

FIGURE 1


70
65
60
55
50
45
40
35
30
PERCENTAGE
1
2
3
4
5
STANDARDS
% REGULAR
% IRREGULAR

To assess whether these apparent differences in reading strategies were significant, the data were analysed using a 2-way ANOVA. This analysis, the results of which are shown in Table 9, yielded the following results:

there was a significant main effect of Recoding Strategy ($F(1,258) = 118.40$; $p < 0.01$) and a significant interaction between Standard and Recoding Strategy ($F(4,258) = 23.17$; $p < 0.01$) but there was no significant main effect of Standard.

TABLE 9

SUMMARY OF RESULTS OF A 2-WAY ANOVA : RECODING STRATEGY (percentage of words pronounced by analogy to regular words, percentage of words pronounced by analogy to irregular words) x STANDARD (1,2,3,4 & 5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr F
Standard	4	0.02	0.00	0.00	1.0000
Recoding Strategy	1	13399.35	13399.35	118.40	0.0001
Standard x Recoding Strategy	4	10486.43	2621.61	23.17	0.0001
Within Cell Error	258	29197.20	MSE 113.17		
Total		53083.00			

The trends which appeared evident in Figure 1 were then further investigated to allow for the separation of standard and recoding strategy, and these results are summarised in Table 10. Results indicated that different strategies were preferred by different standards. At standard 1 level significantly more children read the non-words by analogy to regular words ($t = 8.03$, df 258 $p < 0.01$) as well as at standard 2 level ($t = 10.70$ df 258, $p < 0.01$). Although at standard 3 level ($t = 3.12$, df 258 $p < 0.01$) and

standard 4 level ($t = 4.66$ df 258, $p < 0.01$) the differences were still significant, they were noticeably reduced and by standard 5 level there was no significant difference and the children were equally likely to regularise as they were to use analogies to irregular words.

In order to ascertain whether the increases in the percentage of words pronounced by analogy to irregular words were significant Least Significant Differences of the differences between means for consecutive standards were calculated. Where differences are significant older children pronounced more words by analogy to irregular words than younger children. Although there were no significant differences between standards 1 and 2, and between standards 3 and 4, there were significant differences between standards 1 and 3 ($t = 2.27$, $df = 258$, $p < 0.05$), between standards 2 and 3 ($t = 3.59$, df 258, $p < 0.01$), between standards 2 and 4 ($t = 3.0$, $df = 258$, $p < 0.01$), between standards 3 and 5 ($t = 2.24$, $df = 258$, $p < 0.05$) and between standards 4 and 5 ($t = 3.0$, df 258, $p < 0.01$). These differences indicate that older children pronounced non-words more by analogy to irregular words than younger children.

TABLE 10

RESULTS OF LEAST SIGNIFICANT DIFFERENCES ANALYSES: PERCENTAGE OF NON-WORDS PRONOUNCED BY ANALOGY TO IRREGULAR WORDS

% of Non-Words read by analogy to Regular Words vs by analogy to Irregular Words

For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 n.s.

Increase in % of Non-Words read by analogy to Irregular Words

Between Std 1 and Std 3 $p < 0.05$
Between Std 2 and Std 3 $p < 0.01$
Between Std 2 and Std 4 $p < 0.01$
Between Std 3 and Std 5 $p < 0.05$
Between Std 4 and Std 5 $p < 0.01$

Between Std 1 and Std 2 n.s.
Between Std 3 and Std 4 n.s.

Phonological Tests

Silent Test of Phonology

Table 11 summarises the data obtained on the Silent Test of Phonology and gives the mean and standard deviation for each Standard of each Word Type (regular words, irregular words and non-words) pronounced correctly on Test 3.

TABLE 11

MEANS FOR SILENT TEST OF PHONOLOGY (TEST 3)

		STANDARDS				
		1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
REGULAR (n=20)	MEAN	18.16	18.24	18.91	19.23	19.56
	S.D.	1.74	1.92	1.2	0.85	0.65
IRREGULAR (n=20)	MEAN	16.24	17.56	18.14	18.35	18.81
	S.D.	1.88	1.65	1.29	1.21	0.97
NON-WORDS (n=20)	MEAN	15.24	14.8	17.68	16.04	18.47
	S.D.	3.19	2.3	1.58	2.16	1.3

From this table differences between means were apparent. In order to ascertain whether these differences were significant the data were analysed using a 2-way ANOVA, the results of which are shown in Table 12. The 2 way ANOVA yielded the following results:

there was a significant main effect of Standard ($F(4,387) = 29,72$; $p < .01$), of Word Type ($F(2,387) = 60.63$; $p < .01$) and a significant interaction between Standard and Word Type ($F(8,387) = 4.42$; $p < .01$).

TABLE 12

SUMMARY OF 2-WAY ANOVA : WORD TYPE (Regular Words, Irregular Words, Non-words) x STANDARD (stds 1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr >F
Standard	4	344.85	86.21	29.72	0.0001
Word Type	2	351.8	175.90	60.63	0.0001
Standard x Type	8	102.51	12.81	4.42	0.0001
Within Cell Error	387	1122.7	MSE = 2.9		
Total	401	1921.86			

Post hoc analyses shown in Table 13 allowed for the separation of regular words, irregular words and non-words. Where significant differences between standards are observed the means for higher standards were always better than for lower standards.

For regular words there was no significant differences between standards 1 and 2, and between standards 3 and 4, and between standards 4 and 5. There only significant differences were between standards 1 and 3 ($t = 3.00$, $df = 387$, $p < .01$), between standards 2 and 3 ($t = 2.68$, $df = 387$, $p < .01$) and between standards 3 and 5 ($t = 3.05$, $df = 387$, $p < .01$).

For irregular words the means differed between standards 1 and 2 ($t = 5.72$, $df = 387$, $p < .01$) and between standards 2 and 3 ($t = 2.28$, df 387 $p < .05$) but there were no differences between means for standards for older children.

For non-words there were no significant differences between means for standards 1 and 2, and between standards 3 and 4. There were significant differences between the means for standards 1 and 3 ($t = 9.76$, $df = 387$, $p < .01$), standards 2 and 3 ($t = 11.52$, $df = 387$, $p < .01$), standards 3 and 5 ($t = 4.00$, $df = 387$, $p < .01$) and standards 4 and 5 ($t = 13.11$, $df = 387$, $p < .01$).

Analyses of the differences between Word Types per Standard revealed significant differences for all standards for regular words versus non-words with regular word better than non-words. There were significant differences for standard 1 ($t = 6.08$, df 387, $p < .01$), for standard 2 ($t = 3.44$, df 387, $p < .01$), for standard 3 ($t = 2.39$, df 387, $p < 0.05$), for standard 4 ($t = 6.79$, df 387, $p < .01$) and for standard 5 ($t = 2.57$, df 387, $p < .01$).

For regular versus irregular words performance was better for regular words and there was a significant difference at the 1% level for standard 1 ($t = 4.00$, df 387) but no significant differences for standards 2, 3, 4 and 5 showing that although performance continued to be better on regular words, performance on irregular words approached the ceiling by standard 2.

For irregular words versus non-words performance was better at all standard levels for irregular words but significant differences were only observed for standard 1 ($t = 2.08$, df 387, $p < .05$), for std 2 ($t = 5.75$, df 387, $p < .01$) and for standard 4 ($t = 4.91$, df 387, $p < .01$)

TABLE 13

RESULTS OF LEAST SIGNIFICANT DIFFERENCES (LSD) ANALYSES: SILENT TEST OF PHONOLOGY REGULAR WORDS, IRREGULAR WORDS AND NON-WORDS

Regular Words

Between Std 2 & Std 3	$p < .01$
Between Std 1 & Std 3	$p < .01$
Between Std 3 & Std 5	$p < .01$
Between Std 1 & Std 2	n.s.
Between Std 3 & Std 4	n.s.
Between Std 4 & Std 5	n.s.

Irregular Words

Between Std 1 & Std 2	$p < .01$
Between Std 2 & Std 3	$p < .01$
Between Std 3 & Std 4	n.s.
Between Std 4 & Std 5	n.s.

Non-Words

Between Std 1 & Std 3	$p < .01$
Between Std 2 & Std 3	$p < .01$
Between Std 3 & Std 5	$p < .01$
Between Std 4 & Std 5	$p < .01$
Between Std 1 & Std 2	n.s.
Between Std 3 & Std 4	n.s.

Regular vs Irregular

For Std 1	$p < .01$
For Std 2	n.s.
For Std 3	n.s.
For Std 4	n.s.
For Std 5	n.s.

Regular vs Non-Words

For Std 1	$p < .01$
For Std 2	$p < .01$
For Std 3	$p < .05$
For Std 4	$p < .01$
For Std 5	$p < .01$

Irregular vs Non-Words

For Std 1	$p < .05$
For Std 2	$p < .01$
For Std 3	n.s.
For Std 4	$p < .01$
For Std 5	n.s

Reading Aloud Test of Phonology

Table 14 summarises the data obtained on the Reading Aloud Test of Phonology (Matched in words to the Silent Test) and gives the mean and standard deviation for each standard of each word type (regular words, irregular words and non-words) pronounced correctly on Test 4.

TABLE 14

MEANS FOR READING ALOUD TEST OF PHONOLOGY

		STANDARDS				
		1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
REGULAR WORDS (n=20)	MEAN	17.48	19.32	19.59	19.88	19.89
	S.D.	3.13	0.73	0.65	0.58	0.39
IRREGULAR WORDS (n=20)	MEAN	17.00	18.44	18.77	19.38	19.56
	S.D.	1.96	1.3	1.04	0.56	[illegible] 8
NON-WORDS (n=20)	MEAN	15.00	15.6	17.14	17.58	19.06
	S.D.	3.5	2.19	1.79	1.36	1.31

This table shows differences between means across all standards. In order to ascertain whether these differences were significant, the data were analysed using a 2-way ANOVA , the results of which are summarised in Table 15. The 2-way ANOVA yielded the following results:

there was a significant main effect of Standard ($F(4,387) = 41.06$; $p < .01$), of Word Type ($F(2,387) = 64.99$; $p < .01$) and a significant interaction between Standard and Word Type ($F(8,387 = 3.33$; $p < .01$).

TABLE 15

2-WAY ANOVA : WORD TYPE (Regular Words,Irregular Words,Non-Words) x STANDARD (stds 1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr >F
Standard	4	454.62	113.65	41.06	0.0001
Word Type	2	359.74	175.86	64.99	0.0001
Standard x Type	8	73.79	9.22	3.33	0.0011
Within Cell Error	387	1071.1	MSE = 2.77		
Total	401	1959.25			

Further analyses of the Least Significant Differences between means for standards (summarized in Table 16) revealed significant differences for non-words for all standards; between standards 1 and 2 ($t = 2.7, df = 387, p < .01$), between standards 2 and 3 ($t = 6.4, df = 387, p < .01$), between standards 3 and 4($t = 1.96, df = 387, p < .05$) and between standards 4 and 5 ($t = 8.28$, $df = 387, p < .01$).

Differences between means for standards on the regular words and irregular words were not as consistently significant as the differences for non-words. For regular words there was a significant difference between standards 1 and 2 ($t = 8.36, df = 387, p < .01$) but there were no significant differences for older children. For irregular words there were significant differences between standards 1 and 2 ($t = 6.55, df = 387, p < .01$), between standards 1 and 3 ($t = 7.7, df = 387, p < .01$) and between standards

3 and 4 (t = 2.65,df = 387,p <.01). There were no significant differences between standards 2 and 3, and 4 and 5.

Comparison between the performance on regular versus irregular words did not reveal any significant differences for each standard.

For performance on regular words compared with non-words, significant differences were observed for all standards. Performance was significantly better on regular than on non-words for standard 1 (t = 5.28, df 387, p < 0.01), for standard 2 (t = 7.91, df 387, p < 0.01), for standard 3 2.46, df 387, p < 0.05), for standard 4 (t = 5.02, df 387, p < 0.01) and for standard 5 (t = 2.12, df 387 p < 0.05).

Performance was significantly better on irregular words compared with non-words for standard 1 (t = 4.26, df 387, p < 0.01), for standard 2 (t = 6.04, df 387, p < 0.01), for standard 3 (t = 3.28, df 387, p < 0.01), for standard 4 (t = 3.93, df 387 p < 0.01) but there was no significant difference for standard 5.

TABLE 16

RESULTS OF LEAST SIGNIFICANT DIFFERENCES ANALYSES: READING ALOUD TEST OF PHONOLOGY: REGULAR IRREGULAR AND NON-WORDS

Regular Words
Between Std 1 & Std 2 $p < .01$
Between Std 2 & Std 3 n.s.
Between Std 3 & Std 4 n.s.
Between Std 4 & Std 5 n.s.

Irregular Words
Between Std 1 & Std 2 $p < .01$
Between Std 3 & Std 4 $p < .01$
Between Std 1 & Std 3 $p < .01$
Between Std 2 & Std 3 n.s.
Between Std 4 & Std 5 n.s.

Non-Words
Between Std 1 & Std 2 $p < .01$
Between Std 2 & Std 3 $p < .01$
Between Std 3 & Std 4 $p < .01$
Between Std 4 & Std 5 $p < .01$

Regular vs Irregular Words
No significant differences

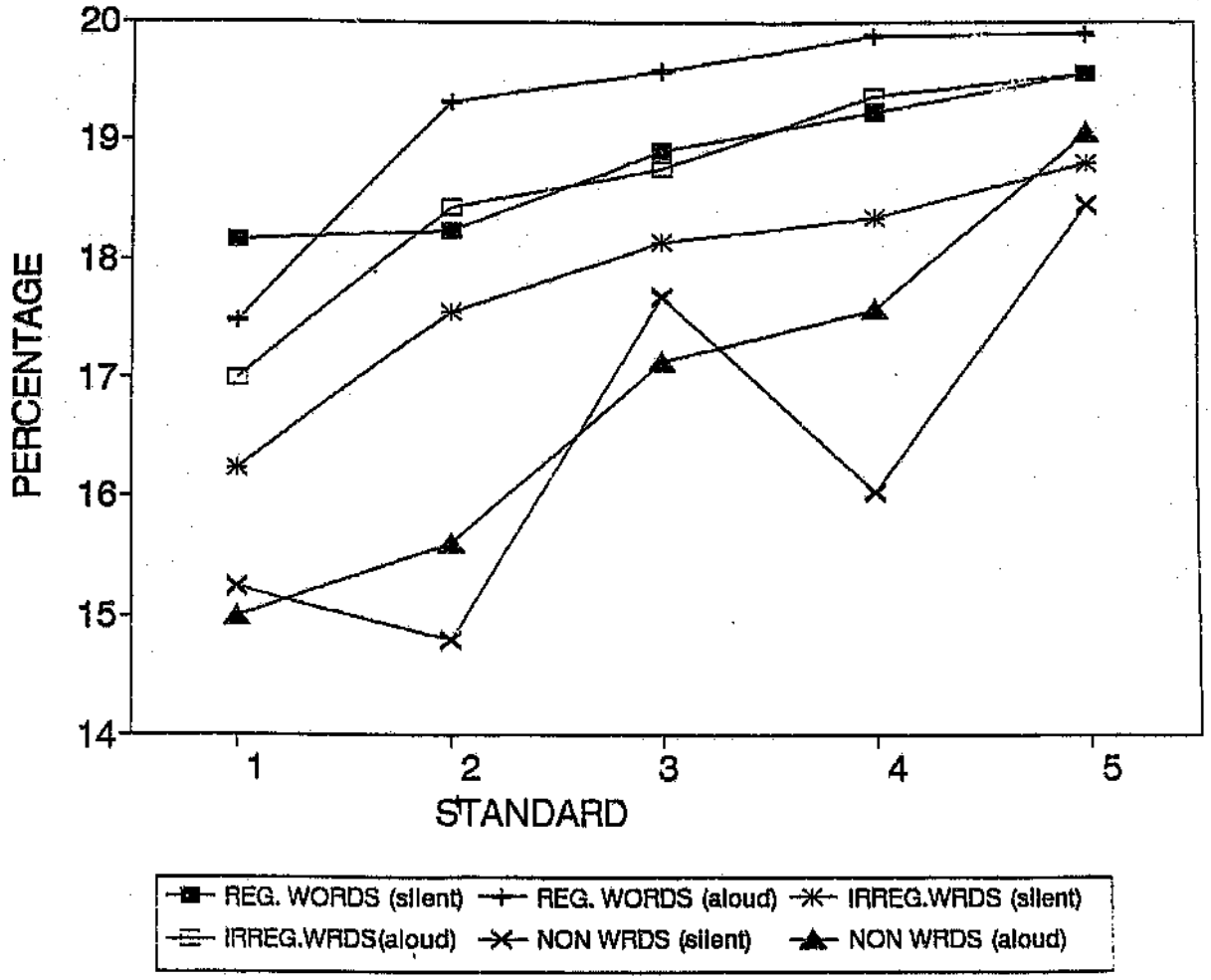
Regular Words vs Non-Words
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .05$
For Std 4 $p < .01$
For Std 5 $p < .01$

Irregular vs Non-Words
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 n.s.

Silent Test of Phonology compared with the matched Reading Aloud Test

Means for correct regular words, irregular words and non-words for each standard on Tests 3 and 4 are plotted on Figure 2. This graph indicates that the patterns for the Silent Test of Phonology and the Reading Aloud Test of Phonology are similar for regular and irregular words and non-words, with overall performance on the matched Reading Aloud tests appearing to differ.

FIGURE 2



To assess the significance of these differences between the subjects' responses on the Silent Test and their responses on the Reading Aloud Test, a 2-way ANOVA was computed. The 2-way ANOVA analysed the data in Table 11 and Table 14 and compared the subjects' performance with respect to standard and word type (regular, irregular and non-words read silently, and regular, irregular and non-words read aloud) and yielded the results which are shown in Table 17. There was a significant main effect of Standard ($F(4,774) = 67.65$; $p < 0.01$) of Word Type ($F(5,774) = 54.57$; $p < 0.01$) and a significant interaction between Standard and Word Type ($F(20.774) + 3.68$; $p < 01$).

TABLE 17

2-WAY ANOVA : WORD TYPE (Silent regular, irregular and non-words; Reading Aloud regular, irregular and non-words) x STANDARD (1,2,3,4 & 5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr F
Standard	4	767.01	191.75	67.65	0.0001
Word Type	5	773.39	154.68	54.57	0.0001
Standard x Type	20	208.76	10.44	3.68	0.0001
Within Cell Error	774	2198.80	MSE 2.83		
Total	803	3942.96			

In order to separate the results of the subjects' performance on the Silent Tests from their results on the Reading Aloud Tests, analyses of the Least Significant Differences were calculated. These results are summarized in Table 18.

For regular words the standard 2 group was significantly better at reading aloud than at making silent judgements about phonology ($t = 2.25$, df 774, $p < 0.05$) but none of the other standards showed any significant differences for either mode of response.

For irregular words only the standard 4 group showed significantly better performance on reading aloud than on the silent tests ($t = 2.21$; $df = 774$ $p < 0.05$) but none of the other groups showed significantly better performance on either mode of response.

For non-words the only significant difference was for standard 4 children ($t = 3.27$; $df = 774$; $p < 0.01$) where reading aloud was better.

TABLE 18

RESULTS OF LEAST SIGNIFICANT DIFFERENCES ANALYSES (LSD'S): SILENT VS READING ALOUD TESTS: REGULAR WORDS, IRREGULAR WORDS AND NON-WORDS

LSD's between results for Silent Tests vs Reading Aloud Tests for Regular Words	
Standard 1	n.s.
Standard 2	$p < .05$
Standard 3	n.s.
Standard 4	n.s.
Standard 5	n.s.

LSD'S between results for Silent Tests vs Reading Aloud Tests for Irregular Words	
Standard 1	n.s.
Standard 2	n.s.
Standard 3	n.s.
Standard 4	$p < 0.05$
Standard 5	n.s.

LSD'S between results for Silent Tests vs Reading Aloud Tests for Non-Words	
Standard 1	n.s.
Standard 2	n.s.
Standard 3	n.s.
Standard 4	$p < .01$
Standard 5	n.s.

Lexical Decision Tests - Visual

Table 19 shows the mean correct responses for Words and Non-Words and gives the means and standard deviations of each standard for Words and Non-Words correctly identified.

TABLE 19

MEANS FOR LEXICAL DECISION - TEST 5: VISUAL

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
WORDS					
MEAN	24.68	25.96	26.59	27.85	28.08
TOTAL (n=32)					
S.D.	2.03	2.01	1.87	1.43	1.46
NON-WORDS					
MEAN	28.36	28.44	30.59	30.46	30.94
TOTAL (n=32)					
S.D.	3.99	3.81	1.27	1.97	1.03

This Table indicates a number of differences between means for the standards. To ascertain whether these differences are significant a 2-way ANOVA was computed and the results are shown below in Table 20. This 2-way ANOVA which compared the subjects' performance with respect to Standard (1,2,3,4 & 5) and Word Type (Words and Non-Words) showed a significant main effect for Standard ($F(4,258) = 17.58$; $p < 0.01$) and of Word Type ($f(1,258) = 122.05$; $p < 0.01$), but there was no significant interaction between Standard and Word Type.

TABLE 20

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (Words, Non-Words) x STANDARD (stds 1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr F
Standard	4	366.65	91.66	17.58	0.0001
Word Type	1	636.45	636.45	122.05	0.0001
Standard x Type	4	21.98	5.49	1.05	0.3800
Within Cell Error	258	1345.44	MSE = 5.21		
Total	267				

In order to separate the Word Types (words and won-words) further analyses of the Least Significant Differences between means were calculated. These results are summarized below in Table 21. For non-words no significant differences were revealed. For words significant differences were found between Standards 1 and 2 ($t = 1.96$, $df = 258$; $p < 0.05$), between Standards 1 and 3 ($t = 2.85$, $df = 258$; $p < 0.01$), between Standards 2 and 4 ($t = 2.85$, $df = 258$; $p < 0.01$), between Standards 3 and 4 ($t = 1.89$, df 258; $p < 0.05$) and between standards 3 and 5 ($t = 2.4$, $df = 258$; $p < 0.05$), indicating that the performance of older children are better at identifying words than younger children.

Comparisons of the performance of each standard on the identification of words versus non-words revealed significant differences for standard 1 ($t = 5.66$, df 258, $p < 0.01$), for

standard 2 ($t = 3.82$, df 258, $p < 0.01$), for standard 3 ($t = 5.80$, df 258, $p < 0.01$), for standard 4 ($t = 4.14$, df 258, $p < 0.01$) and for standard 5 ($t = 5.3$, df 258, $p < 0.01$) showing that at all ages children were better at identifying non-words than they were at identifying words.

TABLE 21

RESULTS OF LEAST SIGNIFICANT DIFFERENCES: LEXICAL DECISION - VISUAL (WORDS AND NON-WORDS)

Words
Between Std 1 and Std 2 $p < 0.05$
Between Std 1 and Std 3 $p < 0.01$
Between Std 2 and Std 4 $p < 0.01$
Between Std 3 and Std 4 $p < 0.05$
Between Std 3 and Std 5 $p < 0.05$
Between Std 2 and Std 3 n.s.
Between Std 4 and Std 5 n.s.
Non-Words
No Significant Differences
Non-Words vs Words
For Std 1 $p < 0.01$
For Std 2 $p < 0.01$
For Std 3 $p < 0.01$
For Std 4 $p < 0.01$
For Std 5 $p < 0.01$

In order to examine the effect of frequency on the scores obtained on the Visual Lexical Decision Tests, Table 22 shows the mean for High and Low Frequency Words, and High and Low Frequency Non-Words correctly identified and shows the means and standard deviations of each standard for these word types.

TABLE 22

MEANS FOR HIGH AND LOW FREQUENCY WORDS AND THEIR MATCHED NON-WORDS LEXICAL DECISION - VISUAL: TEST 5

	STANDARDS				
	1 (n=24)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
WORDS					
MEAN HIGH FREQUENCY (n=16)	15.48	15.8	15.82	15.96	15.94
S.D.	0.64	0.4	0.39	0.19	0.23
MEAN LOW FRLQUENCY (n=16)	9.8	10.16	10.77	11.88	12.14
S.D.	1.96	1.98	1.95	1.42	1.38
NON-WORDS					
MEAN MATCHED TO HIGH FREQUENCY WORDS (n=16)	13.84	14.00	15.00	15.23	15.39
S.D.	2.41	2.1	0.95	1.09	0.64
MEAN MATCHED TO LOW FREQUENCY WORDS (n=16)	14.52	14.44	15.59	15.23	15.39
S.D.	2.42	2.04	0.58	1.12	0.64

The above table shows differences between means of standards for the 4 different word types. Therefore a 2-way ANOVA was computed to ascertain whether these apparent differences were significant

and the results are shown below in Table 23. The 2-way ANOVA, which compared the subjects' performance with respect to Standard (1,2,3,4 & 5) and Word Type (High Frequency Words, Low Frequency Words, High Frequency Non-Words, Low Frequency Non-Words), yielded the following results: there was a significant main effect of Standard ($F(4,516) = 22.49$; $p < 0.01$), of Word Type ($F(3,516) = 316.05$; $p < 0.01$) and a significant interaction between Standard and Word Type ($f(12,516) = 3.37$; $p < 0.01$).

TABLE 23

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (High Frequency Words, Low Frequency Words, High Frequency Non-Words, Low Frequency Non-Words) x STANDARD (1,2,3,4 & 5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr >F
Standard	4	181.32	45.33	22.49	0.0001
Word Type	3	1910.81	636.94	316.05	0.0001
Standard x Type	12	81.41	6.78	3.37	0.0001
Within Cell Error	516	1039.90	MSE = 2.02		
Total	535	3213.44			

As there were significant differences between standards, word types and a significant interaction between standard and word type, further analyses of the Least Significant Differences between means were calculated. The purpose of these analyses was to separate the 4 word types. Significant differences were revealed at all levels for Low Frequency Words; that is there were significant differences between Standards 1 and 2 ($t = 6.0$, $df = 516$; $p <$

0.01), between Standards 2 and 3 ($t = 3.59$, $df = 516$; $p < 0.01$), between Standards 3 and 4 ($t = 6.53$, $df = 516$; $p < 0.01$) and between Standards 4 and 5 ($t = 2.0$, $df = 516$, $p < 0.05$).

Less consistent trends were evident with the other word types. For High Frequency Words there was a significant difference between Standards 1 and 2 ($t = 2.0$, $df = 516$; $p < 0.05$) but no significant differences between the higher standards. There was a similar trend for Low Frequency Non-Words with a significant difference between standards 2 and 3 ($t = 8.71$, $df = 516$, $p < 0.01$) and no other significant differences for the higher standards. High Frequency Non-Words showed significant differences between Standards 2 and 3 ($t = 6.25$, $df = 516$; $p < 0.01$), between Standards 1 and 3 ($t = 7.25$, $df = 516$; $p < 0.01$), between Standards 3 and 5 ($t = 3.73$, $df = 516$; $p < 0.01$) and between Standards 4 and 5 ($t = 2.51$, df 516; $p < 0.05$).

Comparisons between performance on high frequency words and low frequency words revealed significant differences for standard 1 ($t = 9.66$, df 516 $p < .01$), for standard 2 ($t = 8.68$, df 516, $p < .01$), for standard 3 ($t = 7.3$, df 516, $p < .01$), for standard 4 ($t = 6.48$, $df = 516$, $p < .01$) and for standard 5 ($t = 7.06$, df 516, $p < .01$) showing that children at all levels are better at identifying high frequency words than they are at identifying low frequency words. Similarly comparing non-words, matched to high frequency words, with low frequency words significant differences in performance were found for standard 1 ($t = 7.14$, df 516, $p <$

.01), for standard 2 (t = 5.91, df 516, p < .01), for standard 3 (t = 6.12, df 516, p < .01), for standard 4 (t = 3.35, df 516, p < .01) and for standard 5 (t = 6.33, df 516, p < .01) showing that children at all levels are better at identifying non-words matched to high frequency words than they are at identifying low frequency words. When non-words were matched to low frequency words performance was still significantly better than performance on low frequency words for all standards. Therefore comparing non-words, matched to low frequency words, with low frequency words there were significant differences for standard 1 (t = 8.18, df 515, p < .01), for standard 2 (t = 6.65, df 561, p < .01), for standard 3 (t = 7.06, df 516, p < .01), for standard 4 (t = 5.32, df 516, p < .01) and for standard 5 (t = 5.98, df 516, p < .01).

For high frequency words compared with non-words matched to high frequency words, there were significant differences for standard 1 (t = 2.52, df 516, p < .05) and for standard 2 (t = 2.77, df 516, p < .01) but no significant differences were revealed for standard 3, 4 and 5, showing that by standard 3 children were equally able to identify high frequency words as they were to identify non-words matched to high frequency words. The trend was similar when performance on high frequency words was compared with non-words matched to low frequency words. The only significant difference was for standard 2 (t = 2.03, df 516, p < .05) showing that by standard 3 children were equally able to identify high frequency words as they were to identify non-words matched to low frequency words.

TABLE 24

RESULTS OF LEAST SIGNIFICANT DIFFERENCES (HIGH/LOW FREQUENCY WORD, MATCHED NON-WORDS)

High Frequency Words		Low Frequency Words	
Between Std 1 & Std 2	p < .05	Between Std 1 & Std 2	p < .01
Between Std 2 & Std 3	n.s.	Between Std 2 & Std 3	p < .01
Between Std 3 & Std 4	n.s.	Between Std 3 & Std 4	p < .01
Between Std 4 & Std 5	n.s.	Between Std 4 & Std 5	p < .05

Non-Words matched to High Frequency Words		Non-Words matched to Low Frequency Words	
Between Std 2 & Std 3	p < .01	Between Std 2 & Std 3	p < .01
Between Std 4 & Std 5	p < .05	Between Std 1 & Std 2	n.s.
Between Std 1 & Std 3	p < .01	Between Std 3 & Std 4	n.s.
Between Std 3 & Std 5	p < .01	Between Std 4 & Std 5	n.s.
Between Std 1 & Std 2	n.s.		
Between Std 3 & Std 4	n.s.		

High Frequency Words vs Low Frequency Words
For Std 1 p < .01
For Std 2 p < .01
For Std 3 p < .01
For Std 4 p < .01
For Std 5 p < .01

High Frequency Words vs Non-Words matched to High Frequency Words
For Std 1 p < .01
For Std 2 p < .01
For Std 3 n.s.
For Std 4 n.s.
For Std 5 n.s.

High Frequency Words vs Non-Words matched to Low Frequency Words
For Std 1 n.s.
For Std 2 p < .05
For Std 3 n.s.
For Std 4 n.s.
For Std 5 n.s.

Non-Words matched to High Frequency Words vs Low Frequency Words
For std 1 p < .1
For Std 2 p < .01
For Std 3 p < .01
For Std 4 p < .01
For Std 5 p < .01

Non-Words matched to Low Frequency Words vs Low Frequency Words
For Std 1 p < .01
For Std 2 p < .01
For Std 3 p < .01
For Std 4 p < .01
For Std 5 p < .01

Lexical Decision Tests - Auditory

A similar analysis of the same words presented aurally was then carried out. Table 25 shows the mean correct responses for Words and Non-words presented aurally, and gives the means and standard deviations of each standard for Words and Non-Words identified correctly.

TABLE 25

MEANS FOR LEXICAL DECISION - TEST 6: AUDITORY (WORDS AND NON-WORDS)

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
WORDS					
MEAN	27.92	28.00	28.86	29.58	29.58
TOTAL (n=32)					
S.D.	1.38	1.94	1.29	1.36	1.21
NON-WORDS					
MEAN	30.75	29.92	31.00	29.69	30.36
TOTAL (n=32)					
S.D.	0.99	1.16	0.90	2.04	1.47

The data above show that the means for words increase with standard. Means for non-words show ceiling effects at all standards. In order to ascertain whether the difference reflected in the above table were significant, a 2-way ANOVA, which compared the subjects' performance with respect to Standard (1,2,3,4 & 5) and Word Type (Words and Non-Words) was computed. The results are shown in Table 26. There was a significant main effect of Standard ($F(4,258) = 4.32$; $p < 0.05$), of Word Type ($F(1,258) = 64.66$; $p < 0.01$) and a significant interaction between Standard and Word Type ($F(4,258) = 7.07$; $p < 0.01$)

TABLE 26

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (Words, Non-Words) x STANDARD (1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr F
Standard	4	38.73	9.68	4.32	0.0021
Word Type	1	144.81	144.81	64.66	0.0001
Standard x Type	4	63.36	15.84	7.07	0.0001
Within Cell Error	258	577.77	MSE 2.24		
Total	267	824.67			

In order to separate the Word Types (Words and Non-Words) further analyses of the Least Significant Differences between means were calculated. These results are summarized below in Table 27. As found with the Visual Lexical Decision Test there were no significant differences for Non-Words apart from between Standards 2 and 3 ($t = 2.5$, $df = 258$; $p < 0.05$).

For Words, however, significant differences were found at all levels, apart from between standards 3 and 4 indicating a particularly noticeable improvement at standard 3 level. There were significant differences between Standards 2 and 3 ($t = 2.0$, $df = 258$; $p < 0.05$), between Standards 1 and 3 ($t = 2.19$, $df = 258$; $p < 0.05$), between Standards 2 and 4 ($t = 3.65$, $df = 258$; $p < 0.01$), between Standards 3 and 5 ($t = 3.75$, df 258; $p < 0.01$) and between Standards 4 and 5 ($t = 2.02$, $df = 258$; $p < 0.05$).

As with the Visual Lexical Decision Test, a comparison of the ability to identify non-words versus words revealed significant differences at all levels apart from for standard 4. There were significant differences for standard 1 ($t = 6.74$, df 258, $p < .01$), for standard 2 ($t = 4.57$, df 258, $p < .01$), for standard 3 ($t = 4.86$, df 258, $p < .01$) and for standard 5 ($t = 2.23$, df 258, $p < .05$) with differences diminishing as the children grew older indicating an improvement in the ability to identify words particularly up to standard 3 level.

TABLE 27

RESULTS OF LEAST SIGNIFICANT DIFFERENCES: LEXICAL DECISION - AUDITORY (WORDS AND NON-WORDS)

Words

Between Std 2 and Std 3 $p < 0.05$
Between Std 1 and Std 3 $p < 0.05$
Between Std 3 and Std 4 $p < 0.05$
Between Std 2 and Std 4 $p < 0.01$
Between Std 3 and Std 5 $p < 0.01$
Between Std 4 and Std 5 $p < 0.05$
Between Std 1 and Std 2 n.s.

Non-Words

Between Std 2 and Std 3 $p < 0.05$
Between Std 1 and Std 2 n.s.
Between Std 1 and Std 3 n.s.
Between Std 3 and Std 4 n.s.
Between Std 2 and Std 4 n.s.
Between Std 3 and Std 5 n.s.
Between Std 4 and Std 5 n.s.

Non-Words vs Words

For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 n.s.
For Std 5 $p < .05$

In order to investigate the effect of frequency on the results of the Auditory Lexical Decision Tests, Table 28 shows the means correct responses for high and low frequency words, and non-words matched to high and low frequency non-words correctly identified, and shows the means and standard deviations of each standard for these word types on the Lexical Decision (Auditory) Test.

TABLE 28

MEANS FOR HIGH AND LOW FREQUENCY WORDS, AND MATCHED NON-WORDS: TEST 6

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
WORDS					
MEAN	15.68	15.72	15.95	15.96	15.83
HIGH FREQUENCY (n=16)					
S.D.	0.55	0.72	0.29	0.19	0.37
MEAN	12.24	12.28	12.95	13.62	13.75
LOW FREQUENCY (n=16)					
S.D.	1.21	1.82	1.26	1.27	1.21
NON-WORDS					
MEAN	15.68	15.72	15.95	15.96	15.83
NON-WORDS MATCHED TO HIGH FREQUENCY WORDS (n=16)					
S.D.	0.47	0.71	0.29	1.02	0.76
MEAN	15.08	14.68	15.09	14.58	14.92
NON-WORDS MATCHED TO LOW FREQUENCY WORDS (n=16)					
S.D.	0.80	1.16	0.79	1.31	0.95

The above table shows differences between means for standards for the 4 different word types. Therefore a 2-way ANOVA was computed to ascertain whether these apparent differences were significant and the results are shown below in Table 29. The 2-way ANOVA, which compared the subjects' performance with respect to Standard (1,2,3,4 & 5) and Word Type (High Frequency Words, Low Frequency Words, High Frequency Non-Words, Low Frequency Non-Words), yielded the following results: there was a significant main effect of Standard ($f(4,516) = 5.21$; $p < 0.01$), of Word Type ($F(3,516) = 217.28$; $p < 0.01$) and a significant interaction between Standard and Word Type ($F(12,516) = 4.96$; $p < 0.01$).

TABLE 29

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (High Frequency Words, Low Frequency Words, High Frequency Non-Words, Low Frequency Non-Words) x STANDARD (stds 1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr >F
Standard	4	19.67	4.92	5.21	0.0004
Word Type	3	614.84	204.95	217.28	0.0001
Standard x Type	12	56.20	4.68	4.96	0.0001
Within Cell Error	516	486.72	MSE = 0.94		
Total	535	1177.43			

Further analyses of the data were calculated in order to separate the 4 word types. Significant differences were found between standards at all levels for Low Frequency Words. There were

significant differences between Standards 1 and 3 ($t = 2.63$, df 516; $p < 0.01$), between Standards 2 and 3 ($t = 2.48$, $df = 516$; $p < 0.05$), between Standards 3 and 4 ($t = 2.48$, $df = 516$; $p < 0.05$) and between Standards 3 and 5 ($t = 3.2$, $df = 516$; $p < 0.01$), showing that children performed significantly better on low frequency words as they become older. There were, however, no significant differences between standards for High Frequency Words, Non-Words matched to high frequency words and Non-Words matched to low frequency words.

Comparisons were made of the performance of subjects on the specific word types for each standard. For high frequency words compared with low frequency words there were significant differences for standard 1 ($t = 12.74$, df 516, $p < .01$), for standard 2 ($t = 12.74$, df 516, $p < .01$), for standard 3 ($t = 10.34$, df 516, $p < .01$), for standard 4 ($t = 8.7$, df 516, $p < .01$) and for standard 5 ($t = 9.04$, df 516, $p < .01$) showing that children are consistently better at identifying high frequency words presented aurally than they are at identifying low frequency words. Although significant differences were observed for high frequency words compared with non-words matched to low frequency words, these differences were less significant than for the comparison witn low frequency words; for standard 1 ($t = 2.2$, df 516, $p < .05$), for standard 2 ($t = 3.85$, df 516, $p < .01$), for standard 3 ($t = 2.97$, df 516 $p < .01$), for standard 4 ($t = 5.1$, df 516. $p < .01$) and for standard 5 ($t = 4.00$, df 516, $p < .01$).

For high frequency words compared with non-words matched to high frequency words a significant difference was only noted for standard 4 ($t = 3.4$, df 516, $p < .01$) where performance on the identification of high frequency words was better. For standards 1,2,3 and 5 the differences were not significant.

Subjects were better at identifying non-words matched to low frequency words than they were at identifying low frequency words. Significant differences were observed for standard 1 ($t = 10.52$, df 516, $p < .01$), standard 2 ($t = 8.89$, df 516, $p < .01$), for standard 3 ($t = 7.38$, df 516, $p < .01$), for standard 4 ($t = 3.56$, df 516, $p < .01$) and for standard 5 ($t = 5.09$, df 516, $p < .01$) with differences becoming less as the children grew older, with a change being particularly noticeable at standard 3 level. A similar trend was observed for non-words matched to high frequency words versus low frequency words with significant differences for standard 1 ($t = 12.75$, df 516, $p < .01$), for standard 2 ($t = 10.96$, df 516, $p < .01$), for standard 3 ($t = 10.96$, df 516, $p < .01$), for standard 4 ($t = 5.3$, df = 516 $p < .01$) and for standard 5 ($t = 3.56$, df 516, $p < .01$) showing that differences decreased after standard 3 level. The results of these analyses are summarized in Table 30.

TABLE 30

RESULTS OF LEAST SIGNIFICANT DIFFERENCES (HIGH/LOW FREQUENCY WORDS AND MATCHED NON-WORDS) LEXICAL DECISION TEST 6: AUDITORY

Low Frequency Words
Between Std 1 & Std 3 $p < .01$
Between Std 2 & Std 3 $p < .05$
Between Std 3 & Std 4 $p < .05$
Between Std 3 & Std 5 $p < .01$
Between Std 4 & Std 5 n.s.
Between Std 1 & Std 2 n.s.

High Frequency Words
No significant differences

Non-Words matched to Low Frequency Words
No significant differences

Non-Words matched to High Frequency Words
No significant differences

High Frequency Words vs Low Frequency Words
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 $p < .01$

High Frequency Words vs Non-Words matched to Low Frequency Words
For Std 1 $p < .05$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 $p < .01$

High Frequency Words vs Non-Words matched to High Frequency Words
For Std 1 n.s.
For Std 2 n.s.
For Std 3 n.s.
For Std 4 $p < .01$
For Std 5 n.s.

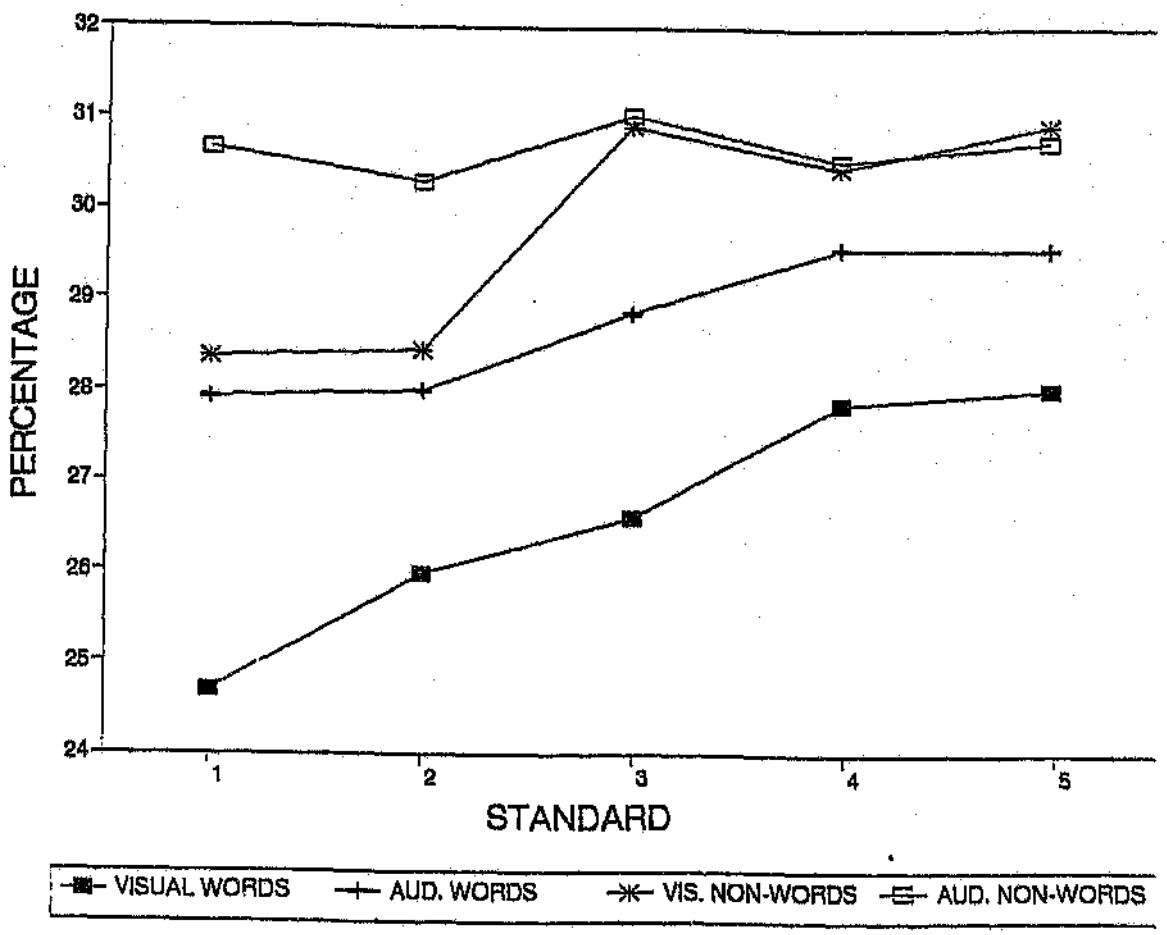
Non-Words matched to High Frequency Words vs Low Frequency Words
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 $p < .01$

Non-Words matched to Low Frequency Words vs Low Frequency Words
For Std 1 $p < .01$
For Std 2 $p < .01$
For Std 3 $p < .01$
For Std 4 $p < .01$
For Std 5 $p < .01$

Lexical Decision Tests: Visual Results compared with Auditory Results

In order to compare the performance of subjects on the Visual Lexical Decision Test with the performance on the Auditory Lexical Decision Test, means for standards for Visual Words, Visual Non-Words, Auditory Words and Auditory Non-Words are plotted on Figure 3. Means for the Words and Non-Words followed similar patterns for the Visual and Auditory Tests, with overall performance on the Non-Words appearing to be better than on Words, and performance on the Auditory Tests as a whole appearing to be better than performance on the Visual Tests.

FIGURE 3



Lexical Decision Tests: Visual Results compared with Auditory Results

Data recorded on Tests 5 and 6 are shown in Table 31 in order to compare the means obtained on Visual Words with those obtained on Auditory Words. Means and standard deviations are given for each standard on both word types.

TABLE 31

MEANS FOR WORDS - TESTS 5 AND 6: LEXICAL DECISION VISUAL AND AUDITORY

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
VISUAL					
MEAN TOTAL WORDS (n=32)	24.68	25.96	26.59	27.85	28.08
S.D.	2.03	2.01	1.87	1.43	1.46
AUDITORY					
MEAN TOTAL WORDS (n=32)	27.92	28.00	28.86	29.58	29.58
S.D.	1.38	1.94	1.29	1.36	1.21

Differences between Visual and Auditory means are evident on the above table. A 2-way ANOVA, computed to investigate the main effect of Standard (1,2,3,4,5)and of Word Type (visual words, auditory words) yielded the following results: there was a significant main effect of Standard ($F(4,258) = 24.85$; $p < 0.01$) and of Word Type ($F(1,258) = 109.95$; $p < 0.01$) but the interaction was not significant. The results of this ANOVA are summarised in Table 32 below.

TABLE 32

SUMMARY OF RESULTS OF 2-WAY ANOVA ; WORD TYPE (Visual Words, Auditory Words) x STANDARD (1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr F
Standard	4	266.41	66.6	24.85	0.0001
Word Type	1	294.63	294.63	109.95	0.0001
Standard x Type	4	24.87	6.22	2.32	0.0574
Within Cell Error	258	691.38	MSE 2.68		
Total	267	1277.29			

In order to separate visual and auditory words thereby facilitating a comparison between the word type by standard, t-Tests were calculated comparing means for visual presentation with means for oral presentation for each standard. The results reveal significant differences for all standards. In each case performance was better on the words presented aurally than on the words presented visually. There were significant differences for standard 1 ($t = 7.04$, $df = 258$; $p < 0.01$), for standard 2 ($t = 4.43$, $df = 258$; $p < 0.01$), for standard 3 ($t = 4.6$, $df = 258$; $p < 0.01$), for standard 4 ($t = 3.8$, $df = 258$; $p < 0.01$) and for standard 5 ($t = 3.9$, $df = 258$; $p < 0.01$). A summary of results is shown in Table 33 below.

TABLE 33

RESULTS OF LEAST SIGNIFICANT DIFFERENCES - VISUAL VS AUDITORY PRESENTATION

For Std 1 - Auditory better than Visual - $p < 0.01$
For Std 2 - Auditory better than Visual - $p < 0.01$
For Std 3 - Auditory better than Visual - $p < 0.01$
For Std 4 - Auditory better than Visual - $p < 0.01$
For Std 5 - Auditory better than Visual - $p < 0.01$

In order to examine the effect of frequency on the comparison of performance on Visual with Auditory words, data for Words recorded on Tests 5 and 6, separating the means and standard deviations for High and Low Frequency Words, Visual and Auditory Lexical Decision are shown in Table 34 below.

TABLE 34

MEANS FOR WORDS - HIGH AND LOW FREQUENCY: LEXICAL DECISION - VISUAL AND AUDITORY

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
WORDS - VISUAL					
MEAN	15.48	15.8	15.82	15.96	15.94
HIGH FREQUENCY (n=16)					
S.D.	0.64	0.4	0.39	0.19	0.23
WORDS - AUDITORY					
MEAN	15.68	15.72	15.95	15.96	15.83
HIGH FREQUENCY (n=16)					
S.D.	0.55	0.72	0.29	0.19	0.37
WORDS - VISUAL					
MEAN	9.3	10.16	10.77	11.88	12.14
LOW FREQUENCY (n=16)					
S.D.	1.96	1.93	1.95	1.42	1.38
WORDS - AUDITORY					
MEAN	12.24	12.28	12.95	13.62	13.75
LOW FREQUENCY (n=16)					
S.D.	1.21	1.82	1.26	1.27	1.21

A 2-way ANOVA was computed to investigate the main effect of Standard (1,2,3,4,5) and of Word Type (High and Low Frequency Visual Words, High and Low Frequency Auditory Words). The results of this analysis are summarised in Table 35 and show a significant main effect of Standard ($F(4,516) = 24.77$; $p < 0.01$), of Word Type ($F(3,516) = 559.73$; $p < 0.01$) and a significant interaction between Standard and Word Type ($F(12,516) = 5.97$; $p < 0.01$).

TABLE 35

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (High Frequency Visual Words, Low Frequency Visual Words, High Frequency Auditory Words, Low Frequency Auditory Words) x STANDARD (stds 1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr F
Standard	4	133.13	33.28	24.77	0.0001
Word Type	3	2256.50	752.17	559.73	0.0001
Standard x Type	12	96.30	8.03	5.97	0.0001
Within Cell Error	516	693.40	MSE 1.34		
Total	535	3179.33			

In order to separate the word types, thereby facilitating a comparison between Visual and Auditory High Frequency Words, and Visual and Auditory Low Frequency Words, a further analysis of the Least Significant Differences between means were calculated. The results revealed significant differences between Visual and Auditory presentation for all standards for Low Frequency Words. In each case the subjects' performance was better on words presented orally than on the visually presented words. There were significant differences for standard 1 ($t = 9.21$, $df = 516$; $p < 0.01$), for standard 2 ($t = 6.42$, $df = 516$; $p < 0.01$), for standard 3 ($t = 6.23$, $df = 516$; $p < 0.01$), for standard 4 ($t = 5.96$, $df = 516$; $p < 0.01$) and for standard 5 ($t = 7.17$, $df = 516$; $p < 0.01$). There were no significant differences for any of the standards for High Frequency Words. Results are summarised in Table 36.

TABLE 36

RESULTS OF LEAST SIGNIFICANT DIFFERENCES - HIGH AND LOW FREQUENCY WORDS VISUAL AND AUDITORY PRESENTATION

Low Frequency Words
For Std 1 Auditory better than Visual - $p < 0.01$
For Std 2 Auditory better than Visual - $p < 0.01$
For Std 3 Auditory better than Visual - $p < 0.01$
For Std 4 Auditory better than Visual - $p < 0.01$
For Std 5 Auditory better than Visual - $p < 0.01$

High Frequency Words
No Significant Differences.

A similar procedure was used to compare the results obtained on Visual Non-Words with those obtained for Auditory Non-Words. Data recorded on Tests 5 and 6 for Non-Words are shown in Table 37. Means and standard deviations are given for each standard for Visual and Auditory Non-Words.

TABLE 37

NORMS FOR NON-WORDS - TESTS 5 & 6: LEXICAL DECISION - VISUAL AND AUDITORY

		STANDARDS				
		1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
VISUAL - NON-WORDS						
TOTAL (n=32)	MEAN	28.36	28.44	30.59	30.46	30.94
	S.D.	3.99	3.81	1.27	1.97	1.03
AUDITORY - NON-WORDS						
TOTAL (n=32)	MEAN	30.66	30.30	31.04	30.54	30.75
	S.D.	0.99	1.16	0.90	2.04	1.47

Some differences between Visual and Auditory means are evident from the above table. A 2-way ANOVA, computed to investigate the main effect of Standard (1,2,3,4,5) and of Word Type (Visual non-words

and Auditory non-words), yielded the following results: there was a significant main effect of Standard ($F(4,258) = 5.24$; $p < 0.01$) and a significant interaction of Standard and Word Type ($F(4,258) = 5.20$; $p < 0.01$) but there was no significant main effect of Word Type alone. The results of this analysis are summarised in Table 38.

TABLE 38

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (Visual Non-Words, Auditory Non-Words) x STANDARD (1,2,3,4,5)

ANOVA SUMMARY TABLE

SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr F
Standard	4	100.16	25.04	5.24	0.0001
Word Type	1	15.76	15.76	3.30	0.0001
Standard x Type	4	99.27	24.82	5.20	0.0001
Within Cell Error	258	1231.83	MSE 4.77		
Total	267	1447.02			

To ascertain whether the differences in word type were significant at each standard level, further analyses of the Least Significant Differences were calculated. Significant differences were found for the younger children. Children in standard 1 performed significantly better on the Auditory tests than they did on the Visual tests ($t = 3.77$, $df = 258$; $p < 0.01$). There was a significant difference for Standard 2 as well ($t = 2.38$, $df = 258$; $p < 0.05$). There were no significant differences for standards 3,4 and 5 indicating that older children performed as well on the Visual as they did on the Auditory tests. The findings are summarised in Table 39.

TABLE 39

RESULTS OF LEAST SIGNIFICANT DIFFERENCES: NON-WORDS - VISUAL AND AUDITORY

For Std 1 - Auditory better than Visual - $p < 0.01$
For Std 2 - Auditory better than Visual - $p < 0.05$
For Std 3 - n.s.
For Std 4 - n.s.
For Std 5 - n.s.

In order to investigate the effect of frequency on the comparison of non-word scores for the Visual and Auditory Lexical Decision Tests, data for non-words identified correctly, separating the means and standard deviations for non-words derived from high and low frequency words presented Visually and Aurally, are shown in Table 40 below.

TABLE 40

MEANS FOR NON-WORDS DERIVED FROM HIGH AND LOW FREQUENCY WORDS: TESTS 5 AND 6

	STANDARDS				
	1 (n=25)	2 (n=25)	3 (n=22)	4 (n=26)	5 (n=36)
NON-WORDS - VISUAL					
MEAN	13.84	14.00	15.00	15.23	15.39
HIGH FREQUENCY (n=16)					
S.D.	2.41	2.1	0.95	1.09	0.64
NON-WORDS - AUDITORY					
MEAN	15.68	15.72	15.95	15.96	15.83
HIGH FREQUENCY (n=16)					
S.D.	0.47	0.71	0.29	1.02	0.76
NON-WORDS - VISUAL					
MEAN	14.52	14.44	15.59	15.23	15.39
LOW FREQUENCY (n=16)					
S.D.	2.42	2.04	0.58	1.12	0.64
NON-WORDS - AUDITORY					
MEAN	15.08	14.68	15.09	14.58	14.92
LOW FREQUENCY (n=16)					
S.D.	0.80	1.16	0.79	1.31	0.95

A 2-way ANOVA was computed to investigate the main effect of Standard (1,2,3,4,5) and of Word Type (high and low frequency non-words presented visually, high and low frequency non-words presented aurally). The results of this analysis are summarised in Table 41 and show a significant main effect of Standard ($F(4,516) = 7.65$; $p < 0.01$), of Word Type ($F(3,516) = 7.16$; $p < 0.01$) and a significant interaction between Standard and Word Type ($F(12,516) = 3.08$; $p < .05$).

TABLE 41

SUMMARY OF RESULTS OF 2-WAY ANOVA : WORD TYPE (High Frequency Visual Non-Words, Low Frequency Visual Non-Words, High Frequency Auditory Non-Words, Low Frequency Auditory Non-Words) x STANDARD (1,2,3,4,5)

ANOVA SUMMARY TABLE					
SOURCE	df	Sum of Squares	Mean Square	F-Value	Pr >F
Standard	4	49.40	12.35	7.65	0.0001
Word Type	3	34.71	11.57	7.16	0.0001
Standard x Type	12	59.77	4.98	3.08	0.0003
Within Cell Error	516	833.22	MSE 1.61		
Total	535	977.10			

The analyses to investigate the Least Significant Differences between means revealed some differences for non-words derived from high frequency words for younger subjects who performed better on the Auditory Test than they did on the Visual Test. There was a significant difference for Standard 1 ($t = 3.11$, $d = 516$; $p < 0.01$), for Standard 2 ($t = 3.44$, $d = 516$; $p < 0.01$) and for Standard 3 ($t = 2.39$, $d = 516$; $p < 0.05$). There were no significant differences for any of the standards for non-words derived from low frequency words. Results are summarised in Table 42.

TABLE 42

RESULTS OF LEAST SIGNIFICANT DIFFERENCES - NON-WORDS DERIVED FROM HIGH AND LOW FREQUENCY WORDS: VISUAL AND AUDITORY PRESENTATION

Non-Words derived from High Frequency Words

For Std 1 - Auditory better than Visual - $p < 0.01$
For Std 2 - Auditory better than Visual - $p < 0.01$
For Std 3 - Auditory better than Visual - $p < 0.05$
For Std 4 - n.s.
For Std 5 - n.s.

Non-Words derived from Low Frequency Words

No Significant differences

4. DISCUSSION

Results of the statistical analysis indicate a general progression of phonological abilities with increasing age. There was an improved performance on regular words, irregular words and non-words as children grew older. In addition when these word types were separated into high and low frequency words, there was an increase in the means for both types between standards as the children became older. For regular words statistically significant differences were more evident for the lower standards. Although means for standards for regular words continued to increase with age, the differences became less significant. For irregular words, performance showed a general statistical improvement with age. There was an increased ability with age to read non-words as well. An analysis of non-word reading showed that as children become older they read an increasing percentage of non-words by analogy to irregular words and the proportion of non-words read by analogy to regular words correspondingly decreases. For each standard the significantly predominant recoding strategy was regularisation, except for standard 5, where children were equally likely to use either analogies to regular or to irregular words. These findings support the experimental hypothesis that performance of the subjects on the phonological tests would differ with age. In addition differences according to age were noted with respect to regularity and frequency of the words, and whether the stimulus was a word or a non-word. Performance on regular words was significantly better for all standards than on irregular words, but

these differences became less with age. A similar trend was evident for non-words and irregular words, where performance was significantly better on non-words, with differences becoming less as the children grew older. Similarly performance was significantly better on regular words than on non-words. These results support the hypothesis that performance would differ with respect to regularity and whether the stimulus was a word or a non-word on the phonological tests. Results showed better performance for high frequency regular words than for low frequency regular words with significant differences being recorded for the lower standards. For irregular words, performance was significantly better for all standards on high frequency words than for low frequency words. These findings support the experimental hypothesis that performance would differ with respect to frequency on the phonological tests.

Silent Reading of regular words, irregular words and non-words did not differ significantly for each standard from the regular and irregular words and non-words when they were read aloud. (see Figure 2)

On the Lexical Decision tests the statistical analysis indicated a general progression in the ability of children to use orthographic recoding as performance improved significantly on the identification of words with age. On the Visual Tests there was an increase in means between standards on the words, and there were statistically significant differences as the children got older at all standards for low frequency words. Performance was

significantly better on high frequency words than on low frequency words for all standards on the visual lexical decision tests. Although performance on the identification of non-words was not significantly better between standards, performance on non-words matched to high frequency words showed significant improvements between standards as the children became older. Children were significantly better at identifying non-words than words on the visual tests. On the auditory tests these differences were more significant for the younger children. These findings support the experimental hypothesis that the performance of subjects on the lexical decision tests would differ with respect to age and the frequency of the word type, and whether the stimulus was a word or a non-word.

Performance on the auditory lexical decision test was significantly better than on the visual tests for words. Similar differences were evident for non-words at the lower standards. These differences in favour of auditory presentation were particularly evident for low frequency words and support the hypothesis that performance would differ depending on whether the word types were presented visually or aurally.

The theoretical framework for this study was a dual processing model. This model allows for access to the word via a phonological encoding process or through a direct visual or lexical route. The phonological process is assumed to occur at the level of graphemes and phonemes and can be used whether the printed letter string is

a word or not. Younger readers tend to rely more on a phonological encoding strategy than do older readers. (Doctor and Coltheart 1981, Seidenberg et al, 1984 and Backman 1984). English is a language in which the correspondence between orthography and phonology is highly variant. Therefore only the most highly regular words can be pronounced correctly by using the phonological encoding strategy. Exception or irregular words can only be pronounced correctly by means of a visual whole-word, direct route It was therefore expected that on th Phonological Tests younger children would perform better on regular words as their visual lexicons would not have developed. As they would still be learning phonological strategies, it was expected that significant differences for regular words would be evident between lower standards, as their knowledge and familiarity with the rules of phonology would still be improving. These differences for regular words are clearly shown in Table 4, where significant differences are recorded between standards 1 and 2, and between standards 2 and 3 at the 1% level and, although the performance continues to improve with age, significant differences between standards are not evident for older children.

This trend is also indicated for low frequency regular words with a significant difference between standards 1 and 2 at the 1% level and a significant difference between standards 2 and 3 at the 5% level and no significant differences between higher standards (see Table 7) although means for all standards are better for older children (Table 5). Regular high frequency words do not show

significant differences (Table 7) as younger readers are likely to have encountered these words in print and therefore, although the means continue to improve with age, the differences were not found to be significant (Table 5). Similarly on the Reading Aloud test of Phonology (matched to the silent test) a significant difference was found for regular words between Standards 1 and 2 (Table 16) but no other significant differences are recorded, although means for regular words improved with age (Table 14) they reached ceiling effect around standard 2. The results therefore support the contention that younger children are still developing phonological encoding skills and therefore differences between the lower standards were significant. Older children are likely to have mastered these skills, which they may still be using for low frequency regular words, with which they are not familiar.

All means on the phonological tests on irregular words are greater as the children become older (norm Tables 2,5,14). Differences between standards for irregular words, however, followed a different trend from that of regular words. There were significant differences between all standards, for irregular words (Table 4), high and low frequency scored together, at the 1% level, apart from between standards 3 and 4. There was, however, a significant difference between standards 3 and 5 which indicated that the trend in performance was significant for standard 1 through to standard 5. When high and low frequency irregular words were separated, however, a different pattern emerged. The pattern for high frequency irregular words showed that younger children in standard

1 even have difficulty with irregular high frequency words. These familiar irregular words have become by standard 2 level, part of the child's visual internal lexicon and so no improvement is found for older children. For irregular low frequency words significant differences were evident for standard 3 upwards at the 1% level. In other words differences were not significant between standards 1 and 2 and performance was poor. As has been stated earlier, irregular words cannot be read by the phonological encoding strategies available to these children. The results therefore suggest that at the standard 2 level, children still have difficulty with unfamiliar irregular words as their visual lexicons are as yet not developed and they are likely to be still in the phonological recoding phase and finding difficulty discriminating between homophones. As children read more widely and develop an increased familiarity with print, their visual lexicons expand. This accounts for the significant differences and improvement evident between standards 3 and 4, and standards 4 and 5. Results therefore on tests of irregular words conform to the dual processing framework and the proposition that younger children use the phonological route, while for older children, who are more proficient readers, the lexical route becomes more predominant.

For non-words on the phonological tests, the means for older children were better than those for younger children and significant differences were recorded between all standards, apart from between standards 3 and 4. There was, however, a significant difference between standards 3 and 5 which confirmed that the trend in performance continued from standard 1 through to standard 5.

(Table 4). On the matched silent and reading aloud tests of phonology differences between standards for non-words were likewise significant. Children are able to read a string of letters whether it is a word or not by using the phonological method. An analysis of non-word reading showed that as children get older they read an increasing proportion of non-words by analogy to irregular words (Table 10). Although a significant difference was not found between standards 1 and 2, there was a significant difference between standard 1 and 3 and standards 2 and 3. Similarly, although a significant difference was not found between standards 3 and 4, there were significant differences between standards 3 and 5 and standards 4 and 5. This showed therefore, a significant overall increase in words pronounced by analogy to irregular words. The indication is that phonological strategies were used by the younger readers to derive a phonological representation for unfamiliar letter strings, while older children used the direct lexical route and read by analogy to the familiar irregular word. As children build up their internal lexicons so more irregular words become available to provide possible analogies for non-words.

A comparison of results on the matched silent and reading aloud tests of phonology revealed few significant differences for each standard. (Table 18) All differences showed better performance on the reading aloud tests. The normal reader would be expected to perform as well on the Silent Test as s/he did on the Reading Aloud as, if a child is able to read a word aloud , using whatever strategy s/he may select to encode that word, then the child should

be able to use the same method to read the same word correctly silently.

The few anomalous significant results, along with the general overall better performance on the reading aloud tests, may be explained by the nature of the test and its administration. The silent test was a group test in which two words had to be read correctly to decide whether they sounded the same, and for this one point was given. The reading aloud list required that only one word needed to be read correctly to obtain one point. This feature of the test along with the group administration, may account for the anomalous differences which were recorded for this sample of normal children. A general explanation why the raw data is better for reading aloud than for the silent test, is that with the silent test decoding of two words was required and these words had to be held in the phonological buffer while a decision was made. Reading aloud did not place any such demands on available memory capacity.

Lexical decision test results similarly revealed developmental trends with older children performing significantly better on both visual and auditory words. For visually presented words a significant difference was not found between standards 2 and 3 but significant differences were recorded between standards 1 and 2 and standards 1 and 3. Similarly, although a significant difference was not found between standards 4 and 5, significant differences were found between standards 3 and 4 and standards 3 and 5 so that

from standards 1 through to standard 5 there was a significant improvement in means. (Table 21). Differences were less significant between standards 3 and 4 and standards 3 and 5. For low frequency words there were significant differences at the 1% level between standards 1 and 2, 2 and 3, 3 and 4. The difference between standard 4 and 5 was less significant at the 5% level (Table 24) but overall, the differences between standards for low frequency words were more often than for words overall (high and low frequency combined). The younger child is less likely to have encountered low frequency words previously and therefore this analysis emphasized differences in reading ability between standards.

Comparisons of performance on the various word types per standard on the visual lexical decision tests, revealed that performance on high frequency words and non-words derived from high frequency words was significantly better. In all cases these differences decreased as the children became older and there was an indication that at standard 3 level the children were using orthographic strategies as differences between standards decreased after standard 3. Although performance on the identification of non-words was not significantly better between standards, performance on non-words derived from high frequency words showed significant improvemnets between standards as the children became older. This seemingly anomalous result may be explained by the familiar visual form of the non-word which causes the younger child to revert to a discrimination-net type strategy, and consequently identify the

non-word incorrectly as a word. Non-words derived from low frequency words do not have many familiar neighbours and therefore are not identified as words.

Results for auditory words showed a similar pattern with more significant differences evident for low frequency words between standards than for words (high and low frequency). For high frequency auditory words there was a significant difference between standards 1 and 2 but no other significant differences were found. This lack of any apparent developmental trend suggests that as younger children are familiar with high frequency words, they have begun to incorporate these words into their internal lexicons at an earlier age than they would have incorporated low frequency words. This finding that there are more significant differences with age for low frequency words than for high frequency words, suggests that children do not simply get more proficient in reading print, but rather that there is a change in reading ability, which can be explained by the development of the orthographic lexicon and a greater dependence upon it. Auditory high frequency words show no significant differences and this indicates that children are able to identify high frequency words presented aurally at an early age and a significant developmental trend is therefore not evident.

Overall there were significant differences for words for all standards between auditory and visual presentation (Table 33), and greater significant differences were evident for low frequency words for all standards. (Table 36) In all cases performances on

auditory words was better than performance on visual words. For a sample of normal readers, this result could be expected as children should have learned to discriminate auditory words before they have learned phonological rules or before their visual lexicon is established. Performance on auditory high frequency words was not significantly different from visual high frequency words, as these words were likely to be visually familiar to even the younger children.

5. CONCLUSION

The developmental trends which have been observed show that the results of this study can be successfully interpreted within the framework of the dual processing model. The scores obtained conform to the view that the relative importance of the non-lexical and lexical routes changes as reading develops. Therefore the results of both Phonological and Lexical Decision tests are in accordance with the proposition that reliance on phonological encoding decreases with the age of the child (Doctor and Coltheart, 1980) and as the child becomes a more proficient reader the use of the lexical route becomes more predominant.

Traditional standardized tests, such as the Schonell Word Recognition Test which gives a reading age, may indicate that a child's reading age is below the corresponding chronological age, but these tests are not adequate diagnostic measures of the specific difficulties of the individual child. The Phonological and Lexical Decision Tests used in this study were administered to a sample of selected "normal" readers and the results conformed to the dual processing model and to the theory of a developmental shift in reading strategies. Therefore these tests can be used as a standard against which the phonological and lexical decision abilities of reading delayed children can be measured.

It can be proposed, for example, that if a child's performance does not improve significantly on the Phonological Tests on regular

words between standards 1, 2 and 3 and that a performance ceiling is not reached around this standard,, that the development of phonological skills is delayed. Similarly, if scores on the irregular and non-words do not show an increase from standard 1 through to standard 5, the indication is that the visual lexicon is not age-appropriate. Furthermore when the word-types are separated into high and low frequency, difficulties with either reading strategy can be emphasised. On irregular low frequency words on the phonological tests, significant differences would not be expected to be noticed for younger children, but if a gradual progression of skills, conforming to the normal readers, were not evident after standard 2, impairment of the development of the input lexicon might result. If a child had, therefore, performed adequately on regular words, s/he might have mastered phonological rules, but would be unable to become a skilled reader as s/he would not be able to read the irregular words, for these exception words cannot be sounded out and the visual lexicon would not have developed adequately.

Although a difference in raw data is shown between the reading aloud and the silent Tests, a significant difference is not expected for "average" readers. If a child exhibits a very significant difference in performance on these tests, then s/he is not reading as average children read. If, for example, scores on the Reading Aloud test are clearly lower, an 'output' problem could be identified and internal phonology may be misled by an articulation deficit.

The tests of lexical decision indicate, for example, that average readers should have reached a ceiling by the end of standard 2 when it comes to recognising the visual appearance of high frequency words. These words would therefore be stored in the visual memory. The raw data for low frequency clearly show a significant progression from standard 1 through to standard 5, and show that even average readers may not reach the ceiling by standard 5.

If children are able to read high frequency words adequately, but have difficulty reading the matched non-words, this would be an indication that reading is being mediated almost solely by the lexical procedure and therefore pronounceable non-words cannot be read aloud.

Results show that average readers could be expected to do better on Auditory low frequency words on the Lexical Decision Tests than on the visual tests, as children are likely to have become familiar with the sound of a low frequency word before they have formed a visual representation of the word. A child who performs significantly better on the Visual tests rather than on the Auditory Lexical Decision Tests may possibly be diagnosed as having an auditory discrimination difficulty.

These examples serve to indicate how the tests administered in this research can be applied to identify any deviation from the development of normal processing strategies in children of different standards.

A case study of a standard 2 boy with an age-appropriate score on the Neale Analysis of Reading Ability and the Schonell Graded Word Reading Test (R1) serves to illustrate the properties of the tests used in this study. The standard 2 pupil was excluded from the sample on the grounds of his poor reading and academic performance at school. Although I.Q. (Senior South African Intelligence Scale, SSAIS) was in the average range and the reading age was within a few months of the chronological age, there was a history of learning difficulties.

Name: D.S. Standard: 2
Date: April 1990 Age: 10 years 4 months

Neale Analysis of Reading Ability: 9 years 11 months
Schonell Graded Word Reading Test: 9 years 11 months

Scores on Psycholinguistic Tests	Score	Std 2 Mean	SD
Phonological			
Regular Words /40	35.00	37.44	1.72
Regular Words HF /20	19.00	19.44	0.7
Regular Words LF /20	16.00	18.00	1.57
Irregular Words /40	27.00	29.88	3.05
Irregular Words HF/20	20.00	19.60	1.47
Irregular Words LF/20	7.00	10.28	2.00
Non-Words	27.00	33.88	3.89
% Non-Words read by analogy to irregular words	14.81%	33.90%	10.92
Silent Test of Phonology			
Regular Words /20	17.00	18.24	1.92
Irregular Words /20	14.00	17.56	1.65
Non-Words /20	12.00	14.8	2.3
Reading Aloud Test of Phonology (Matched to Silent Test)			
Regular Words /20	19.00	19.32	0.73
Irregular Words /20	14.00	16.44	1.3
Non-Words /20	15.00	15.60	2.19

Lexical Decision Test -	Visual			Auditory		
	Score	Mean	S.D.	Score	Mean	S.D.
Words HF /16	16.00	15.80	0.4	15.00	15.72	0.72
Words LF /16	7.00	10.16	1.93	15.00	12.28	1.82
Non-Words (matched HF)	12.00	14.00	2.1	13.00	15.24	0.71
Non-Words (matched LF)	13.00	14.44	2.04	14.00	14.68	1.16

The Psycholinguistic assessment was carried out to determine the reading strategies employed by the child and to determine the stage of his reading skills.

D.S 's knowledge of English orthography was assessed by means of the Lexical Decision Tests. His score for low frequency words on the visual test (43.75%) was significantly below the mean (63.5%) calculated for standard 2 ($z = 1.64$, $p < .05$). As a significant difference was not present between his ability to identify words (71.88%) and non-words (78.13%), nor were there significant differences from the means for performance on high frequency regular words (D.S. = 100% ; mean = 98.75%), and non-words matched to high frequency words (D.S. = 75% ; mean = 87.5%) or non-words matched to low frequency words (D.S. = 81.25% ; mean = 90.25%), it appears that D.S. had particular difficulties identifying low frequency words. A comparison was therefore made of his ability to identify low frequency words presented visually (43.75%) with his ability to identify low frequency words presented aurally (93.75%). The comparison revealed a highly significant difference (chi sq = 7.127, df 1 $p < .007$) with performance on auditory presentation being significantly better. This indicates a reading problem, rather than a language deficit.

Looking at the phonological test scores it is noted that D.S. was able to read non-words (87.5%) as well as words (77.5%). If performance on words had been better than performance on non-words, D.S. would have been using a visual strategy.

Further evidence on the phonological tests points to reliance on phonological strategies more than the average standard 2 pupil. Performance on regular words was age-appropriate (D.S. = 87.5% ; mean = 93.6%) but performance on low frequency irregular words was significantly lower than the mean for the standard (D.S. = 35% ; mean = 54% ;z = 1.64, $p < .05$). While the difference in performance on regular (87.5%) and irregular words (67.5%) as a total does not reach significance level (chi sq = 3.512 df 1, $p < .05$), when D.S.'s performance on low frequency regular (80%) and low frequency irregular words (35%) is compared, the difference is highly significant (chi sq = 6.55, df 1 $p < .01$). These results suggest a delayed progression into orthographic reading and a reliance on the phonological route. Perhaps a more sensitive test of a preference to use one route or another, is the percentage of non-words read by analogy to regular or irregular words. D.S. read only 14.81 % of non-words by analogy to irregular words, compared to a standard 2 mean of 33.9 %. This difference was found to be significant ($z = 1.74$, $p < .05$) and suggests that, as D.S.'s visual lexicon did not appear to be developing at a standard 2 level, less words were available to use as analogies for the non-words formed from irregular words. Therefore he tended to regularize significantly more than the average standard 2 child.

There were no significant differences between D.S.'s scores on the matched silent and reading aloud tests of phonology. (Regular: Silent = 85%, Reading Aloud = 95% ; Irregular: Silent = 70%, Reading Aloud = 70% ; Non-Words: Silent = 60% , Reading Aloud =

75%). This suggests that D.S. had no difficulty with the processes involved in the articulation of words during the reading process. On these matched tests D.S.'s scores on regular and non-words were not significantly different from the means for the standard as he was able to utilise his phonological skills for both word types. Performance on the irregular words was, however, significantly different from the standard average; for silent irregular words (D.S. = 70% , mean = 87.8% ; $z = 2.16$, $p < .02$) and for reading aloud irregular words (D.S. = 70%, mean = 92.2% ; $z = 3.42$, $p < .01$). This supports the contention that although the subject has phonological skills, orthographic reading is delayed, a clear indication of surface dyslexia (Frith 1985).

Further testing in August 1991 reflected a widening gap on the Schonell Graded Word Reading Test and the Neale Analysis of Reading Ability (9 months below chronological age) and a deterioration in spelling and academic progress during the standard 3 year. The means calculated as a result of this study support the theory that at standard 2 to 3 level children are becoming more orthographic. D.S.'s scores of 1990 on the tests already pointed to a delay in the development of the visual input lexicon. By standard 3 this delay is more obvious as the average standard 3 reader is becoming more reliant on the lexical route. This case study serves to illustrate a possible application of these psycholinguistic tests.

The emphasis placed on the elimination of confounding variables in these tests needs to be reiterated. Sample items were matched for

frequency of occurrence, letter and syllable length, and part of speech. Although this study has provided considerable evidence in support of the hypotheses, future research could take into account further possible confounding variables.

The sample consisted of 134 children, 77 girls and 57 boys from 2 single sex private English medium schools. Although selection of the children by means of the Schonell Test served to counteract, to a certain extent, the effect of the specific socio-economic group from which the sample was drawn, future research could aim to generalise the study. A sample more representative of other socio-economic groups would be more appropriate for the establishment of reliable norms.

There are indications from the data collected, that a study investigating the effect of sex on the test means may provide insight into the cognitive development of primary school boys and girls.

The means for the standards on the series of psycholinguistic tests conformed to the framework of the dual processing model, showing that different reading strategies were utilised for different word-types/stimuli at different ages. Therefore developmental norms have been provided and developmental trends were identified and analysed in accordance with the aims of the study. It has been shown that the implications of this research are that these tests can be used as a standard against which the abilities of reading-

delayed children can be measured. As the tests have a diagnostic capacity, strategies for remediation of children's reading difficulties, based on the results of the tests, can be formulated.

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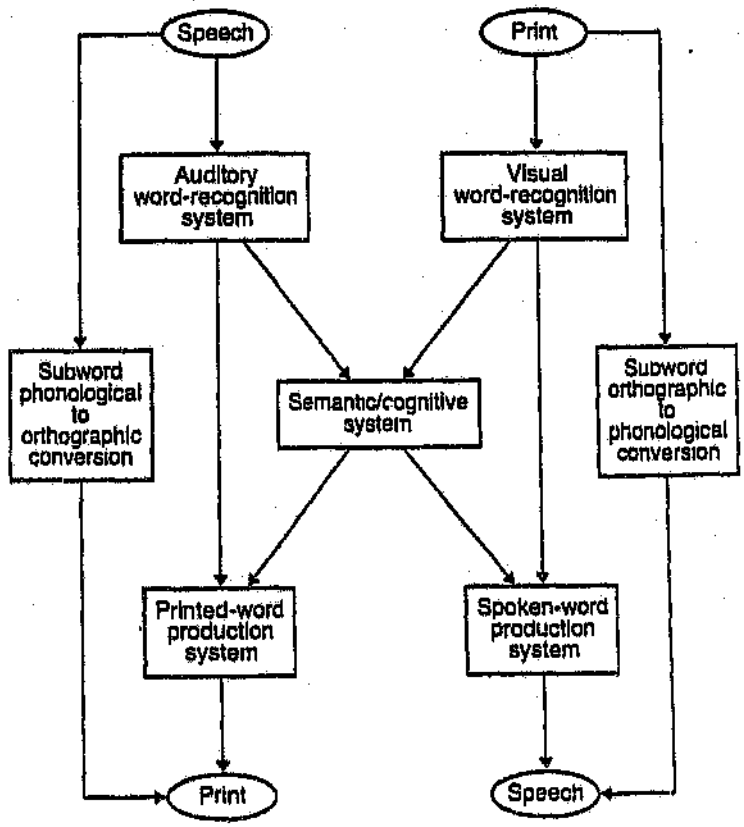
APPENDIX 1

AN INFORMATION PROCESSING MODEL OF LANGUAGE

HARRIS, M. AND COLTHEART, M. (1986) Language Processing in Children and Adults p 149.



APPENDIX 2

SCHONELL: GRADED WORD READING TEST

tree	little	milk	egg	book
school	sit	frog	playing	bun
flower	road	clock	train	light
picture	think	summer	people	something
dream	downstairs	biscuit	shepherd	thirsty
crowd	sandwich	beginning	postage	island
saucer	angel	ceiling	appeared	gnome
canary	attractive	imagine	nephew	gradually
smoulder	applaud	disposal	nourished	diseased
university	orchestra	knowledge	audience	situated
physics	campaign	choir	intercede	fascinate
forfeit	siege	recent	plausible	prophecy
colonel	soloist	systematic	slovenly	classification
genuine	institution	pivot	conscience	heroic
pneumonia	preliminary	antique	susceptible	enigma
oblivion	scintillate	satirical	sabre	beguile
terrestrial	belligerent	adamant	sepulchre	statistics
miscellaneous	procrastinate	tyrannical	evangelical	grotesque
ineradicable	judicature	preferential	homonym	fictitious
rescind	metamorphosis	somnambulist	bibliography	idiosyncrasy

APPENDIX 2 .1

SCHONELL GRADED WORD READING TEST

INSTRUCTIONS FOR ADMINISTERING THIS TEST

The Test should be given in a friendly atmosphere in which the child is thoroughly at ease. It should not take place within the hearing of other children.

Younger children or weaker readers should start the test at the beginning. Better readers can start at a later group of ten words. If any word is failed, however, the preceding group of ten words is given until all ten are read correctly. Credit is then given for all words preceding this point. Testing is discontinued when ten consecutive words are failed. The reading age for the total number of words correctly read is given in the table.

The temptation to help the child should be resisted. He should not, for example, be asked to repeat a word he has almost but not quite pronounced correctly nor should he be given any clues as to how to attack a particular word.

Credit should not be given unless the word is clearly correct, e.g. 'flowers' for 'flower' is incorrect as is 'postage' when the last syllable is pronounced as the word 'age'.

Revised Norms (1971) for Schonell, Graded Word Reading Test

established by Geoffrey Bookbinder, based on the testing of 10000 children in Salford and adjusted to the national norm. See Schonell and Goodacre, *The Psychology and Teaching of Reading* (5th edition. Oliver & Boyd 1974), pp 216-7.

No. of words read correctly	R.A. Yrs Mths	No. of words read correctly	R.A. Yrs Mths	No. of words read correctly	R.A. Yrs Mths
0-1	6.0 minus	33	8.3	61	10.4
2	6.0	34	8.4	62	10.5
3	6.2	35	8.5	63	10.6
4	6.4	36-37	8.6	64	10.7
5	6.5	38	8.7	65	10.8
6	6.6	39	8.8	66	10.9
7-8	6.7	40	8.9	67	10.10
9	6.8	41	8.10	68	11.0
10	6.9	42	8.11	69	11.1
11-12	6.10	43	9.0	70	11.3
13-14	6.11	44	9.1	71	11.4
15	7.0	45	9.2	72	11.5
16	7.1	46	9.3	73	11.6
17-18	7.2	47	9.4	74	11.8*
19	7.3	48	9.5	75	11.10
20-21	7.4	49-50	9.6	76	12.0
22-23	7.5	51	9.7	77	12.1
24	7.6	52	9.8	78	12.2
25-26	7.7	53	9.9	79	12.3
27	7.8	54	9.10	80	12.4
28	7.9	55	9.11	81	12.5
29	7.10	56	10.0	82	12.6
30	8.0	57-58	10.1	83 +	12.6 +
31	8.1	59	10.2	*Revised reading ages beyond 11.6 have been extrapolated from the 7+11½ year age population.	
32	8.2	60	10.3		

SCHONELL: GRADED WORD READING TEST
ISBN 0 05 000407 7

Instructions and details of interpretation for this test are to be found in
"READING AND SPELLING TESTS: HANDBOOK OF INSTRUCTIONS"
ISBN 0 05 000413 1

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APPENDIX 3

STIMULI FOR READING ALOUD REGULAR, IRREGULAR AND NON-WORDS :

PHONOLOGICAL TESTS 1 AND 2

Stimuli for reading aloud regular, irregular words and non-words derived from the irregular words.

Stimuli are matched for: frequency of occurance (Caroll, Davies & Richman 1973); letter and syllable length; part of speech

REGULAR WORDS				IRREGULAR WORDS				NON-WORDS	
HIGH FREQ.		LOW FREQ.		HIGH FREQ.		LOW FREQ.		HIGH FREQ.	LOW FREQ
week	149	pest	1.48	walk	155	wand	1.3	salk	mand
base	145	peel	3.66	baby	133	wasp	3.56	haby	basp
sand	109	arch	3.93	iron	123	hymn	3.49	oron	tymn
hope	96	tile	3.49	lady	87.4	buoy	4.17	tady	luoy
note	105	reed	3.58	sign	108	tomb	3.82	zign	vomb
feel	227	duel	1.87	move	292	ache	1.72	gove	iche
help	738	rust	5.48	half	739	pint	4.9	galf	sint
ring	93.9	plug	6.74	bear	96	debt	6.55	zear	kebt
horse	208	gloom	3.88	group	286	steak	4.21	froup	theak
seven	125	slate	2.65	death	90.4	dwarf	2.2	leath	twarf
study	392	brood	2.46	money	308	gross	3.15	doney	fross
sheep	81	trout	7.21	blood	106	gauge	7.57	plood	dauge
dance	71	shrug	1. 3	touch	73.9	cough	4.86	rouch	sough
order	268	choke	1.09	build	221	shove	1.79	puild	chove
happen	84.3	export	4.47	listen	150	soared	4.09	histen	voared
bottle	56.4	napkin	3.39	beauty	54.8	nephew	1.65	teauty	dephew
letter	238	manure	1.38	answer	330	orchid	1.22	aiswer	erchid
simple	168	modest	5.64	broken	99.9	subtle	4.53	froken	qubtle
common	201	reptile	4.08	machine	134	butcher	4.72	bachine	hutcher
product	78.9	cartoon	2.22	islands	57	biscuit	2.04	aslands	fiscuit
TOTAL	3635		70		3644		69.5		
mean	182		3.5		182		3.58		
S.D.	151		1.73		153		1.69		
MAX	738		7.21		739		7.57		
MIN	56.4		1.09		54.8		1.22		

APPENDIX 4

SCORING SHEET - PHONOLOGICAL TESTS 1 AND 2

READING ALOUD REGULAR AND IRREGULAR WORDS

			PRONOUNCIATION CORR.	PRONOUNCIATION ACTUAL
gauge	I	L		
product	R	H		
shrug	R	L		
feel	R	H		
half	I	H		
broken	I	H		
cough	I	L		
trout	R	L		
pest	R	L		
money	I	H		
base	R	H		
build	I	H		
soared	I	L		
arch	R	L		
slate	R	L		
machine	I	H		
move	I	H		
help	R	H		
answer	I	H		
note	R	H		
bear	I	H		
export	R	L		
sheep	R	H		
dwarf	I	L		
group	I	H		
beauty	I	H		
hope	R	H		
week	R	H		
blood	I	H		
touch	I	H		
wasp	I	L		
seven	R	H		
iron	I	H		
horse	R	H		
lady	I	H		
wand	I	L		
plug	R	L		
orchid	I	L		
reed	R	L		
duel	R	L		
butcher	I	L		
subtle	I	L		
rust	R	L		
hymn	I	L		
common	R	H		
baby	I	H		
biscuit	I	L		
simple	R	H		
walk	I	H		
buoy	I	L		
tomb	I	L		
cartoon	R	L		
letter	R	H		
ring	R	H		
islands	I	H		
sign	I	H		
ache	I	L		
bottle	R	H		
reptile	R	L		
happen	R	H		
modest	R	L		
pint	I	L		
debt	I	L		
manure	R	L		
order	R	H		
sand	R	H		
listen	I	H		
death	I	H		
dance	R	H		
napkin	R	L		
steak	I	L		
shove	I	L		
brood	R	L		
peel	R	L		
nephew	I	L		
tile	R	L		
gloom	R	L		
gross	I	L		
choke	R	L		
study	R	H		

NON-WORDS DERIVED FROM IRREGULAR WORDS

	PRONOUNCIATION IRR	PRONOUNCIATION REG	PRONOUNCIATION ACTUAL
teauty			
basp			
fiscuit			
aiswer			
tady			
froup			
tymn			
puiid			
fross			
vomb			
plood			
theak			
froken			
sough			
leath			
dauge			
luoy			
hutcher			
gove			
gaif			
chove			
bachine			
zear			
mand			
haby			
gubtle			
saik			
aslands			
kebt			
doney			
voared			
dephew			
erchid			
oron			
iche			
histen			
sint			
zign			
rouch			
twarf			

REGULAR WORDS	HF CORR	=	/20	TOTAL CORR =	/40
	LF CORR	=	/20		
IRREGULAR WORDS	HF CORR	=	/20	TOTAL CORR =	/40
	LF CORR	=	/20		
NON-WORDS	READ AS IRR.WORD	=	/40	TOTAL	/40
	READ AS REG.WORD	=	/40		
LOW FREQUENCY	CORR.	=	/40		
HIGH FREQUENCY	CORR.	=	/40		

APPENDIX 4.1

INSTRUCTIONS FOR THE ADMINISTRATION OF TESTS 1 AND 2

READING ALOUD REGULAR AND IRREGULAR WORDS AS WELL AS NON-WORDS DERIVED FROM THE IRREGULAR WORDS.

Person administering test should sit so that subject cannot see scoring sheet.

INSTRUCTIONS FOR ADMINISTERING TEST OF REGULAR AND IRREGULAR WORD READING

1. "Here are some cards."
   Give set of cards to subject.

2. Show first practice card to subject.
   "On each card there is one word."

3. Point to first practice word.
   "Please read this word to me."

4. If response is INCORRECT :
   "No, this word is ....."
   Point to and say the correct response.
   "Now you say the right word."
   If / when the response is CORRECT :
   "That's right. Well done. Please turn the card over and read the next word to me."
   Subject turns to the next practice word.

5. Repeat 4 until all practice items have been completed correctly.
   "That's right. Well done. Now you have read all the practice words. I would like you to read the rest of the words to me. Do you understand what to do?"

6. If subject does not understand, repeat steps 1 - 5.

7. When subject makes a response, either correct or incorrect, they may be praised and encouraged eg. "Yes, that's right / Good / Well done" No indication of an incorrect response should be given. Subject must respond to every item. If subject is reluctant to respond, he/she should be encouraged eg. "Please say what you think the word is, even if you're not sure that it is correct."

8. If necessary, the subject may be asked "Please slow down, take your time and read carefully."

9. On completion of test subject should be praised.

INSTRUCTIONS FOR ADMINISTRATION OF NON-WORD READING TEST.

1. "Here are some cards."
   Hand cards to subject.

2. On each card there is one word."
   Show first practice item to subject.

3. "You may not have seen these words before. Some of them may look strange, but I should like you to try and read them to me."
   Point to practice item.
   "Please read this to me."

4-9 Follow instructions for REGULAR AND IRREGULAR WORD test.

APPENDIX 5

STIMULI FOR THE SILENT TEST OF PHONOLOGY : TEST 3

SOUND SAME					SOUND DIFFERENT				
REGULAR HOMOPHONES									
HOMOPHONE	FREQ	HOMOPHONE	LOG FREQ	GRAPHIC SIM	NON HOMOPHONE	FREQ	NON HOMOPHONE	LOG FREQ	GRAPHIC SIM
tacks	0.358	tax	1.487	475	talks	1.107	tax	1.487	475
paced	0.325	paste	1.048	480	paved	0.776	paste	1.048	480
days	2.58	daze	-0.071	495	days	2.58	dame	-0.137	495
tail	2.04	tale	1.173	520	tail	2.041	tile	0.543	520
sail	1.721	sale	1.368	520	pail	1.425	pile	1.523	520
loan	0.629	lone	0.86	520	loan	0.629	lane	0.943	520
plain	1.767	plane	2.122	600	plain	1.767	plant	2.199	600
flea	0.54	flee	0.601	645	flee	0.601	fled	1.134	645
heel	0.701	heal	0.137	700	cheat	0.033	cheap	0.982	700
steel	1.877	steal	1.1	780	steal	1.877	stall	1.038	780
TOTAL				5735					5735
FREQ	2.969					2.981			
IRREGULAR HOMOPHONES									
knows	1.977	nose	1.961	218	grows	1.741	rose	1.895	218
war	2.155	wore	1.737	365	hot	2.338	hate	1.238	365
pour	1.392	pore	0.149	520	pour	1.393	pork	0.824	520
bare	1.545	bear	1.982	545	dare	1.134	dear	1.826	545
stake	0.713	steak	0.624	620	sneak	0.551	snake	1.543	620
bold	1.152	bowled	-0.638	663	bold	1.152	boiled	1.04	663
berry	0.346	bury	0.826	668	ferry	0.74	fury	0.645	668
board	1.978	bored	0.898	680	bread	1.886	bored	0.898	680
hall	1.676	haul	0.966	700	hall	1.676	heal	0.137	700
peace	1.727	piece	2.314	740	piece	2.314	price	1.66	740
TOTAL				5719					5719
FREQ	2.997					2.973			
NON-WORD HOMOPHONES									
afe		aif		387	afe		auf		389
voared		vored		855	voiled		voled		855
bauze		baws		466	bauze		bams		466
nime		nyme		700	nime		nume		700
queed		kweed		550	querd		smeed		550
scane		skain		380	scang		skain		380
aud		awd		567	ald		ard		567
keam		keem		700	kerm		keem		700
rabe		raib		520	rabe		ralb		520
zole		zoal		520	zolk		zole		520
				5645					5645

APPENDIX 5.1

INSTRUCTIONS AND PRACTICE LISTS FOR THE SILENT TEST OF PHONOLOGY

TEST 3

INSTRUCTIONS

On each line are two words. Sometimes sound the same and sometimes they do not sound the same. If you think they SOUND the same put a tick in the SOUND SAME column. If you think they SOUND DIFFERENT put a tick in the DO NOT SOUND THE SAME column.

		SOUND SAME	DO NOT SOUND SAME
PRACTICE LIST 1			
pain	pant		
sail	salt		
road	rode		
sea	see		
peel	pale		
pain	pane		
PRACTICE LIST 2			
gone	gown		
cry	quay		
none	nun		
key	quay		
bone	bun		
throne	thrown		
PRACTICE LIST 3			
zill	ziel		
scrup	skrup		
quop	kwop		
spone	spoan		
gucp	grop		
zall	zacl		

APPENDIX 6

SILENT TEST OF PHONOLOGY - TEST 3: 2 ANSWER LISTS (REGULAR WORDS)

REGULAR	LIST 1	SOUND SAME	DO NOT SOUND SAME
tail	tile		
tacks	tax		
flea	flee		
dame	days		
flee	fled		
plain	plane		
loan	lone		
plain	plant		
paved	paste		
heel	heal		
laces	lax		
pain	pane		
which	witch		
hole	whole		
wade	ward		
feat	felt		
but	butt		
neat	meet		
here	hair		
fed	feed		
missed	mist		
here	hear		
chair	cheer		
tide	tied		
prays	praise		
shot	hot		
sole	soul		
thyme	theme		
try	tied		
praise	plays		

STOP DO NOT TURN OVER PAGE

REGULAR	LIST 2	SOUND SAME	DO NOT SOUND SAME
steal	stall		
tail	tale		
talks	tax		
pile	pail		
days	daze		
steel	steal		
cheat	cheap		
paced	paste		
loan	lane		
sail	sale		
knot	not		
prays	praise		
here	where		
lacks	lax		
passed	pest		
pain	pane		
which	winch		
put	putt		
seat	salt		
feat	feet		
maid	made		
read	reed		
hair	here		
stare	stair		
stole	stool		
thyme	time		
hair	hare		
road	rode		
sea	see		
peel	pale		

STOP. DO NOT TURN OVER PAGE

APPENDIX 7

SILENT TEST OF PHONOLOGY - TEST 3: 2 ANSWER LISTS (IRREGULAR WORDS)

IRREGULAR	LIST 1	SOUND SAME	DO NOT SOUND SAME
dare	dear		
knows	nose		
board	bored		
pour	pork		
bread	bored		
berry	bury		
bold	bowled		
ferry	fury		
hot	hate		
hall	haul		
air	heir		
spare	spear		
roe	rough		
barn	urn		
know	no		
dew	do		
none	nun		
through	threw		
wear	were		
late	light		
stood	should		
grew	glue		
but	by		
feet	fete		
knew	new		
right	write		
gone	gown		
praise	plays		
guise	gums		
cry	quay		

STOP. DO NOT TURN OVER PAGE.

IRREGULAR	LIST 2	SOUND SAME	DO NOT SOUND SAME
piece	price		
bare	bear		
grows	rose		
sneak	snake		
pour	pore		
peace	piece		
hall	heal		
war	wore		
bold	boiled		
stake	steak		
wear	where		
wood	would		
blew	blue		
through	three		
bone	bun		
knob	no		
guise	guys		
sew	so		
doe	dough		
sir	air		
fate	fete		
pause	paws		
throne	thrown		
while	white		
ate	eight		
earn	urn		
brake	break		
key	quay		
know	now		
may	my		

STOP. DO NOT TURN OVER PAGE.

APPENDIX 8

SILENT TEST OF PHONOLOGY - TEST 3: 2 ANSWER LISTS (NON-WORDS)

NON-WORDS LIST 1		SOUND SAME	DO NOT SOUND SAME
zole	zoal		
kean	keem		
scang	skain		
bauze	baws		
queed	kweed		
afe	aif		
ald	ard		
nime	nyne		
voiled	voled		
rabe	raib		
fyde	phide		
oobe	roib		
frew	frue		
pirg	purg		
dyfe	dufe		
feps	brex		
eaf	eeps		
oolm	boyn		
tays	toise		
nyfe	mife		
zight	zeet		
knool	knod		
nied	niek		
dassed	dast		
skrup	shrup		
zaid	zade		
dracks	drax		
plick	plik		
spone	spoan		
quop	grop		

STOP. DO NOT TURN OVER PAGE.

NON-WORDS LIST 2		SOUND SAME	DO NOT SOUND SAME
kerm	keem		
bauze	bams		
afe	auf		
rabe	ralb		
voared	vored		
scane	scain		
aud	awd		
queed	smeed		
nime	nume		
zolk	zole		
oobe	koab		
fyde	prode		
nied	nide		
oolm	koyn		
frew	fren		
knood	knod		
pessed	possed		
nied	nide		
fecks	phex		
dife	dyfe		
vight	vite		
tays	taise		
pird	purd		
eaf	eeph		
dralks	drax		
plak	plick		
sorup	skrup		
quop	kwop		
zaid	zard		
spean	spone		

STOP. DO NOT TURN OVER PAGE.

APPENDIX 9

READING ALOUD TEST OF PHONOLOGY - TEST 4: SCORE SHEET

REGULAR WORDS			IRREGULAR WORDS			NON-WORDS		
TIME = ...			TIME = ...			TIME = ...		
	RESPONSE			RESPONSE			RESPONSE	
	CORR\	ACTUAL		CORR\	ACTUAL		CORR\	ACTUAL
cheat	\		hall	\		rabe	\	
cheap	\		heal	\		ralb	\	
lane	\		boiled	\		skain	\	
pile	\		snake	\		smeed	\	
tile	\		beer	\		nume	\	
paved	\		war	\		voiled	\	
plant	\		bury	\		ard	\	
dame	\		pork	\		bams	\	
stall	\		price	\		zole	\	
tail	\		dare	\		nime	\	
plain	\		ferry	\		ald	\	
pail	\		steak	\		queed	\	
loan	\		bold	\		scang	\	
tax	\		rose	\		auf	\	
fled	\		board	\		keem	\	
talks	\		knows	\		afe	\	
steal	\		piece	\		zolk	\	
days	\		pour	\		bauze	\	
paste	\		hate	\		voled	\	
flee	\		bread	\		kerm	\	

TOTALS

REGULAR WORDS	IRREGULAR WORDS	NON-WORDS
CORRECT = /20 = %	CORRECT = /20 = %	CORRECT = /20 = %
ERRORS = /20 = %	ERRORS = /20 = %	ERRORS = /20 = %

HI SQ.

REGULAR WORDS	IRREGULAR WORDS	NON-WORDS
SILENT vs ALOUD	SILENT vs ALOUD	SILENT vs ALOUD

APPENDIX 10

STIMULI FOR LEXICAL DECISION TESTS - VISUAL AND AUDITORY

TESTS 5 AND 6

LEXICAL DECISION VISUAL		WORDS		NON-WORDS	AUDITORY WORDS	
HIGH FREQUENCY			LOG FREQ			LOG FREQ
FOUR	1	girl	2.124	jirl	list	2.334 bist
	2	rain	2.225	hain	ship	2.241 thip
	3	tree	2.415	pree	town	2.342 hown
	4	note	2.021	lote	wife	2.013 bife
mean freq			2.25			2.25
FIVE	1	river	2.307	siver	music	2.182 fusic
	2	blood	2.025	clood	eight	2.076 oight
	3	start	2.316	plart	horse	2.318 torse
	4	north	2.097	gorth	glass	2.196 blass
mean freq			2.204			2.201
SIX	1	square	2.146	equare	street	2.121 spreet
	2	notice	2.322	sotice	circle	2.164 mircle
	3	window	2.179	sindow	person	2.34 derson
	4	forest	2.064	torest	object	2.068 onject
mean freq			2.188			2.188
SEVEN	1	general	2.037	memeral	million	2.004 killion
	2	machine	2.13	rachine	surface	2.307 murface
	3	village	2.068	hillage	brother	2.017 krother
	4	problem	2.265	groblem	teacher	2.146 weacher
mean freq			2.134			2.137
total freq			3.401			3.4
mean freq			2.196			2.196
Std Dev			1.651			1.631
LOW FREQUENCY						
FOUR	1	wind	0.013	gand	mint	0.452 fint
	2	jest	0.348	heat	bead	0.365 tead
	3	pore	0.149	vore	wick	0.013 gick
	4	silt	0.301	rilt	jute	-0.337 jord
mean freq			0.223			0.22 jute
FIVE	1	zebra	0.441	gebra	jewel	0.468 yewel
	2	brute	0.124	trute	crumb	-0.398 grumb
	3	winch	-0.523	dinch	stain	0.418 clain
	4	shrub	0.502	chrub	baron	0.146 faron
mean freq			0.281			0.265
SIX	1	plight	-0.092	glight	tripod	-0.018 pripod
	2	mammal	0.547	jammal	salute	0.487 dalute
	3	bandit	0	mandit	splint	0.253 sklint
	4	bonnet	-0.223	fonnet	wigwam	-0.081 pigwam
mean freq			0.242			0.276
SEVEN	1	gallery	0.301	jallery	gorilla	-0.086 borilla
	2	surgeon	0.378	murgeon	luggage	0.301 juggage
	3	drizzle	-0.409	crizzle	vampire	-0.398 zampire
	4	carcass	0.161	harcass	penguin	0.456 senguin
mean freq			0.193			0.182
total freq			1.44			1.441
mean freq			0.236			0.238
Std Dev			0			-0.016

APPENDIX 10.1

INSTRUCTIONS AND PRACTICE LIST FOR LEXICAL DECISION - VISUAL

TEST 5

Read each string of letters carefully. Decide if it is a REAL WORD or NOT A WORD. If it is a REAL WORD put a tick in the REAL WORD column. If it is NOT A WORD put a tick in the NOT A WORD column.

PRACTICE LIST

	REAL WORD	NOT A WORD
nife		
knife		
blood		
mune		
moon		
fabe		
mud		
bluk		
fune		
fail		
tune		
wife		
fale		
blud		
male		
mife		

STOP. DO NOT TURN OVER.

APPENDIX 11

LEXICAL DECISION TEST - VISUAL : TEST 5 - ANSWER LISTS 1 AND 2

LIST 1	REAL WORD	NOT A WORD
mandit		
start		
square		
jest		
forest		
bonnet		
groblem		
hain		
gorth		
silt		
river		
gand		
north		
torest		
sotice		
machine		
hoise		
wose		
leap		
pake		
bite		
zine		
wole		
cleap		
socks		
bool		
preet		
mint		
dream		
bloom		

STOP. DO NOT TURN OVER YET.

LIST 2	REAL WORD	NOT A WORD
fonnet		
rilt		
tree		
problem		
jallery		
general		
surgeon		
gallery		
plart		
rachine		
brute		
shrub		
piver		
lote		
plight		
drizzle		
thew		
take		
bed		
nine		
goat		
tox		
hood		
noise		
nose		
gland		
cheek		
floom		
wool		
vone		

STOP. DO NOT TURN OVER YET.

APPENDIX 11.1

LEXICAL DECISION TEST - VISUAL: TEST 5 - ANSWER SHEETS 3 AND 4

	:REAL WORD	:NOT A WORD		:REAL WORD	:NOT A WORD
carcass	:	:	vore	:	:
zebra	:	:	gebra	:	:
pree	:	:	crizzle	:	:
jammal	:	:	harcass	:	:
jirl	:	:	dinch	:	:
clood	:	:	rain	:	:
bandit	:	:	notice	:	:
pore	:	:	village	:	:
meneral	:	:	murgeon	:	:
blood	:	:	nammal	:	:
sindow	:	:	equare	:	:
note	:	:	hest	:	:
wand	:	:	hillage	:	:
ohrub	:	:	winch	:	:
girl	:	:	glight	:	:
window	:	:	trute	:	:
pole	:	:	loat	:	:
prum	:	:	rope	:	:
size	:	:	lane	:	:
hurt	:	:	yooks	:	:
tood	:	:	slurt	:	:
drum	:	:	ohew	:	:
wope	:	:	gite	:	:
fox	:	:	prane	:	:
ped	:	:	nize	:	:
glute	:	:	theek	:	:
sweet	:	:	flute	:	:
bone	:	:	wint	:	:
coal	:	:	gream	:	:
sland	:	:	roal	:	:

STOP. DO NOT TURN OVER YET.

APPENDIX 11.2

LEXICAL DECISION TEST - VISUAL : TEST 6 - SCORE SHEET

			RESPONSE			HIT	MISS	CR	FA
mandit	non	LF	W /	NW					
start	word	HF	W /	NW					
square	word	HF	W /	NW					
jest	word	LF	W /	NW					
forest	word	HF	W /	NW					
bonnet	word	LF	W /	NW					
groblem	non	HF	W /	NW					
hain	non	HF	W /	NW					
gorth	non	HF	W /	NW					
silt	word	LF	W /	NW					
river	word	HF	W /	NW					
gand	non	LF	W /	NW					
north	word	HF	W /	NW					
torest	non	HF	W /	NW					
sotics	non	HF	W /	NW					
machine	word	HF	W /	NW					
fonnet	non	LF	W /	NW					
rilt	non	LF	W /	NW					
tree	word	HF	W /	NW					
problem	word	HF	W /	NW					
jallery	non	LF	W /	NW					
general	word	HF	W /	NW					
surgeon	word	LF	W /	NW					
gallery	word	LF	W /	NW					
plart	non	HF	W /	NW					
rachine	non	HF	W /	NW					
brute	word	LF	W /	NW					
shrub	word	LF	W /	NW					
piver	non	HF	W /	NW					
lote	non	HF	W /	NW					
plight	word	LF	W /	NW					
drizzle	word	LF	W /	NW					
TOTAL									

			RESPONSE			HIT	MISS	CR	F
carcass	word	LF	W /	NW					
zebra	word	LF	W /	NW					
pree	non	HF	W /	NW					
jammal	non	LF	W /	NW					
jirl	non	HF	W /	NW					
clood	non	HF	W /	NW					
bandit	word	LF	W /	NW					
pore	word	LF	W /	NW					
meneral	non	HF	W /	NW					
blood	word	HF	W /	NW					
sindow	non	HF	W /	NW					
note	word	HF	W /	NW					
wand	word	LF	W /	NW					
chrub	non	LF	W /	NW					
girl	word	HF	W /	NW					
windbw	word	HF	W /	NW					
vore	non	LF	W /	NW					
gebra	non	LF	W /	NW					
crizzle	non	LF	W /	NW					
harcass	non	LF	W /	NW					
dinch	non	LF	W /	NW					
rain	word	HF	W /	NW					
notice	word	HF	W /	NW					
village	word	HF	W /	NW					
murgeon	non	LF	W /	NW					
mammal	word	LF	W /	NW					
equare	non	HF	W /	NW					
hest	non	LF	W /	NW					
hillage	non	HF	W /	NW					
winch	word	LF	W /	NW					
glight	non	LF	W /	NW					
trute	non	LF	W /	NW					
TOTAL									

WORDS	HF	CORRECT
	HF	ERRORS
	LF	CORRECT
	LF	ERRORS
NON-WORD	HF	CORRECT
	HF	ERRORS
	LF	CORRECT
	LF	ERRORS

CHI SQ.
VISUAL LEX. DECISION vs
AUDITORY LEXICAL DECISION
HF WORDS
TOTAL WORDS
HF NON-WORDS
TOTAL NON-WORDS

APPENDIX 12

LEXICAL DECISION AUDITORY : ANSWER SHEET

NAME: STANDARD: DATE:

	REAL WORD	NOT A WORD		REAL WORD	NOT A WORD
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
7			7		
8			8		
9			9		
10			10		
11			11		
12			12		
13			13		
14			14		
15			15		
16			16		
17			17		
18			18		
19			19		
20			20		
21			21		
22			22		
23			23		
24			24		
25			25		
26			26		
27			27		
28			28		
29			29		
30			30		
31			31		
32			32		

APPENDIX 12.1

LEXICAL DECISION TEST - AUDITORY : TEST 6 - SCORE SHEET

	RESPONSE			HIT	MISS	CR	FA		RESPONSE			HIT	MISS	CR	FA
sklint	non	LF	W / NW	:	:	:		penguin	word	LF	W / NW	:	:	:	
horse	word	HF	W / NW	:	:	:		jewel	word	LF	W / NW	:	:	:	
street	word	HF	W / WN	:	:	:		hown	non	HF	W / NW	:	:	:	
bead	word	LF	W / NW	:	:	:		dalute	non	LF	W / NW	:	:	:	
object	word	HF	W / NW	:	:	:		bist	non	HF	W / NW	:	:	:	
wigwam	word	LF	W / NW	:	:	:		oight	non	HF	W / NW	:	:	:	
weacher	non	HF	W / NW	:	:	:		splint	word	LF	W / NW	:	:	:	
thip	non	HF	W / NW	:	:	:		wick	word	LF	W / NW	:	:	:	
blass	non	HF	W / NW	:	:	:		killion	non	HF	W / NW	:	:	:	
jute	word	LF	W / NW	:	:	:		eight	word	HF	W / NW	:	:	:	
music	word	HF	W / NW	:	:	:		derson	non	HF	W / NW	:	:	:	
fint	non	LF	W / NW	:	:	:		wife	word	HF	W / NW	:	:	:	
glass	word	HF	W / NW	:	:	:		mint	word	LF	W / NW	:	:	:	
onject	non	HF	W / NW	:	:	:		faron	non	LF	W / NW	:	:	:	
mircle	non	HF	W / NW	:	:	:		list	word	HF	W / NW	:	:	:	
surface	word	HF	W / NW	:	:	:		person	word	HF	W / NW	:	:	:	
pigwam	non	LF	W / NW	:	:	:		gick	non	LF	W / NW	:	:	:	
fute	non	LF	W / NW	:	:	:		yewel	non	LF	W / NW	:	:	:	
town	word	HF	W / NW	:	:	:		zampire	non	LF	W / NW	:	:	:	
teacher	word	HF	W / NW	:	:	:		senguin	non	LF	W / NW	:	:	:	
borilla	non	LF	W / NW	:	:	:		clain	non	LF	W / NW	:	:	:	
million	word	HF	W / NW	:	:	:		ship	word	HF	W / NW	:	:	:	
luggage	word	LF	W / NW	:	:	:		circle	word	HF	W / NW	:	:	:	
gorilla	word	LF	W / NW	:	:	:		brother	word	HF	W / NW	:	:	:	
torse	non	HF	W / NW	:	:	:		juggage	non	LF	W / NW	:	:	:	
murface	non	HF	W / NW	:	:	:		salute	word	LF	W / NW	:	:	:	
crumb	word	LF	W / NW	:	:	:		spreet	non	HF	W / NW	:	:	:	
baron	word	LF	W / NW	:	:	:		tead	non	LF	W / NW	:	:	:	
fusic	non	HF	W / NW	:	:	:		krother	non	HF	W / NW	:	:	:	
bife	non	HF	W / NW	:	:	:		stain	word	LF	W / NW	:	:	:	
tripod	word	LF	W / NW	:	:	:		pripod	non	LF	W / NW	:	:	:	
vampire	word	LF	W / NW	:	:	:		grumb	non	LF	W / NW	:	:	: