

AN ANALYSIS OF THE SHORT AND LONG-TERM VALIDITY OF THE PHONIC INVENTORIES

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ABSTRACT

The Phonic Inventories are a three level spelling test which was developed to enable identification of the patterns of spelling error made by children, as an aid for teachers and therapists. The aim of this study is to test the assumptions of face validity, content validity, construct validity and discriminant validity of the Phonic Inventories, as well as their short and long-term reliability. This has been done by using both longitudinal and cross-sectional datasets from 1979 and 2001. The results of the study indicate that the three levels of the instrument are reliable, and that they have potential for clinical as well as classroom use in determining which alphabetic rules learners have or have not acquired. They also have potential for use by teachers for screening purposes, with the aim of identifying learners experiencing difficulties in learning the rule systems used in reading and writing.

DECLARATION

I declare that this dissertation is my own unaided work. It is submitted for the degree of Masters in Research by Coursework and Dissertation in the University of the Witwatersrand, Johannesburg. It has not been submitted before any other degree or examination in any other university.

Carla Pereira

7th day of January, 2008.

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CHAPTER 1

GENERAL ORIENTATION AND PROBLEM FORMULATION

1.1 Introduction

“Reading and writing are both cultural imperatives in today’s information based society ... and will become increasingly important as avenues to reward and success” (Kaminski & Good, 1998, p.113, in Broom, 2001, p.xv, emphasis added by author).

As suggested by the above quote, the ability to read and write fluently in at least one language, is likely to be amongst the most, if not *the* most, essential tool at the disposal to an individual who desires to be an effective, contributing and competitive member of their modern day society.

The poor state of reading and writing in South African schools has become well known, through cross-national tests which regularly show our children exhibiting lower levels of literacy than those of many countries, including much poorer neighbours such as Mozambique, Botswana and Swaziland. Thus South Africa came ninth out of the 14 African countries who participated in the SACMEQ¹ Grade 6 literacy test published in 2005 (Moloi & Strauss, 2005).

According to Minister Naledi Pandor the Department of Education’s own Systemic Evaluation 2005 Grade 6 Report reveals “a crisis in our system”. Thirty thousand learners were tested in literacy, numeracy and science and achieved a national mean score of 38% in literacy in the language of teaching and learning

¹ Southern and Eastern African Consortium for Monitoring Education Quality, is a collaboration between 15 countries, through the respective Ministries of Education. South African Minister Naledi Pandor is the current Chair.

(LOLT, which is generally English), 27% in mathematics and 43% in natural science. Additionally, the report also revealed that learners not only couldn't read in the LOLT, but equally poor results emerged from the mother-tongue reading tests (DoE, 2005).

Speech-language therapist D. Klop from the University of the Western Cape (cited in Caelers, 2005) reported that more than 60% of grade 3 pupils were not performing at the reading and numeracy levels expected at that grade. She suggests that most children from disadvantaged backgrounds begin school with a lag of 2 years or more and so are not ready to begin learning how to read (Caelers, 2005). This is supported by the numerous evaluation studies conducted by JET Education Services over the last 10 years (see Mahahle project impact evaluation report, Mveledzandivho project midterm evaluation report and the COUNT baseline evaluation report).

The problem with education in South Africa is compounded by the fact that learners in primary schools are not given the necessary literacy and language skills. Many teachers in the South African context lack the proficiency and confidence to sustain instruction in a second language and to deal with learner experiencing barriers to learning². Hartshorne suggests that a quality primary school system would make the greatest difference to social well-being and economic development of South Africa (Hartshorne, 1992, 1996, 1999). He argues that without a solid foundation, investments in secondary and tertiary education are wasted.

Low levels of literacy place poor children in South Africa at a double disadvantage on leaving school, whether they seek to survive in the subsistence economy, on the factory floor, or whether they enter university to study for careers in business or the professions. This is the new meaning of marginalisation in post-apartheid South Africa (Moloi & Strauss, 1995).

² See www.jet.org.za

Improving the curriculum and teaching methods through improving assessment methods is becoming increasingly important internationally and is central to South African educational transformation. Using new assessment approaches to reform education in the context of outcomes-based assessment requires research into the design of new performance-based and diagnostic assessment instruments and a move away from the once off test or examination as the criterion for success (see Feuer et al, 1993; Gipps, 1994; Gong & Reidy, 1996; Fourali, 1997).

Various evaluation studies done by JET Education Services³ seem to suggest that there is a need for simple, easily accessible programmes and/or instruments which can be used by primary school educators in the classroom to improve teaching. This is particularly necessary where teachers have learners with special needs in their classrooms.

Traditional measures of ability are costly, time consuming and usually require the services of trained personnel and they are available only to a fortunate few. Additionally, tests in general usage have been normed on English speaking population groups (usually from the USA or Europe) and measure acquired knowledge, which is gained through participation in the dominant culture (Utley, Haywood and Masters, 1992) and therefore a fair appraisal in South Africa cannot be assured. Traditional standardized intelligence tests neither remediate nor prescribe and so make no provision for change beyond identification of problems (Kriegler & Skuy, 1996).

A testing instrument that would require little training in administration, which could be used to streamline the testing process to assure that children with specific learning disabilities were identified for further testing and, ultimately, participation in remediation programmes to address their particular individual needs is therefore ideal. There is therefore a pressing need to develop tests,

³ *Ibid.*

which measure the ability of children to draw on their own cognitive abilities to acquire knowledge.

The Phonic Inventories are assessment and testing instruments which aim to establish how children use sound/symbol relationships to create written words. They were originally developed for use clinically as the basis for planning clinical teaching interventions. They have also been used in a remedial school environment for the purposes of highlighting children's difficulties and for monitoring the progress of children from year to year. They have also been used to plan sessional tutoring interventions for South African children with learning difficulties as part of a remedial programme called the "Targeted Revisualisation Programme"⁴.

1.2 Relevance of this study

The above contextual background has been provided to indicate that South Africa is in a difficult situation with respect to coping with children with special needs. Due to historical factors, the education system is in a state of transition; the process of change is likely to be laborious and expensive and can be expected to continue over the next 20 years (South Africa Government Information, April, 2005). It is a system that is focused on access to education of children as a whole group, rather than the specialised needs of smaller groups, such as children with learning difficulties. Even so, the needs of this group are recognised as requiring attention. The first step must be on assessing who these children are, where they are and what their needs are.

Given these concerns, there is a need for screening instruments which can be used on a wide scale in working with children in the mainstream education system to identify those children who may have learning difficulties and should

⁴ Refer to Appendix A for a detailed description on the programme.

be referred for full assessment. The Phonic Inventories are screening instruments which attempt to do this.

1.3 Focuses of this study

The Phonic Inventories were originally developed thirty years ago, on the basis of two pilot studies which aimed to establish their face validity with teachers, as well as their content validity as measured both against the sequence of instruction followed in introducing spelling in South African primary schools, as well as against previously validated spelling tests (Potter, 2001). The pilot studies were designed and implemented as follows:

- a. Face validity was established by asking primary school colleagues how the instruments related to what was taught in two remedial schools and a mainstream primary school, and whether the instruments focused on what they considered spelling ability to be.
- b. Content validity was established by relating the instruments to the sequence of instruction recommended by the head teacher of a large South African primary school, as the basis for the schemes of work normally followed by teachers in the introduction of phonic rules in the junior primary grades in the school.
- c. Construct validity was established by cross-validation over a two year period, by using the instruments in conjunction with standardized measures of spelling, and establishing the relationship of the instruments with these measures.
- d. Discriminant validity was assessed by analysing the errors made by learners in two remedial schools and relating this to the errors made by learners in a mainstream primary school. The types of errors made by the remedial learners were then used as the basis for focused instruction.

After the pilot studies, the instruments were then used clinically over a fifteen year period, and gradually changed and adapted. No manual was produced, nor was the reliability and validity of the revised instruments established.

The aim of this study was to test the assumptions of face validity, content validity, construct validity and discriminant validity of these instruments. The short and long-term reliability and validity of the instruments will also be assessed.

In planning the study, the face validity of the instruments was first checked in a workshop conducted with the teachers in the target schools, as part of establishing whether the study was feasible. Given the existence of datasets gathered from learners in full-time remedial education and in mainstream classes during pilot development of the instruments in 1978 and the standardization and revision of the instrument in 1979, the decision was then taken to re-administer the instruments to both learners in a full-time remedial education and in the mainstream in 2001. The datasets available for analysis were thus both longitudinal and cross-sectional.

The focuses of this study are:

- a. Analysis will be undertaken to determine whether there is concurrent and long-term stability in the Phonic Inventories. To examine the long-term reliability of the instruments and to establish whether they contain any problem items. This will be done both by analysing the initial datasets gathered in 1979 and comparing the trends with those of the 2001 data set. Concurrent reliability will be then estimated from reliability indices, while long-term stability will be established by investigating whether there is any evidence of similar patterns of errors over the last 20 years.
- b. The study will also focus on establishing evidence of the concurrent and long-term content and construct validity of the instruments. The ability of

the instruments to discriminate between these groups will be established concurrently by comparing the performance of children with and without learning difficulties on the Phonic Inventories, and longitudinally by establishing whether the ability of the instruments to predict group membership at this point in time is similar to twenty five years ago.

It is hypothesized that:

- a. The Phonic Inventories will be able to tap into certain functional difficulties associated with dyslexia as found in children who have been diagnosed with learning difficulties.
- b. Difficulties in spelling the type of words used in the Phonic Inventories will be associated with the development of phonological awareness.

There are a number of practical implications of this study both for teachers and clinicians. One is that analysing patterns of errors made in written language may provide a suitable and practical choice for screening children with potential learning difficulties. Another is that the Phonic Inventories may provide a valid and reliable procedure for screening for learning difficulties which can be used in schools and classrooms. A third is that the information yielded by the Phonic Inventories is not only potentially useful diagnostically, but can also provide detailed information relevant to planning instruction, and monitoring the progress made by learners.

CHAPTER 2

BACKGROUND TO THE PHONIC INVENTORIES

2.1 Introduction

The Phonic Inventories were developed thirty years ago by Prof. Charles Potter of the University of the Witwatersrand, Johannesburg, based on the Harvard studies conducted by Jean Chall (1967). As mentioned in the previous chapter, they have been utilized clinically to establish an initial starting point for remediation as well as in a remedial school environment for the purpose of ongoing monitoring of progress of children with learning disabilities⁵.

One of the ways in which the Phonic Inventories have previously been used has been to establish a baseline of the types of spelling errors made by children. This has been used to develop a checklist of target skills for instruction.

As used clinically, the spelling errors made by the child can be clustered and grouped, as the basis for determining which alphabetic rules the child has or has not acquired with the aim of establishing the rule system used by the child in reading and writing. The child's own rule system then forms the basis for targeting additional alphabetic rules. Remediation thus involves a variety of activities which aim to establish target rules, and to build memory integrities, through a process of mediation. Progress is then monitored through analysis of the child's errors both prior to and during the process of remediation.

⁵ Refer to Appendix A for a more detailed description of the Targeted Revisualisation Programme, in which the Phonic Inventories have been used in a number of previous studies.

This current study investigates whether it is also possible to use the Phonic Inventories for the purposes of identification of children with learning difficulties. This research thus focuses on the psychometric qualities of the instruments, and their ability to provide information which is discriminative.

2.2 Levels of the Phonic Inventories

The Phonic Inventories consist of three written spelling tests which measure the ability to apply phonemic awareness and alphabetic awareness into the written production of heard words. Owing to the link between reading and spelling as cognitive processes (see Chapter 3: Literature Review), reading experience is likely to mediate the child's performance on all three tests. Each test targets different spelling requirements to which the child must apply his/ her ability. These are as follows:

- **Phonic Inventory Level One**

The focus here is on individual vowels, individual consonants and consonant blends. The words may have an individual consonant, individual vowel, and individual consonant. They may also take the form of an individual vowel followed by an individual consonant, an initial blend, individual vowel, individual consonant or an initial blend, an individual vowel and then an end blend. Examples of words from this test are: *on*, *bed*, *pram*, *grunt* and *flush*. At this level, the focus is on short vowel sounds and simple consonant sounds. Phonemic awareness and alphabetic awareness are crucial for good performance on this test. This test is made up of 50 words.

- **Phonic Inventory Level Two**

On this test the focus is on long vowel sounds occurring together with initial and ending consonants and consonant blends. Examples of words from this test are *go*, *we*, *far*, *boat*, *please*, *crowd*, *fern* and *there*. All are

based on long vowel sounds, either with a vowel diagraph, an /-e/ on the end of the word or as a function of the consonants in the word. Good performance on this test requires good knowledge of both phonemes and the alphabetic principle to know which graphemes represent which sounds and how these work together. However, as there is more than one grapheme to represent some of these phonemes, the child must also rely on reading experience reading to know which graphemes are appropriate in which instances. This test is made up of 59 words.

- **Phonic Inventory Level Three**

For this test the focus is on polysyllabic words. The words are presented in groups, with each group being based on a root word, and then requiring the child to modify it with prefixes and suffixes. Examples of words from this test are *chop, chopping, chopper, chopped; happy, happily* and *happiness*. To perform well on this test requires good phonemic and alphabetic awareness as well as knowledge of rules for building out from root words to have a grasp of the spelling rules appropriate for polysyllabic words. Reading experience is also likely to influence knowledge of how words are adapted for suffixes and the rules for these adaptations. This test is made up of 48 words.

2.3 Skills measured by the Phonic Inventories

The Phonic Inventories were originally developed as criterion-referenced tests (Potter, 2001). They were conceptualised as being related to particular developmental stages in the teaching of spelling, as opposed to being norm or group-referenced. The instruments' purpose is to ascertain how children make words and which phonic and alphabetic rules the children have established and have not yet established.

The Phonic Inventories were thus developed as knowledge and content-based tests. The scoring system was designed to identify the type of spelling errors made by a child. Initial research (Potter, 1969) indicated that the instruments could be successfully used to assess areas on which instruction needed to focus as well as to monitor progress made by children.

The Phonic Inventories have subsequently been used clinically with children identified as having learning difficulties as a way of establishing the types of errors made by children, to establish an appropriate level of instruction as well as to plan the sequence of remedial programmes. The errors have first been clustered and grouped to identify patterns of errors made by a child. This information has then been used to inform instruction.

The instruments have also been used for testing children in groups in remedial schools (Potter, 2001), for the purpose of establishing a baseline of the individual patterns of spelling errors made by children in the classroom. Using this kind of information, an individual record and profile can be made for each child. Given evidence of specific types of errors requiring remediation which appear to be persistent in children with learning difficulties, the evidence from this previous research suggests that the Phonic Inventories should be investigated as an instrument which could be used to identify children with potential learning difficulties within the school system.

The rationale would be to identify whether there were differences in patterns or frequencies of particular types of spelling errors made by children in remedial education as compared to children in mainstream schooling. If such differences were found, this evidence could be used for screening purposes to identify at risk children in mainstream schooling.

2.4 Previous studies which have used the Phonic Inventories

A number of studies have previously been conducted using the Phonic Inventories. The first two were pilot studies conducted by Potter (1979). The aim of these studies was to establish whether particular types of spelling error would be found with higher frequency in samples of learners identified as having learning difficulties, relative to learners in the mainstream. The instruments used were then refined.

They were then administered as part of two longitudinal case studies of children with learning difficulties (Sfetsios, 2002; Potter, 2004). Each of these studies followed up the progress of a single child over a seven year period in the 1990's.

In addition, the instruments have been used in a number of studies in which children with learning difficulties have been provided with additional after-school tutoring (MacReadie, 2001; Wilson, 2001; Retsos, 2002, Picton, 2002; George, 2002; Ravenscroft 2002). In each of these studies, the information yielded by the instruments has been used for the purposes of planning instruction, as well as for the purposes of monitoring the progress made by individual children as well as groups of children.

Two large-scale studies involving learners in mainstream schools have also been conducted. The first is a study by Grasko (2005), which focused on learners in a remedial school and learners in mainstream schools in a location close to the remedial school. The aim of Grasko's study was to establish whether particular error profiles could be established indicative of children with learning disabilities.

The second is the current study, which focuses on analysis of longitudinal data from two mainstream schools using the instrument. The design of the current study focuses on establishing the concurrent and long-term reliability and validity of the instrument, by comparing the error patterns made by children in

mainstream classes with the error patterns made by children in equivalent grades at a full-time remedial school. The research design is also based on analysis of data from the original pilot studies conducted twenty years ago in conjunction with more recent data, and comparison of trends in these different datasets.

In designing the current study, the researcher has had access to the following datasets:

Table 1: Research design table

Data from:	Purpose	Samples	Instruments	Analysis
Pilot Study 1	Standardisation of instruments Trend Analysis	Grade 4/5 remedial school Grade 4 mainstream school Grade 5 mainstream school (conducted in 1978)	Schonell Spelling Test Form A Phonic Inventories Levels 1 + 2	Development of error categories Cross-tabulation Establishment of high frequency error types
Pilot Study 2	Testing of revisions to instrument Comparison of remedial and mainstream learners	Grades 2-7 remedial school Grades 2-7 mainstream school (conducted in 1979)	Schonell Spelling Test Form A Daniels and Diack Spelling Test Phonic Inventories Levels 1, 2 + 3	Refinement of error categories Cross-tabulation Analysis of frequencies of errors
Current study	Analysis of psychometric properties of instrument Trend Analyses Refinement of instrument	Grades 1-7 remedial school Grades 1-7 mainstream school	Phonic Inventories Levels 1, 2 + 3	Cross-tabulation Analysis of proportions of errors Refinement of diagnostic error categories Comparison for frequencies of errors for both samples Reliability analysis Discriminant analysis

2.5 Samples of data analysed in the current study

The remedial and mainstream classification groups used in the current study were drawn as follows:

2.5.1 Data from pilot study one

Sample One: The remedial learners were involved in full-time remedial education in a combined Grade 4/5 classroom at Crossroads remedial school in Johannesburg (N=16). This was a mixed gender sample consisting of children who had all been through the school's multi-disciplinary assessment process, and had each been diagnosed as learning disabled, and requiring full-time remedial education. The senior author of this paper was the class teacher as well as supervisor of the educational programmes of each of these children. The first two levels of the Phonic Inventories were developed for use with this class, as a way of providing detailed diagnostic information on the alphabet knowledge and phonological/phonic skills of each of the children.

Samples Two and Three: The post-test scores of this sample were then compared with two mixed gender samples of learners from Emmarentia primary school, using data obtained by the remedial/learning support teacher at the school. Each of the learners in these samples was in a mainstream class, following a normal government school programme at either Grade 4 or Grade 5 levels. The Phonic Inventories were applied to assist in screening these samples to identify children who were weak in spelling. This was used as an indicator of possible learning difficulties. The children were then drawn into remedial programmes organised by the class teachers and the remedial/learning support teacher.

2.5.2 Data from pilot study two

Sample Four: The remedial learners for the second pilot study were drawn from a group of children involved in fulltime remedial education at Norwood remedial school in Johannesburg (N = 74). Sample Four was a mixed gender stratified sample consisting of children from Grades 2 to 7, who had all been through the school's multi-disciplinary assessment process, and had each been diagnosed as learning disabled, and requiring full-time remedial education. The senior author of this paper was the school supervisor of the educational programmes of each of these children. A third level of the Phonic Inventories was developed for use with this sample, as a way of providing detailed diagnostic information on the advanced phonological/phonic skills and the syllabification skills of each of the children.

Sample Five: The post-test scores of this sample were then compared with a mixed gender stratified sample of learners from Emmarentia primary school (N = 207), drawn from Grades 2 to 7, using data obtained by the class teachers and the remedial/learning support teacher at the school. Each of the children in this sample was in a mainstream class, following a normal government school programme.

2.5.3 Data from pilot study three

Sample Six: This was a mixed gender stratified sample of remedial learners were drawn from the group of children involved in fulltime remedial education at Japari Remedial School in Johannesburg (N = 143). The sample was drawn from children from Grades 1 to 7. Each of the children had been through the school's multi-disciplinary assessment process, and had been diagnosed as learning disabled, and requiring full-time remedial education.

Sample Seven: The data for Sample Six were then compared with a mixed gender stratified sample of learners from Parkview junior (N = 136) and Parkview senior schools (N = 229). As with Sample Six, the learners in Sample Seven were drawn from Grades 1 to 7, using data obtained by the class teachers for each of these levels. Each of the children in Sample Seven was in a mainstream class, following a normal government school programme.

The current study is thus based on non-experimental, comparative assumptions, and utilises a series of ex post facto analyses conducted longitudinally for cross-validation purposes. The overall assumption guiding this study is that, despite having been used clinically and in previous research, no long-term analyses have been conducted which examine the Phonic Inventories in terms of their psychometric qualities. There is no formal information relating to either the reliability or the validity of the instrument, which is fundamental to its acceptance as a psychological test.

It is for this reason that the current study, using 2001 test data, will be examining the psychometric properties of the Phonic Inventories (and specifically the reliability and validity of the instrument) by comparing it to the earlier administration of the tests in the late 1970s. However, before going further into the design, it is important to ground the Phonic Inventories within a model or theory. It is therefore necessary to look at the literature in the area of reading and spelling, which now follows.

CHAPTER 3

A LITERATURE SURVEY OF WRITING SYSTEMS, DYSLEXIA, READING AND SPELLING

3.1 Introduction

The borders between the fields of psychology and education have increasingly blurred during the last four decades. The purpose of this chapter is to place current reading and spelling theories in their modern context, and to focus on the contributions made by psychologists and psycholinguistics to understanding the cognitive processes involved in literacy. This forms the theoretical background to the research questions, which are stated in Chapter 4: Research Design and Methodology.

Literacy includes the ability to read, write and spell. Until recently, however, despite its importance, there has been less research on the processes relating to production of written language than the processes which relate to reading. Spelling has traditionally been considered as a secondary code of language, derivative of speech. Writing as a linguistic skill has similarly been under-emphasized. It has been variously conceptualised as a photograph of spoken language (de Saussure, 1916), or as a code of transcription (Luria, 1973, 1990), with spelling presumed to be based on inner pronunciation of the phonic (sound) forms of the spoken language.

Cognitive researchers have been slow to recognise that written language is neither a complete isomorph of the spoken language (Gelb, 1963) nor a process of reading-in-reverse (Bradley & Bryant, 1983; Bradley, 1989). It has, however, in recent years come to be regarded as a complex and autonomous system of

representation, both of the deeper lexical-morphemic levels of language (Chomsky & Halle, 1968; Craigie, 1927; Francis, 1958; Hockett, 1958; Scragg, 1974; Vachek, 1989; Ellis, 1982; Venezky, 1970, 1999), as well as of the mappings of phonology. As such, spelling proficiency has come to be regarded as a highly complex intellectual achievement in its own right, and worthy of psycholinguistic interest in the same way as other language-based skills, such as speech perception, speech production and reading comprehension.

Recent advances in knowledge of the processes involved in the spelling and writing have been motivated by work from two quarters: firstly, linguistic analyses of writing systems, out of which has developed the consideration of spelling as a language-based skill involving a number of developmental stages; and secondly, case studies of neurological deficits in cognitive processing which have seriously challenged prevailing assumptions about both writing and spelling. Thus, firstly, relevant considerations of the writing system will be outlined, followed by a theoretical review of current theories of the spelling and reading process and of its development.

3.2 Writing systems

The writing systems of the world are divided into three types: logographic writing, such as Chinese, where each symbol represents a different spoken word; syllabic systems, such as Japanese Kana, where each symbol represents one syllable of the spoken language; and alphabetic writing, such as English, where in principle each symbol represents a particular phoneme (distinctive sound) of speech (Ellis, 1982; Kessler & Treiman, 2003).

There are limitations in each of these systems (Harris & Coltheart, 1986). For example, in a logographic system in which writing represents the spoken word, one cannot write a word if one has never actually been exposed to or actively taught its corresponding representational symbol. Similarly, in a spoken language

comprised of both mono- and polysyllabic words, it is difficult to learn the syllabic system. This is especially so in a language such as English, which contains a great many different syllables and in which different combinations of vowels are used to represent similar spoken sounds.

Some written languages, such as Finnish, Italian, Hawaiian and Afrikaans, are based on shallow or transparent orthographies that closely approach the ideal alphabetic system, in which a single phoneme is always matched by a single grapheme. Others such as English possess a deep or opaque orthography that bears a complex correspondence between spelling and speech (Hanna, Hanna, Hodges and Rudorf, 1966). This is because spoken and written English is a polyglot language, influenced by many languages throughout history: Anglo-Saxon, Latin, Greek and Romance languages, all of which played a role in establishing the words as they are spoken today.

3.1.1 Historical development of the English orthography

The original inhabitants of the British Isles, the Celts, spoke a language of the *Indo-European* family. They were conquered by Julius Caesar in 54B.C. The Romans departed to return almost a century later and then stayed for nearly 400 years (Birsh, 1999; Henry, 2003). During the 5th century AD, during the period of Old English, Germanic groups, the Jutes, Saxons and Angles began to settle in different parts of England. They adopted neither the language nor the religions of their new home (Balmuth, 1992; Birsh, 1999). Rather Anglo-Saxon became the dominant language, and the vocabulary stressed the people, objects and events of daily life⁶.

During this same time Germanic, Celtic, Latin, Greek, Anglo-Saxon, Scandinavian and French words also entered Old English. At the end of the

⁶ Birsh (1999) argues that there were 5 factors which shaped the English language during this period of Old English: Teutonic invasion and settlement; the Christianizing of Britain; the creation

period, “that language was no longer the basically Teutonic and highly inflected Old English but the hybrid-becoming, Romance-importing and inflection dropping Middle English” (Nist, 1966, p.107). Anglo-French compounds (e.g., *gentlewomen*, *faithful*, *faithfulness*) appeared during this period.

At the time of the Renaissance, a renewed Latin influence penetrated the language during the period of Mature Middle English. Many of the words we use today are borrowed from the Latin of this period, including *index*, *library*, *medicine*, and *instant*. Latin affixes also entered the language in great numbers during this period. Prefixes (e.g., *ad-*, *pro-*) and suffixes (e.g., *-ent*, *-al*, *-ion*) were added to root words to form words such as *adjacent*, *prosecution* and *rational* (Claiborne, 1983; Birsh, 1999).

During the period of the Late Middle English (1422-1489), the written word grew in importance. Caxton introduced the printing press to England and printed books using the English spoken in London by the well-to-do (Birsh, 1999). Many spelling conventions were set into place at this time, and even more of English orthography was set during period of Early Modern English.

It was during the period of Late Middle English and Early Modern English when the sound patterns, especially the vowel sounds of the language, underwent changes, an event termed the “Great Vowel Shift” (Jespersen, 1909). The vowel shift resulted in certain vowel sounds being articulated in new positions and assured a sharp separation between phonology and spelling. For e.g., in Mature Middle English of Chaucer, the vowel sound in *bite* was pronounced /e/ as in *bee*, but in Early Modern English of Shakespeare’s time, it shifted to /a/ as in *bay*. This shift caused problems for spellers “because stabilized spellings now came to represent different sounds” (Hanna et al, 1971, p49). This meant that a number of different graphemic combinations were used to represent a large number of permissible phonemic combinations. Changes continued through the

of a national English culture; Danish-French Warfare, political adjustment and cultural

period of Late Modern English to reach the pronunciation today. What has emerged in modern written English is a system which is largely phonetic (Antoine, 1991), but which is based on a complex or opaque orthography.

3.1.2 English orthography and spelling

In the English alphabetic system, several orthographic features serve to complicate the alphabetic principle (Hanna et al, 1966; Birsh, 1999; Henry, 2003). As previously stated, a grapheme, the written representation of a phoneme, is not necessarily represented by one letter. For example, the phoneme /o/ in the word *though* is represented by the four-letter graphemic option <ough>. In addition, some graphemes represent two or more phonemes, such as <ea> in *head, beat and break*, for example. Further complications arise in that the same phoneme may be represented by different graphemes, for e.g., /t/ in the words *to* and *two*. There are also many borrowed words from other languages, and since their incorporated written form is not based upon the same underlying phoneme-grapheme relationship, they disobey the normal correspondence, for e.g., *choir*. Another complicating feature is that the relationship between spelling and phonetic representation is often sacrificed to preserve morphological, syntactic and semantic informations (Chomsky and Halle, 1968). For e.g., although /ed/ is pronounced differently in *frayed, landed*, and *kissed*, the spellings of these words preserve information about their common syntactic structure; similarly, although the pronunciation of /g/ in *sign* and *signature* their spellings preserve their common derivation.

Given these complications and inconsistencies in the relationship between pronunciation and orthography, psycholinguists have suggested that accurate spelling cannot be accomplished solely by means of access to a system specifying phoneme-grapheme conversion rules, as the traditional phonic mediation theories assumed. In order to spell all English words correctly, there

assimilation; and the decline of Old English as a result of the Norman Conquest (Nist, 1966).

needs to be access to a lexical system containing whole-word spelling representations (Ellis, 1982). However, in addition to a lexicon consisting of previously stored words, there also needs to be access to an alphabetic system for generating written language. Fischer, Shankweiler and Lieberman (1985) indicate that it is more accurate to view orthography as a rational system that requires linguistic sensitivity whereby the regularities of word structure at various levels of linguistic representation are implicitly apprehended and utilised by ordinary spellers⁷. They outline three levels of linguistic representation: a basic level of phoneme-grapheme correspondences; a morphemic level, that requires learning morphemes and the conventions for combining morphemes to form new words; and an advanced level, which requires knowledge of phonological rules that map underlying morphophonemic segments to their surface phonetic form, for example, *heal* and *health*.

In their study of college students, Fischer et al (1985) found correctness of spelling to be related to accuracy in analysing written words into component morphemes, all of which had been represented by both good and poor spellers. Several other studies with young children have shown that pattern abstraction occurs as part of spelling acquisition. Schwartz and Doehring (1977) demonstrated that spelling ability is associated with an orderly acquisition of morphological and orthographic patterns. They found good spellers to be in advance of poor spellers in the mastery of these patterns (Adams, 1990). Research has also shown that good and poor spellers do not differ greatly in their visual memory abilities (Lennox & Siegel, 1998).

⁷ This approach is consonant with the view of *emergent literacy* (Sulzby & Teale, 1991) which sees children as active participants in the process, as dynamic learners who generate hypotheses about their environment and consequently about print, including productive written text. Emergent literacy consists of the knowledge, attitudes, and skills that are developmental precursors to more established forms of literate behavior (Whitehurst & Longigan, 1998). It develops not only as a result of direct instruction, but also as a product of a stimulating and responsive environment (Arzubiaga, Rueda, & Lilia, 2002). Components of emergent literacy include phonemic awareness, concepts of print and story, reading styles, and literacy as social or cultural practice (Purcell-Gates, 2001). Research shows that good emergent literacy skills are likely to enhance children's school experiences and help them get started on the path to reading success (Senechal & LeFreve, 2002).

Thus, what differs in good spellers is that they possess well-developed phonological processing skills that not make them aware of sounds in words but also support the learning of letter patterns in words (Moats, 1995; Lennox & Siegel, 1998; Moats & Farrell, 1999). Good spellers also have good orthographic memory. This memory is more specific to remembering letter patterns and words than visual memory (Carreker, 1999, 2000, 2005). The development of this memory is dependent of well-developed phonological processing skills. Good spellers know not only how sounds are represented but know how words should look (Adams, 1990). In addition, good spellers are able to simultaneously draw support from their awareness of syntax, morphology and semantics. Rubin (1988) showed that children in both kindergarten and first Grade vary considerably in their implicit and explicit knowledge of morphology and that this variability reflected in early writing ability.

In spite of the complexities, most children become proficient spellers, and it has been demonstrated that by the third year in primary school young children have phonological, orthographic, morphological and visual knowledge of words. Both good and poor spellers attempt to use all of these sources of knowledge in spelling (Waters, Bruck, and Malus-Abramowitz, 1988). Any model of spelling process must thus take into account both the mapping of written language and the internal mental representations derived from the primary linguistic activities of listening and speaking and the secondary activity of reading.

Besides the study of the processes of writing and spelling as they emerge in proficient spellers, it is also possible to learn from these processes as they emerge in the significant proportion of children and adults who encounter specific difficulties with learning to read, write and spell – people who are usually referred to as ‘dyslexics’. This is a focus of the current study, and for this reason, before describing some of the theories which have been proposed to explain the spelling process, a discussion of what is meant by dyslexia is first necessary.

3.3 Dyslexia

In defining dyslexia, there are two possible approaches with respect to its manifestation in children. The first dates back to the origin of the term, as a congenital disorder associated with the left cerebral hemisphere of the brain, related to disturbances in learning to read (Seymour, 1986). The second approach attempts to understand dyslexia from a functional perspective, as related to aspects of language and cognition as these map onto the types of tasks children are required to do in school.

3.3.1 Congenital approach to understanding dyslexia

The congenital⁸ approach is well explained by the classification system outlined by Rains (2002). According to Rains (2002), there are two main categories of dyslexia. The first is *visual word-form dyslexia*. This refers to dyslexia where the deficit is in processing the word as a unit. Under this category, there is placed spelling dyslexia (the inability to recognise words as a coherent visual unit), neglect dyslexia (the misreading of the beginning or end parts of words), and attentional dyslexia (where words can only be read in isolation, and not in the context of sentences or paragraphs).

The second category is called *central dyslexia*. In this category are surface dyslexia (where words are read by the application of grapheme-phoneme conversion, and only words that follow this can be read) and phonological dyslexia (where a learned sight vocabulary is used to read).

Finally, Rains (2002) describes *deep dyslexia*, where there exists some combination of the above deficits, though what combination exactly is variable between individual cases.

⁸ The congenital approach is best explained in terms of the Dual Route model of reading (Coltheart et al, 1985, 1993) which is based on work with adult dyslexics (see Section 3.5.3 of this chapter).

However, it should be noted that there is no agreement in the literature that a model of dyslexia derived from studies of adult dyslexics necessarily applies to children (Potter, Grasko & Pereira, 2006). The first reason for this lack of agreement is that the deficits manifested by young children change, as they mature rapidly on a neurological level. A second reason is that the demands of the school curriculum also change, and what may be acceptable as a response by a child at one level in the curriculum may not acceptable at another level.

As a result, the definition adopted by the World Federation of Neurology stresses a combination of congenital, cognitive as well as socio-cultural factors:

"A disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and sociocultural opportunity. It is dependent upon fundamental cognitive disabilities, which are frequently of constitutional origin" (Kolb & Whishaw, 1996, p. 516).

It is important to note, however, that every phrase in the definition of dyslexia adopted by the World Federation of Neurology has been disputed (Kolb & Whishaw, 1996). It is thus not possible to state that there is agreement in the field concerning the nature of dyslexia and its classification from a congenital perspective.

3.3.2 Congenital approach to spelling deficits

If reading deficits expose the input function of dyslexia, then spelling deficits expose the output function. According to Rains (2002), there are three categories of spelling impairment. First are linguistic or central disorders of spelling, such as spelling by sound (phoneme-grapheme conversion) and vocabulary based spelling (words learned by sight). These map very neatly back to the categories of reading impairments. Second are disorders of spelling assembly, which refer to difficulties in knowing the correct sequence of letters. The third category refers

to disorders that are secondary to spatial processing impairment (i.e. spatial agraphia), and so is relevant specifically to the task of writing words. While this is important for understanding the underlying cause of the disorder, it stems from different cognitive functions.

Rains (2002) also distinguishes between acquired and developmental dyslexia. Developmental dyslexia follows the same categorization as *central dyslexia* for the acquired, but is not the result of a known cerebral lesion, low intelligence or environmental issues. Similarly, for developmental and acquired, there is often overlap between surface, phonological and deep dyslexia within individuals. According to Rains (2002) this should be regarded as an important indication of the structure of the cognitive systems, on which reading relies. This indicates the importance that the congenital approach places on causation.

Central to this approach is that “dyslexic brains are structurally atypical” (Voeller, 2004, p.740). Anatomically, there are differences between normal readers and dyslexic readers. Moreover, studies using neuroimaging show that there are definite patterns of activation that occurs when a person with dyslexia reads. Since these differences are apparent even in young children, it seems they result from early neurobiological processes (Voeller, 2004).

3.3.3 Cognitive approach to understanding dyslexia

While the above approach to understanding dyslexia is based on organic and physiological assumptions, a second approach to understanding dyslexia is a functional one. This does not purport that the underlying cause is not important, but the deficit is described on the basis of functionality. “If fundamental cognitive deficiencies underlie dyslexia, they must be deficiencies in cognitive abilities which are required for the acquisition of reading and writing but are themselves of a more general nature and application” (Ellis, 1993, p.95). That is, the focus is

not on the underlying neurological deficits, but rather on the cognitive deficits related to actual output.

Cognitive skills such as phonological awareness, visual processing and short-term memory have been put forward as the fundamental deficit areas in dyslexia (Ellis, 1993). However, if there were one cause of dyslexia, then all dyslexics would present the same difficulty patterns when reading and writing when in fact there is substantial variation in the deficits that dyslexics present, most generally between Developmental Phonological Dyslexia and Developmental Surface Dyslexia, but even this does not classify all deficiencies experienced by dyslexics (Ellis, 1993).

There is also a relationship between disorders of reading and disorders of writing (Johnson and Myklebust, 1967). It is thus necessary to shift focus from a skill-based approach to instruction to one of a 'dynamic language process' (Johnson and Myklebust, 1967). This approach links language abilities across verbal and written language; receptive and expressive and allows for the understanding that cognitive skills developed for one area of language will benefit another. It accounts for transference and generalisation of ability. This suggests that any definition of a language disability should be able to encompass all language skills, as they are all related. It is thus likely that if a child has difficulty reading, he/ she will also have difficulty writing and spelling. However, reading ability is still usually the focus skill in definitions of learning disability that are broad enough to encompass all language skills.

From this approach, dyslexia as a syndrome can be expanded to include all difficulties with written or spoken language such as reading, writing, spelling, and speaking or listening. From this understanding, a comprehensive definition of dyslexia offered by Høien and Lundberg (1991 cited in Lundberg, 1999) reads as follows:

"Dyslexia is a disturbance in certain linguistic functions of critical importance for a productive use of the alphabetic principle when written language is coded. The

disturbance is primarily expressed as difficulties in achieving automatised word recognition during reading. It is also clearly manifest in poor spelling. The dyslexic disturbance often runs in families, and there are reasons to assume that a genetic disposition is involved. A characteristic feature of dyslexia is that it tends to persist. Even though reading sometimes can reach an acceptable level, the problems related to spelling remain.” (p.10)

This definition refers to children of normal, or above-normal, intelligence, with all other factors of vision, hearing, home life and education being adequate, who experience difficulties with learning how to read and write (Ellis, 1993). But what is especially significant about this definition is the focus on defining what the features of dyslexia *are* rather than what they *are not*.

3.3.4 The delay versus difference debate

An ongoing argument in the understanding of dyslexia is the delay versus difference debate (Snowling, Goulandri & Defty, 1998). These authors suggest that there are qualitative differences between children with dyslexia and normal learners, and that the differences are not merely the result of learning delays. However, it can be argued that by matching children with dyslexia to younger, normal learners, there is the chance that differences that were quantitative to begin with, have, over time, changed how the child with dyslexia reads. This is especially relevant, as pointed out by Schatschneider & Torgesen (2004), as inaccurate reading and less practice reading delays the number of ‘sight’ words a child learns, and a large lexicon of known words is required for efficient reading.

Perhaps the element left out of learning difficulties thus far is context. Johnson and Myklebust (1967) point out that before any judgment can be made about the potential of a child, one must first look at the opportunities that have been available to the child. They note that a child can only learn when exposed to *real opportunity to learn* (Johnson & Myklebust, 1967).

Following from this, the *opportunity to learn* exists in the classroom. It is most often the teacher who first notes a problem (Wadlington & Wadlington, 2005) and the teacher's attitude has a great effect on the students (Wadlington & Wadlington, 2005). Dyslexia may most apparently manifest at school, and so the child's experience of it in the classroom can have profound effects on the child, such as low self-esteem, frustration, helplessness, stigma and depression (Currie & Wadlington, 2002; Wadlington & Wadlington, 2005). Teacher's attitudes will be a reflection of their beliefs and understanding about dyslexia. Wadlington and Wadlington (2005), using a sample of 250 faculty members and students in a college of education, explored beliefs about and understanding of dyslexia by use of a survey. Their findings were that, overall, the sample (consisting of elementary teachers, secondary teachers, special education teachers, counsellors and administrators), had a weak understanding of dyslexia.

In summary, it is clear that from a long history the concept of dyslexia has become a useful, functional concept; one that is still dynamic; one which allows for relevant research as well as application in the field but one that is still often misunderstood, even by persons who are involved in work with such children.

It is apparent from the literature that learning disabilities and dyslexia are terms which is differently understood and variously defined. They can be defined either in terms of its congenital⁹ and physiological basis, or functionally as related to underlying cognitive processes¹⁰. There is, however, consensus that early diagnosis of children with functional differences to other children is of paramount importance, and that priority needs to be placed on establishing procedures which can be used to identify children likely to be learning disabled.

Dyslexia, it has been argued, is a lifelong issue of constitutional origin that cannot be cured (Lyon, 1995; Birsh, 1999; Murphy, 2004; Ramus, 2003), however, with

⁹ The congenital approach is best explained by the Dual Route model of reading (Coltheart et al, 1985, 1993).

¹⁰ See Ellis, 1993.

the right early intervention and prevention programmes, students with dyslexia and other poor readers can increase reading skills to at least average levels. Such programmes must combine instruction with phoneme awareness, phonics, spelling, reading fluency and reading comprehension strategies. The Targeted Revisualisation Programme deals with all these aspects at various levels in the programme in its attempt to improve the reading and spelling level of a child with a learning difficulty.

3.3.5 Dyslexia and spelling

Individuals with dyslexia typically have significant difficulties with spelling as well as with reading (Boder, 1973; Critchley, 1975; Bourassa & Treiman, 2003; Kessler & Treiman, 2003). Bourassa and Treiman (2003) note that reading-level match studies have been used with regards to discovering causal factors in reading problems resulting from dyslexia. The roles of phonologic and orthographic skills have been refined from such work. However, few similar studies have been conducted for spelling problems resulting from dyslexia, to explore if phonologic and orthographic skills are also dissociable for spelling. So although research on dyslexia shows strong evidence for deficits in phonological awareness and that these people counteract this by using orthographic knowledge and word-specific memory, there is only weak evidence that the same is true for spelling.

Bourassa and Treiman (2003) did a spelling level matched study to investigate this, and concluded there were no differences between children with dyslexia and those without who were spelling level matched. They found no evidence that children with dyslexia display a specific deficit in spelling as a result of poor phonological processing. It seems that there were no qualitative differences, with children with dyslexia performing very similar to younger normal learners.

They did however find differences with regards to the application of certain 'rules for spelling' in English, with the children in dyslexia showing poor understanding of these rules, such as the /-e/ in 'tripe' versus 'trip'. These morphological rules are learned implicitly over time and are known to take time acquire. However, commonly occurring rules may be learnt from frequency through exposure, such as the plural /-s/ (Kemp & Bryant, 2003).

Even so, the authors conclude that the processes involved in spelling by children with dyslexia are not different from those used by normal learners, and hence their performance and errors (while delayed) are not different from normal learners (Bourassa & Treiman, 2003). Although there is evidence that this is the case for reading, they conclude that for spelling it is not. In conclusion, they did not find *"unusual spelling errors or highly atypical patterns of performance that occur only among children with dyslexia and that can serve as markers of dyslexia"* (Bourassa & Treiman, 2003, p.329).

3.3.6 Methods of identifying dyslexia

Dyslexia requires specific testing to be identified, especially for early identification (Voeller, 2004). And although dyslexia is often hereditary, children who develop normally are not usually tested (Voeller, 2004). Ideally, intervention should occur before school entry, but this is very unlikely to happen (Voeller, 2004). The consensus is that testing and intervention should occur as early as possible and be as unobtrusive as possible to ensure the most favourable outcome.

At a first level, the focus is normally on functioning, the requirement being to identify children who are underachieving. This is done through a process of screening. The purpose of screening tests is to identify children who are experiencing specific types of difficulties due to specific deficits. Underachievement is not defined according to Grade level alone, but in terms of learning (mental) capacity, chronological age, and previous learning experiences

(Johnson & Myklebust, 1967). There are then various areas that are assessed in more depth, including receptive and expressive processes as well as verbal and non verbal, reading, written language, spelling and arithmetic to name a few (Johnson & Myklebust, 1967).

This model of assessment based on underachievement is the basis for the current standard assessment in South Africa, which consists of the child completing an intelligence test as well as a battery of tests of achievement (Francis et al, 2005). These may include tests tapping reading, writing, spelling, language and motor skill and could be administered by a team of professionals, including psychologists, speech therapists, occupational therapists and remedial therapists. This approach, known as the IQ-discrepancy model, the aptitude-achievement discrepancy or the IQ-achievement discrepancy, operationalizes dyslexia as a severe discrepancy between achievement and intellectual ability (Francis et al, 2005). This then has classifications for seven domains of deficits, such as of reading, of maths, or of language (Fletcher et al, 2004). There are exclusion criteria that states that LD (dyslexia) should not be classified if: the primary cause is a sensory disorder, a mental deficit, an emotional disturbance, or an economic disadvantage, for example (Fletcher et al, 2004).

However, this model has been questioned in the literature (e.g. Fletcher et al, 2004; Stanovich, 2005). There have been critiques and suggestions for alternatives approaches for identifying dyslexia, based on two salient points (see Grasko, 2005): first, the discrepancy model has little empirical evidence supporting its use, and second, the empirical evidence suggesting its flaws is growing. According to Fletcher et al (2004), there have been a number of reports recommending that the IQ / aptitude-achievement model be abandoned. Not only this, but a survey conducted nationally in the USA found that two thirds of teachers felt that the current model was *too slow in identifying children* and most felt that the methods were not effective (Fletcher et al, 2004).

Stanovich (2005) gives a strong argument that the use of aptitude-achievement discrepancy as a means of defining learning disabilities, specifically dyslexia, is keeping this measurement a 'pseudoscience'. The author substantiates this claim by an argument based on four premises. That is, for the aptitude-achievement discrepancy model to be based on research findings, there would need to be evidence to support the following four propositions (Stanovich, 2005):

- The pattern of information-processing skills that underlie dyslexia should be different for low and high IQ readers. However, the evidence is precisely to the converse, with high and low IQ readers displaying similar information-processing skills.
- The neuroanatomical differences of dyslexia should be different for high and low IQ readers with dyslexia. Here the evidence has shown neuroanatomical anomalies related to dyslexia but none related to reading-IQ discrepancy.
- Different treatments should be required for high and low IQ readers with dyslexia. Again, the evidence suggests that this is not the case. Many reviews have all concluded that there is no interaction between aptitude and treatment.
- The aetiology for high and low IQ readers with dyslexia should be different due to difference in heritability of deficits. Although there is some evidence to support this claim, it is still inconclusive. Both high and low IQ readers with dyslexia are found to be the result of both genetic and environmental aetiology.

Another major question with respect to the discrepancy model is with regards to reliability. According to Francis et al (2005), because of the 'arbitrary' cut-points of what is considered to be a discrepancy, membership of "normal" and "disordered" groups are not stable over time. By using data from a longitudinal study, as well as simulated datasets, these authors show how, with repeated testing, children who have been classified as aptitude or IQ discrepant (and thus learning disordered) may change groups over time. This is an artefact of any

psychometric measure where the distribution of scores is continuous. In essence, the critique focuses on cut-off points, which are usually arbitrary, with no natural break separating the groups.

The recommendations from these findings is that valid and reliable assessment necessitates performance testing as well as clinical judgment by a multidisciplinary team, which is a way around the psychometric issues. The performance scores are still necessary, especially to identify specific problem areas. This approach, while attempting to circumvent one serious issue in assessment of dyslexia, compounds the issues of expense and slow diagnosis, being unmanageable both in terms of time and money. This type of assessment would only be available to a fortunate few in the current South African educational climate. However, the argument for more reliable testing is worthwhile.

Another possibility then is a focus on classroom performance where a child does not respond to quality instruction (Francis et al, 2005) (though this is never guaranteed). This would require short, focused assessments over time, which could assess level of performance as well as change in performance on a specific ability. It is worth suggesting that the development of a classroom-based instrument for assessing phonological awareness (such as the Phonic Inventories), given the evidence for its importance, may be a worthwhile focus for research. The aim would be to develop tests of phonological ability, which could measure all children as opposed to having a multitude of instruments and then requiring the educator to pick the most relevant one.

Other alternatives have been suggested, such as that made by Fletcher et al (2004). This proposal goes further than supplying another means of measure, but rather outlines a different approach. Instead of extensive assessment that takes a long time, is expensive and delays any intervention until achievement levels are low enough for the IQ-discrepancy to meet criteria, they recommend moving

to 'treat then test' approach. The approach follows three tenets highlighted by the NCLB (Fletcher et al, 2004):

- General screening for dyslexia of all learners in the beginning school years
- Implementing early intervention programmes
- Constantly monitoring progress and causation of outcomes

The benefits of this type of approach are that classroom teachers would be involved at the first stage of the programme for identifying children with potential difficulties. The programme would then run seamlessly within the education programme and so not require extra funding or specially trained personnel (though current educators may need extra training). It would allow for early identification as well as intervention, both of which have been highlighted as important.

The literature covered in this section can thus be summarised as follows: there is general dissatisfaction (among academics and educators) with the current assessment procedures used for identifying children with dyslexia or the potential to develop difficulties. These procedures are not well founded and evidence discounting their value is growing. New approaches are focused on fitting in with classroom activities to allow for earlier identification, quicker intervention, as well as ongoing assessment and decreased costs. The requirement is for instruments that teachers can administer in the classroom to groups of learners, which allow for early identification, are highly predictive, and sensitive enough to monitor change. It is unlikely this will all be in the form of one test, but rather a battery of tests, based on empirical evidence, in which academics and educators can be confident.

As a final note, Simpson and Everatt (2005) make the observation that a screening test or measure is only worthwhile to the degree to which it correctly

identifies children who require intervention. They conclude that a screening test needs to have strong predictive validity of the abilities it is measuring.

In terms of the different predictors¹¹ in learning to read, spell and write, it is important to consider what constitutes normal reading and spelling development. This will provide a framework within which to consider the various aspects of dyslexia or learning disabilities, as these relate to the current study.

3.4 Reading and spelling process and development

3.4.1 Reading process and development

In order for a person to read, symbols of the printed page must be translated into spoken words (i.e., decoding), and meaning must be connected to those words. Reading is, according to Gough's Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), the product of decoding and comprehension. These two components of reading work together in a delicate, interdependent balance. Inefficiency in one of the components can lead to reading failure (Lebov, 2003). The reader who has difficulty with decoding will not be able to derive meaning from the text, conversely, the reader who has difficulty with specific levels of spoken language will receive little rewards for his or her efforts (Carreker, 1999, 2000, 2005).

The extent to which the reader succeeds in establishing the relationship between the symbols and spoken language is dependent on his or her sensitivity to the internal sound structure of language (i.e., phonemic awareness; Stanovich, 1986; Adams, 1990; Stanovich, 1993; Harrison, 1996; Snow et al, 1998). In addition to recognising that words have sounds, the reader must realise that printed words consist of letters that correspond to those speech sounds. These insights allow the reader to establish the alphabetic principle or code that is necessary for

¹¹ See Section 3.4.3 for discussion on predictors of reading, writing and spelling.

acquiring decoding skills. The importance of phonemic awareness (Adams, 1990; Bradley & Bryant, 1983; Goswami & Bryant, 1990; Liberman, Shankweiler & Liberman, 1989; Stanovich, 1992) cannot be overemphasised as it provides the foundation for decoding.

Decoding requires knowledge of the phonemic, graphophonemic, syllabic and morphemic structures of the language. The reader uses a variety of strategies for translating the printed word into its spoken equivalent: sound-symbol correspondences, structural analysis, instant word recognition and contextual cues.

The appreciation of the relationship between sounds and letters develops through phonemic awareness and instant letter recognition (i.e., print awareness; Adams, 1990). This understanding, in turn, develops *sound-symbol correspondences* (i.e., graphophonemic patterns), that enable the reader to sound out unfamiliar words. Initially the beginning reader recognises words by associating a word with some visually distinguishing characteristics (e.g., dog as a circle in the middle with a tail at the end; Gough & Hillinger, 1980). As the reader encounters more and more words, the visual characteristics that make words distinguishable diminish. The reader begins to cue recognition by selecting some of the letters in a word, usually the first and last letter (Ehri, 1991). He or she is now better able to distinguish words, but accuracy is limited as many words share the same initial and final letters (Carreker, 1999, 2000, 2005). When the reader attends to all of the letters, he or she can sound the correct pronunciation of an unfamiliar word (Gough & Hillinger, 1980).

Both phonological awareness and sound-symbol correspondences are critical co-requisites in reading acquisition (Share & Stanovich, 1995). The reader needs an introduction to a few sound-symbol patterns to begin sounding out words. As the reader sounds out words, he or she reinforces the sound-symbol correspondences that have been introduced and establishes new ones (Adams,

1990). By using known sound-symbol correspondences and phonological sensitivity, the reader approximates the pronunciation of the unknown word. The approximate pronunciation combined with available contextual cues enables the reader to determine the correct pronunciation and thereby provides the reader an opportunity to acquire knowledge of the sound-symbol correspondences within the unknown word. With repeated encounters, the reader builds an orthographic memory of words that eventually he or she instantly recognises the words without having to sound them out (Adams, 1990).

In addition to letters, words have syllables (i.e., linguistic units) and morphemes (i.e., smallest meaningful units of language). Structural analysis, the perception of orthographic syllables and morphemes, enables the reader to decode long unfamiliar words and fosters a decoding process that is less cumbersome and more efficient than sounding out each letter. By recognising different syllables, the reader can accurately predict the sound of the vowel in a syllable. With knowledge of morphemes, the reader focuses on units of letters that recur in words (e.g., the reader sees *tract* in *tractor*, *attractive*, and *subtraction*). The reader only has to sound out the part of the morpheme that he or she does not recognise (Henry, 1996).

Morphemes also give clues that allow the reader to infer meanings of words (Moats, 1994; Henry, 1996). Orthographic patterns established through graphophomemic, syllabic and morphemic awareness greatly economise the learning of a reader's lexicon (i.e., spoken and written word knowledge).

It must be noted that literature on reading is vast and, to a great extent, unintegrated largely because research topics and interests have been approached from different directions from within different disciplines, including psychology, education, and linguistics. The vast majority of reading research has concentrated on the psychological processes of reading in the individual reader, and therefore on the internal relations between perceptual processes,

orthographic systems and, to a lesser extent, the reader's knowledge of his or her own language.

One crucial source of confusion is between *theories of reading*. The history of research on reading, and attitudes towards reading methods, tend to have been a series of reactions and counter-reactions: phonic methods abandoned in favour of whole-word methods, only to regain favour again later; the view that reading is decoding letters into sounds has been attacked on the grounds that reading is a "psycho-linguistic guessing game" (Stubbs, 1980, p.9) which uses syntactic and semantic information.

3.4.1.1 *Teaching reading in the classroom*

The debate about how to teach reading has drawn the attention of many teachers away from what is actually involved in learning to read. Amongst researchers, however, a good deal of consensus has been built about what is entailed in learning to read in a language with an alphabetic writing system (Murray, 2006). It is clear from the literature (see Adams, 1990; Uhry, 1999; Schatschneider & Torgesen, 2004) that there are two things which young learners need in order to gain a foothold on the first rung of the literacy ladder: firstly, phonemic awareness (the ability to notice individual sounds in spoken words) and secondly, alphabetic knowledge (recognition of the letters of the alphabet and how they relate to the sounds of the language). Phonemic awareness and alphabetic knowledge are the two best predictors of the progress a child will make in the early years of learning to read (Murray, 2006). In order to become proficient readers, learners need to develop automatic and rapid letter and word recognition and comprehension and fluency in reading. (See e.g. Adams 1990; Harrison 1996; Snow et al 1998; Stanovich, 1986, 1993; Watkins & Coffey, 2004; Snow, Griffin & Burns, 2005).

The researchers referred to above draw largely on psychology as their theoretical base. Researchers with a more social orientation argue that this is a decontextualised, skills-based view of literacy (e.g. Street, 1997). From their perspective, literacy takes its meaning from the social context in which it occurs; it is a social practice and must be understood as such (see e.g. Heath, 1983).

Murray (1996) argues that in relation to young children learning to read in Grade 1, literacy is a skill, which involves brain-processing capacities, and is learned through practice. It is also a social practice, which is acquired through apprenticeship to those who engage in the practice. In the case of young school children, the home, community and classroom are all potential sites from which literacy takes meaning and in which apprenticeship can occur. Skills such as phonemic awareness can be acquired implicitly in the home and community through listening to stories, singing and playing language games; in these contexts value will be attached to the activity which will give it meaning and integrate it into the child's life. Phonemic awareness can also be learned explicitly in the classroom as the teacher draws learners' attention to the systematic features of language. The challenge for the teacher is to link this to the experiences the child brings to the classroom.

3.4.1.2 *Development of phonemic/phonological¹² awareness*

In order to read in a language such as English, children need to be able to isolate the different sounds or phonemes in words and distinguish them from each other (e.g. distinguish between the initial sounds in 'cat', 'sat', 'mat' in English). Many English speaking children acquire this ability by, for example, having stories read to them (Adams 1990), reciting nursery rhymes (Goswami & Bryant, 1990; Bryant

¹² These terms are sometimes used interchangeably (see Adams, 1990; Stanovich, 1986); some writers see phonological awareness as a slighter broader concept of which phonemic awareness is a significant part.

et al 1990) and playing games such as 'I spy with my little eye something beginning with ...'¹³

In research that has been carried out elsewhere, a causal relationship has been established between phonemic/phonological awareness and learning to read (Stanovich, 1986)¹⁴. Children who have a well-developed phonological awareness when they enter Grade 1, will learn to read more quickly; and explicit teaching of phonemic/phonological awareness will assist all children in learning to read. A number of studies suggest that teaching phonological awareness is especially helpful for those children who come from homes where there is little exposure to print and reading (Adams, 1990). Research also suggests that phonemic/phonological awareness developed in learners' home language can be transferred to their additional languages (August et al 2005; Wade-Wolley 2005).

However, phonemic/phonological awareness also develops over time, and as children learn their alphabet and begin to read, their phonemic/phonological awareness develops and improves. Stanovich (1986) describes this phenomenon as a 'reciprocal relationship'. Phonemic/phonological awareness is both a cause and an effect of learning to read. Thus children gain from both explicit teaching of phonemic/ phonological awareness, and from the **experience** of reading and writing, which deepens their understanding of the sound system. This suggests that literacy programmes need to provide opportunities for learners to practice reading and writing and to develop phonological awareness.

Adams (1990 as cited in Uhry, 1999) described phonemic awareness as progressing hierarchically through five levels of difficulty, namely:

¹³ It should be noted that very little, if any, research has been done into the language play and experience of African speaking children and how this affects the development of phonological/phonemic awareness. Furthermore, most research into the development of initial literacy has been carried out in relation to English; English and African languages have a different phonology, morphology and syntax. The notion of a 'word' is different in African languages from that in English. There is an urgent need to carry out research that could inform the teaching of phonics in the indigenous languages of South Africa.

- **An ear for rhymes**

Previous ability with rhymes has been found to correlate with reading ability (Adams, 1990; Maclean, Bryant, & Bradley, 1987). Thus children who can hear rhymes can intuitively recognise that part of the word, the onset (initial phoneme), is exchanged for another phoneme in rhyming words.

- **Matching words by rhyme and alliteration**

The second level of phonemic awareness involves matching two spoken words either by alliteration (i.e., similar onsets) or by rhyme. This can be assessed through use of research task designed by Bradley and Bryant (1983) that is called the *oddy* or *odd-one out task*.

- **Segmenting onsets**

Adams (1990) describes the third level as syllable splitting. At this point, phonemes are not merely intuited but are consciously segmented off from spoken words. The most common first attempts at segmenting involve the initial phoneme. Researchers have evidence that words break easily at the onset-rime division, the point at which the initial phoneme can be separated from the middle vowel and ending consonant, or the rime (Treiman, 1985). For example, it is easier to segment the word *map* into /m/-/ap/ than into /ma-/ /p/.

- **Full Segmentation of all phonemes in words**

Not until the age of six, or the beginning of formal reading instruction, do children reach Adam's fourth level of phonemic awareness, in which all the phonemes are segmented (e.g., the spoken word *map* segmented as .m/ /a/ /p/. At this point a child is able to make use of the alphabetic principle to figure out how to read unfamiliar words on his or her own.

¹⁴ Stanovich (1993) claims that phonemic awareness is the best predictor of the ease of early reading acquisition.

- **Manipulation of phonemes**

At the fifth and most complex of Adam's levels of phonemic awareness, children are able to delete or exchange phonemes. They can say *seat* without the /s/ sound as "eat" and can reverse sounds in *cat* to say the word "tack".

At each of these levels, there is wide range of differences in children's abilities. However, children at the low end of the scale who do not tend to catch up to peers when they are left on their own will continue to have difficulty with both phonemic awareness and alphabetic principle unless they are provided with direct instruction.

3.4.1.3 *The role of phonics*

In order to learn to read, learners must grasp that "print maps speech" (Stanovich, 2005). Phonics is an explicit method of teaching children that there is a systematic relationship between sounds and letters, and that spellings represent phonemes. An important part of learning to read is the ability to work out and recognize previously unrecognized words. Decoding of this kind is not, as some people suggest, meaningless – if children already have the word in their spoken vocabulary, it will be meaningful (Stanovich, 1986). Adams (1990) suggests that the most important benefits of phonics instruction are related to fluent reading; in her view, the ability to recognize letters, spelling patterns and whole words effortlessly and automatically is the key to fluent reading (see also Stanovich, 1986).

Research suggests that systematic phonics instruction in the beginning phase of reading is most effective (Armbruster et al, 2003). However, it is important to keep in mind that there is a reciprocal relationship between reading and writing; as children actively try to write and spell words, this will enhance their knowledge of phonics. Systematic phonics instruction therefore needs to be

integrated into a broader literacy programme that gives learners a rich experience of reading and writing.

3.4.1.4 *Developing fluency*

Fluent readers recognise words (and the letters they are made up of) automatically, freeing up the processing capacity of the brain to focus on comprehension. Reading speed is important in comprehension and fluency, because if a reader does not recognise words quickly enough meaning will be lost. Automaticity in reading develops gradually with a lot of practice over time and is related to vocabulary knowledge, the amount of accessible text a learner is exposed to, and motivation to read. According to Stanovich (1986; 1993) there is reciprocal causation between these different factors in reading success, which results in good readers getting better and better, and poor readers falling further and further behind. Thus the gap between good and poor readers gets wider and wider as time goes by. This is what Stanovich (1986) calls the ‘Matthew principle’:

The Matthew principle

Extract from Stanovich (1993, p.281) referring to an earlier paper (1986) in which he introduced the notion of the ‘Matthew principle’:

Children who begin school with little phonological awareness have trouble acquiring alphabetic coding skill and thus have difficulty recognizing words. Reading for meaning is greatly hindered when children are having too much trouble with word recognition. When word recognition processes demand too much cognitive capacity, fewer cognitive resources are left to allocate to higher level processes of text integration and comprehension. Trying to read without the cognitive resources to allocate to understanding the meaning of text is not a rewarding experience. Such unrewarding early reading experiences lead to less involvement in reading-related activities. Lack of exposure and practice on the part of the less-skilled reader further delays the development of automaticity and speed at the word recognition level. Thus, reading for meaning is hindered, unrewarding reading experiences multiply, practice is avoided or merely tolerated without real cognitive involvement, and the negative

spiral of cumulative disadvantage continues. Troublesome emotional side effects begin to be associated with school experiences, and these become a further hindrance to school achievement.

Conversely, children who quickly develop efficient decoding processes find reading enjoyable because they can concentrate on the meaning of the text. They read more in school and, of equal importance, reading becomes a self-chosen activity for them. The additional exposure and practice that they get further develops their reading abilities. I speculated that reading develops syntactic knowledge, facilitates vocabulary growth, and broadens the general knowledge base. This facilitates the reading of more difficult and interesting texts. Thus, the increased reading experiences of these children have important positive feedback effects that are denied the slowly progressing reader.

What this points to is the need to diagnose as early as possible when a child is struggling to relate sounds to letters and words, and to give him or her individual support (Clay 1979, 1993). It also highlights the need to develop children's fluency, which can be done as early as Grade 1. For example, the teacher can provide a model of fluent reading when involved in shared reading of a 'big book.' Young learners themselves need many opportunities to read (both aloud and silently) texts at an appropriate level, that is a level at which they experience a high degree of success. Opportunities to read the same text a number of times, including situations in which learners get guidance and feedback from the teacher, are likely to improve their word recognition, speed, accuracy and fluency. It is also helpful to build up learners' recognition of 'sight words' that occur repeatedly in texts (e.g. 'were', 'was' in English).

3.4.1.5 *Level of difficulty of texts*

Children will only develop fluency and enter the cycle of positive reinforcement if they are provided with interesting texts at an appropriate level of difficulty (Stanovich, 1993). For independent reading, texts should be relatively easy; it has been suggested that no more than 1 in 20 words should be difficult for the

reader (Armbruster et al, 2003). Instructional texts, which will be mediated by the teacher can be more challenging; it has been suggested that no more than approximately 1 in 10 words should be difficult (Armbruster et al, 2003). Texts with more than 1 in 10 difficult words create frustration for the reader.

Clearly in a class of 35 or more children, there will be children at different reading levels. Reading programmes therefore need to have Graded reading material so that children can work at an appropriately challenging level, and move from level to level.

3.4.1.6 *Developing vocabulary*

As we have just seen, the amount of difficult vocabulary in a text provides a rough guide as to the difficulty of the text. Vocabulary therefore plays an important role in reading. When young children are learning to read, it is helpful if the words they are trying to make sense of in print are already part of their oral vocabulary. The larger a child's vocabulary, therefore, the better they are likely to be able to read. Cunningham and Stanovich (2003, p.34) claim that, "*After decoding skills, a child's vocabulary is one of the most important factors in fluent and easy reading.*" Obviously, it is helpful if reading programmes are structured in such a way that vocabulary is progressively built up and teachers use strategies to develop the vocabulary necessary to read specific texts.

Once children have learnt how to read, their vocabulary improves **as a result of reading**. According to Cunningham and Stanovich (2003), the difference between children with extensive vocabularies and those with limited vocabularies is the amount of print they have been exposed to. Again, we see the Matthew principle in operation: the more children read, the wider their vocabularies become and the better they read. They are in what Cunningham and Stanovich (2003, p.34) describe as a "*positive feedback loop, a reciprocal effect in which reading increases their ability to read.*" This emphasizes the importance of giving

children adequate exposure to print in Grade 1; without this, they will fall behind as readers and find it difficult to catch up (Murray, 2006).

In the early stages of learning to read, learners need texts which are accessible but sufficiently challenging to develop their vocabulary. They need multiple exposures to new vocabulary to support recognition. They benefit from a combination of explicit teaching of vocabulary in context and the acquisition of vocabulary through exposure.

3.4.1.7 *Developing reading comprehension*

If children can read accurately and fluently, they will be able to construct meaning of two kinds: firstly, literal meaning and secondly, a more reflective, purposeful understanding of text. In order to construct a literal understanding of text, readers need relevant background knowledge and vocabulary; understanding of sentence structure; and reading strategies such as predicting, clarifying what they have read, and using questions to guide their understanding. To develop a more reflective, purposeful, understanding of text, readers need to personally respond to texts in terms of their own experiences, beliefs and so on; and they need to be able to discriminate between the purposes and audiences for different kinds of texts (e.g. stories, poems, non-fiction) (Murray, 2006).

In the early stages of reading, learners need texts with simple sentence structure on familiar topics where their background knowledge will support the decoding of print. However, as learners become more proficient in reading, texts need to extend their background knowledge and command of sentence structure. Learners need exposure to different kinds of texts (fiction, non-fiction, poems) and different kinds of visual material.

Comprehension can be developed by explicit teaching, for example, modeling comprehension strategies in shared reading with 'big books', activating

background knowledge, showing how to monitor comprehension, asking questions, encouraging learners to retell stories, and so on.

3.4.2 Spelling process and development

To understand the vital role spelling plays in learning to read and the spelling errors students make, it is important to understand how spelling develops.

A young child's first writing experience is usually in the form of drawing. As the child is exposed to print, he or she begins to differentiate writing from drawing and begins to imitate the print he or she has seen using letter like or number like forms (Cassar & Treiman, 1997). This is the precommunicative stage (Moats, 1995). In this stage, a child's writing shows a lack of understanding of the concept of a word, the alphabetic principle, or the conventions of print such as spaces between words and the left to right progression of writing. A grasp of the alphabetic principle merges with the child's realisation that spoken words can be represented in print. According to Ferreiro (1983), the child will first attempt to connect speech to print at the level of the syllable instead of at the level of the phoneme and will write a symbol for each syllable, for example, *b* for *be* or *nf* for *enough*.. As the child becomes more aware that individual letters represent individual sounds, he or she enters a semi-phonetic stage (Moats, 1995) and uses incomplete but phonetic representation of words. For example, the child will use the initial or salient consonants of a word, such as *s*, *c*, or *sd* for *seed* (Rubin & Eberhardt, 1996), or the child may use letter names, such as *left* for *elephant* (Adams, 1990; Treiman, 1994).

Further experiences with print and writing move the child to a stage of complete phonetic representations, of the phonetic stage (Moats, 1995). Every sound in a word is represented, but the child does not show knowledge of conventional spelling patterns. The child may spell *same* as *sam*, thus neglecting the final *e*

sound (Treiman, Zukowski & Richmond-Welty, 1995). The inflection *-ed* may be represented as *t* as in *askt* or *d* as in *hugd*.

According to Moats (1995), in these early stages of spelling development, a child is literal in his or her spelling of words, (e.g., *k* is almost always spelled *k*). As the child begins to read more, he or she becomes more sensitive to the letter pattern in words. Without being taught, he or she may discover orthographic pattern and sense its constraints. The child may discover that /k/ can be spelled *ck* and sense that it does not occur in the initial position of a word. In this transitional stage, as the child becomes more aware of letter patterns in words, his or her spelling may seem “off-base” (Moats, 1995, p.40). From exact phonetic representations of every sound, the child’s spellings may become a mixture of phonetic components and salient visual features in words. This change in spelling usually signals a heightened awareness of letter patterns (Carreker, 1999).

Moats’ model of how children develop spelling ability is supported by Treiman (1998). Treiman argued that for young children spelling involves a *creative linguistic process* rather than habitual learning involving rote visual memorisation. Treiman suggests that young children create spelling for words based on their knowledge of language and their knowledge of print, noting that many of children’s common spelling mistakes make sense once the knowledge that they bring with them into the spelling task has been taken into account. Treiman also suggests that as children progress, their knowledge of the spelling system grows and deepens, thus enabling them to become progressively better spellers.

Treiman (1998), as a result of his studies, outlines three areas of findings that are of direct interest to the Phonic Inventories. These are phonetic errors, syllable position and spelling and the role of letter names in beginning spelling.

- **Phonetic errors**

Treiman defines phonetic errors as “those in which each sound is symbolized with a letter or group of letters that may represent that sound in conventional English” (Treiman, 1998, p.375). For example, /plad/ for /plaid/ is a phonetic error as opposed to /pad/ for /plad/ which is a nonphonetic error. For the Phonic Inventories, this corresponds to medial vowel and medial vowel digraph errors and long-short vowel errors.

- **Syllable position and spelling**

This error refers to the times when children leave out consonants that are the first letter in an ending blend (e.g. the /n/ in pant) or the last letter in an initial consonant blend (e.g. /n/ in snow). This corresponds to initial and end blend errors as well as syllabification errors on the Phonic Inventories.

- **The role of letter names in beginning spelling**

Children are often exposed to the names of letters by the time they begin to spell. When they are unsure of a spelling, they may use the letter name instead of the phonic sound to spell. This encapsulates another category of spelling errors made by children. This corresponds to initial and end consonant errors, as well as medial vowel errors on the Phonic Inventories.

Treiman (1997; 1998) highlights four changes that tend to occur with increased spelling skills including, firstly, the internalisation of classification of sounds that are embodied in the conventional orthography, secondly, becoming increasingly reliant upon conventional spelling, thirdly, the rapid learning about letter patterns in printed words and, finally, reaching an understanding that morphemes are often spelled in a consistent fashion.

In this respect however, languages such as Afrikaans and African languages have a ‘shallow’ or ‘transparent’ orthography in which graphemes and phonemes have an invariant relationship. A ‘phonological’ reading and spelling strategy

would therefore be a successful approach to employ when engaging with these languages (Besner & Smith, 1992; Broom, 2001). By contrast however, *English* has a 'deep' or '*opaque*' *orthography*. The pronunciation of a word in English therefore is not always predictable from its spelling since no one-to-one correspondence between phonemes and letters of the alphabet that represents those phonemes in print exists. The English alphabet for example, has only 26 letters in comparison to at least 36 phonemes in spoken English (Harris & Coltheart, 1986). Some letters in English therefore, represent more than one sound such as the *c* in *cat* and *city*. Furthermore, some sounds are represented by more than one letter with every correspondence being context sensitive.

As a result therefore, a reader cannot be certain as to which phoneme a letter represents without knowledge of its surrounding letters, for example *ow* in *flown* and *clown*, the *eak* in *beak* and *steak* and the *ough* in *cough*, *rough*, *through* and *though* (Gough & Wrenn 1998; Venexky, 1995, 1970; Wijk, 1966; Broom, 2001). Moreover, many exceptions or irregular words exist in the English language, which do not conform to any of the rules of English phonology, such as *yacht* and *choir*. For these words, word specific knowledge must be available for their successful decoding. In the English language therefore, it is clearly evident that sound-to-spelling translations are less dependable and that many instances exist where spelling should require the complete and accurate recall of letter patterns and words (Frith, 1980; Treiman, 1997; 1998; Carreker, 2000, 2005).

Furthermore, English decoding is also complicated by *homophonic words* that have dissimilar spellings and meanings yet are represented by the same phonology, such as *sale* and *sail*, which may be decoded using phonological rules, but still require word specific information linking the graphemic representations to their respective meanings. Skilled decoding of English orthography therefore is a very difficult activity necessitating both the ability to use phonological processing as well as orthographic processing (Hanna, Hanna, Hodges & Rudorf, 1966; Frith, 1980; Carreker, 2000; 2005).

Interactions of cognitive factors may influence word recognition in unpredictable ways (Ellis, 1993). It is also likely that cognitive factors interact in influencing written language output and spelling ability. One view is that the more frequently a child has been exposed to a word, the more likely it is that the child will spell the word correctly. Another is that hearing a word in context (for example, read out in a sentence) may make it easier for the child to correctly spell that word. Another is that, as with reading, underlying cognitive factors such as phonological processing, visual processing, as well as working memory influence spelling ability.

3.4.2.1 *Spelling in the classroom*

In the classroom however, spelling is typically treated as an *afterthought* to or as a by-product of *reading*. The assumption is that if students learn to read, they learn to spell and as a result, spelling instruction is given little importance and minimal attention during the instructional day (Carreker, 2000; 2005; Potter, Grasko & Pereira, 2006). Furthermore, this view fails to recognise the integral role spelling instruction plays in learning to *read* since it has been shown that spelling instruction enhances reading proficiency through the reinforcement of letter patterns (Adams, 1990).

Moreover, it has been argued that spelling is a more difficult skill to learn in comparison to reading. As noted by Carreker (2000, 2005) therefore, spelling instruction should be intimately integrated with the teaching of reading but, because spelling has its own distinctive characteristic and demands, it should also be distinct from reading and explicitly taught. Carreker (1999) argued that just as beginning readers need explicit teaching to become good readers, beginning spellers need explicit teaching to become good spellers. Without this formal instruction, beginning spellers will not establish the awareness and memory of letter patterns that will make them good spellers. Spellers must be taught in a manner that will increase awareness and memory of letter patterns

and words, considering sequential multisensory structured spelling instruction to be particularly useful in this regard (Carreker, 2000, 2005).

3.4.3 Predictors of reading, spelling and writing abilities

Despite the difficulties with defining dyslexia as well as divergent diagnostic criteria and a myriad of theoretical explanations (Zillmer & Spiers, 2002), there is evidence of a high prevalence of learning disabilities across different cultures. For this reason, there has been a strong impetus towards early identification of children with dyslexia, as well as emphasis on research into predictors of reading, writing and spelling abilities (Birsh, 1999).

Literature in the field has identified that the following – to greater or lesser degrees – predict reading (and spelling) ability:

- Phonological ability (e.g. Schatschneider & Torgesen, 2004; Uhry, 1999)
- General language ability (e.g. Soifer, 1999)
- Orthographic knowledge (e.g. Cardoso-Martins & Pennington, 2004; Badian, 2005)
- Rapid naming ability (e.g. Schatschneider & Torgesen, 2004; Sunseth & Bowers, 2002; Cardoso-Martins & Pennington, 2004)
- Short-term memory (e.g. Schatschneider & Torgesen, 2004)
- Morphological knowledge (e.g. Nunes, Bryant & Olsson, 2003)

One difficulty is that not all of these predictors are independent abilities, and there is some amount of interdependency when they develop in a child. Also, although these abilities tend to predict a child's reading ability, there is evidence that as a child's reading ability improves, there is two-way learning (Morris, Bloodgood, Lomax & Perney, 2003). That is, learning to read then enhances these skills (Rains, 2002; Zillmer & Spiers, 2002).

However, of these abilities, phonological awareness has by far proven to be the strongest and most stable predictor. Following Bradley and Bryant's pioneering work in identifying a link between phonological awareness and the development of reading in children, firm correlations have been consistently found between phonological awareness and reading ability (Uhry, 1999). A number of studies, using various methodologies, found a strong correlation between phonological awareness and reading ability. That is, children who scored poorly on phonological awareness were later found to be weak readers, and children who scored well, were found to be good readers.

Phonological awareness has been found to prepare children for learning to read, with regards to learning phonics, word analysis and learning spelling (Adams, Foorman, Lundberg, & Beeler, 1998; Chard, Simmons, & Kameenui, 1998, cited in Chard & Dickson, 1999). Moreover, it has been established that it is a child's phonemic awareness on entering school that is most closely related to success in learning to read (Adams, 1990; Stanovich, 1986; Chard & Dickson, 1999).

Furthermore, a study using a sample of 435 children from nine schools in the UK screened children at school entry (aged four or five) as predictors for their curriculum performance at age seven. They found phonological and orthographic awareness to be the best predictors of performance (Savage & Carless, 2004).

Many sources describe how important phonological awareness is for learning to read (Goswami & Bryant, 1992; Muter, 1998), for speed and efficiency when learning to read (Goswami & Bryant, 1992) as well as the positive effects of these skills on reading and spelling ability (Morais, Mousty & Kolinsky, 1998). A number of studies have indicated that phonological awareness is causally related to the *development* of reading and writing skills (Bradley & Bryant, 1985; Brady, 1997). There is also limited evidence available to support the importance of the role that phonological coding plays in skilled reading as suggested by Frost & Bentin (1990) and Eysenck & Keane (2000).

Overall, however, research suggests that the role of phonological mediation in reading and writing is less successful in children suffering learning disorders and also tends to decline with age, with children later on being able to identify words by their orthographic patterns and to recognise common words as complete units through the influence of visual as opposed to phonological coding as proposed by numerous of the models of reading as discussed above, and through the influence of the word superiority effect (Brady, 1997; Bryant & Bradley, 1985; Goswami & Bryant, 1990).

As a result, particularly of the importance placed upon reading and writing ability within contemporary society, considerable research effort has been devoted to identifying predictors of the progress of children's learning to read and write (Uhry, 1999). As a highly complex and unnatural task, when learning to read and write in an alphabetic script such as English, the child is required to gradually learn that printed words convey meaning, that the graphemes of printed words map on to the speech segments at the phonemic level and that there are irregularities in these mappings.

In addition, when reading text, children also have to integrate the meaning of words within phrases and sentences using knowledge of syntax and semantics, thus developing the ability to not only comprehend words as units but rather the text as a whole, which is the ultimate purpose of reading (Ruddell & Unrau, 1994; Carreker, 2000, 2005). In teaching reading, Walcutt et al (1974, p.4, in Uhry, 1999) set up as their primary goal that they are committed to "*reading for meaning*".

3.5 Theories of reading and spelling development

Section 3.4 dealt with the process involved in learning to read and spell. This section will now look at the main theories relating to these processes and how these processes occur and develop.

There are two branches of theories of learning to read and spell **which** have been proposed:

- Developmental and stage-related models such as Frith's stage model (Frith, 1985), Chall's psycholinguistic model (Chall, 1967) and the Dual Route theory (Coltheart et al, 1985, 1993);
- Interactive and connectionist theories such as Seymour's (1986; 1987) Dual Foundation Model, and Goswami's Interactive Analogy model (Goswami, 1986; 1988); and
- Connectionist theories

3.5.1 Frith's model of the development of reading and spelling

Frith (1985) describes the child as passing through three phases during the acquisition of literacy: the logographic, the alphabetic and the orthographic. Transition through the phases does not move along simultaneously for reading and spelling but develop sequentially.

Reading during the ***logographic stage*** is based upon crude visual features. Visually similar words are likely to be confused. At this stage the child is not yet aware of the importance of letter order in printed words. Marsh et al (1981) argued that visual reading is not conducive to good spelling and indeed, spelling at this stage is minimal – a child may only be willing to write one or two highly familiar words (perhaps their own name and some everyday words), or they start to represent speech sounds with letters of the alphabet, but they achieve partial representation only. They use the first letter to stand for the whole word (for example, B for back), or they write the first letter and last consonant (for example, BC for back, FT for feet). Visually plausible errors may also result because of this.

The ***alphabetic stage*** is entered first for spelling and subsequently it seems that these skills are transferred to reading. What happens is that children wishing to write have only impoverished images of printed words, therefore they start to spell words as they sound. In other words, children often use a letter-name strategy to provide a total mapping of the phonological pattern of each word. Not only are first and last consonants used but also vowels appear (for e.g., back bac). Common misspellings of short vowel sounds at this stage often involves using the letter-name of a vowel spoken from a similar articulatory place in the mouth (for e.g., fish ---- fes) (Read, 1971).

It has already been argued that in order for a child to spelling alphabetically, phoneme awareness is necessary. But this is not the only requirement, the child needs to be able to segment the sound stream and to memorize and sequence sound segments. Since alphabetic competence is dependent on a number of auditory and phonological skills, many children with a history of speech and language problems have been found to have difficulty in mastering the alphabetic principle (Broom & Doctor, 1995; Birsh, 1999). Frith (1985) has argued that developmental dyslexia reflects a failure to break through the alphabetic phase and typically retain logographic skills (Snowling, 1984).

The third stage is the ***orthographic phase***, which Frith describes as the phase which characterizes adult literacy. In this stage, the speller increasingly uses visual and morphological representations, instead of sole reliance of a phonological strategy. This stage represents a breakthrough in conceptualization, because children can then go beyond the one-to-one sound-letter strategy and use a group or pattern of letters to represent a sound (that is, use phoneme-to-grapheme mappings). Frith further stresses that children who have reached this stage are able to access abstract representations of printed words. These allow accurate reading and automatic spelling. Thus, children are able to spell words correctly, using consonant blends (e.g., flip), digraphs (chop) and vowel markers (came) appropriately.

It is possible that the detailed representations are the result of an amalgamation of logographic and alphabetic strategies. Words may first be registered in a global manner in an internal lexicon during the logographic stage. During the alphabetic stage, the use of letter-sound rules during reading redirects attention to the internal left to right structure of printed words. During the orthographic phase, reading and spelling are both analytical, but independent of sound (Frith, 1985).

A number of problems with Frith's theory have been cited (Seymour, 1990). Frith's theory clearly specifies distinct stages through which reading and spelling proceeds, but the model offers no explanation as to why it was necessary to establish a logographic strategy prior to an alphabetic strategy. Frith (1985) states that children spell logographically before they spell alphabetically, but this has been disputed by Goswami and Bryant (1990) who found little evidence for a logographic stage in spelling development at all. Although it suggests that an orthographic stage develops by merging the logographic and alphabetic stages, how this might occur is not elucidated. In addition, Frith does not specify each stage in terms of a modular information processing system, so the relationship between the developing structures and those of the ultimate, skilled model is not stipulated (Broom & Doctor, 1995). Furthermore, Seymour and McGregor (1984) acknowledge that the strategies envisaged by Frith in her stage model are conceptually correct, but argue that each stage is resolved not by passing onto the next stage, but by the establishment of a separate lexicon (i.e. that logographic development coexists with alphabetic/orthographic development).

Despite these problems, much contemporary reading and spelling research attempt to use and apply Frith's model. For example, Sawyer, Kim, Lipa-Wade (2000) have applied Frith's developmental phase model to identify "at-risk" beginning readers at the end of kindergarten. Tasks given to the children in this study sampled competencies across the logographic and early alphabetic phases of the hierarchical model of reading acquisition proposed by Frith and later

refined by Ehri. Seventy-one students, ranked in the lower 50% of their classes by teachers or targeted by a sentence dictation task, were tested. Factor analysis with the promax rotation showed elements of the screen loaded on three factors. Regression analyses revealed letter/sound knowledge (13 consonants) to be the best predictor of the Grade 1 spelling and dictation tasks as well as word reading and comprehension (Grades 1 and 2) and spelling (Grades 2 and 3) on norm-referenced state tests of educational progress. Tests to examine differences among students who were, generally, more vs. less successful on the screen yielded clear achievement distinctions through Grade 3.

3.5.2 Chall's psycholinguistic model of reading

Another developmental stage model is that presented by Chall (1967, 1983, 1996). According to Chall, students proceed through predictable stages of learning to read. During the pre-reading stage up until about 6 years old, children begin to control language. By the time students reach kindergarten they should have some print knowledge and vocabularies of about 6,000 words. Many children can write their names.

In stage 1, children develop a sense of the alphabetic principle and use sound-spelling relationships. Through Grades 2 and 3, the second stage of reading, students develop their decoding skills, their fluency and additional strategies to make meaning from text. Stage 3, which lasts from Grades 4 through 8 is a time when students encounter wide varieties of texts and contexts, and all the reading demands that accompany these experiences. They must extend their vocabularies if they are to effectively obtain information from text; the texts also extend the background experiences and strategic habits of readers.

In stages 4 and 5, through high school and college, the language and cognitive demands of readers increase, and they are expected to analyze texts critically and understand multiple points of view. By stage 5, reading is considered truly

constructive, that is readers take in significant range of information and construct their own understanding for their own individual uses based on analysis and synthesis.

3.5.3 Dual model of reading

During the 80s and 90s a number of investigations into acquired reading and spelling disorders were conducted within the framework of the information processing theory (Caramazza, Miceli & Villa, 1986). Based on the study of adult patients with neurological deficits, Coltheart developed a detailed model reflecting the discrete stages thought to be involved, in the particular internal cognitive process, as well as the order in which they come into play (Harris & Coltheart, 1986; Ellis & Young, 1988). The model is expressed in terms of specific processing components, such as auditory recognition of words, segmentation of verbal sounds into phonemes, and working memory units with specific buffer functions.

This model, the “dual route” model, indicates two main routes for reading, a lexical/direct route and a sublexical/indirect route. Competent reading requires that both routes are available. The lexical route is appropriate for reading words with which the subject is familiar, since visual representations of these words are stored in a visual input lexicon. This route is not appropriate for reading unfamiliar items, such as orthographically legal nonsense words, which are not represented in the lexicon. However, the sublexical route is appropriate for reading both familiar and unfamiliar words provided they conform to rules of grapheme-to-phoneme conversion (Broom & Doctor, 1995). Impaired functioning of a component in one route leads to reliance on the other, e.g., a person with phonological dyslexia will rely on the lexical route and will have difficulty in reading unfamiliar or nonwords (Coltheart, 1987; Ellis & Young, 1988; Broom & Doctor, 1995).

Although it is possible for the two routes to function independently, it is also possible for them to interact. Campbell (1983, cited in Ellis, 1993), using a sample of skilled writers, dictated nonwords preceded by real words. It was found that how the nonwords were spelled depended on what the preceding word was. For example, the sample was asked to spell /prein/. If the word before was /brain/, they tended to spell it /prain/. If the word before was /crane/, they tended to spell it /prane/. This suggests that the sample retrieved some information from the lexical route (the known part) and then used the sub lexical route of phoneme-grapheme conversion to complete the word. In fact, Snowling (2000) suggests that not only is this integration possible, it is *necessary* for good spelling. This is relevant to the order in which the words in a spelling test are read out. Knowledge of the spelling of some words may influence the spelling of other words (Lennox & Siegel, 1998).

From this understanding of how skilled readers use the Dual Route processing model, Harris and Coltheart (1986) have outlined four phases in learning to read English:

- **The sight-vocabulary phase**

At this phase, a child can read a small number of words via the direct (or lexical) method, words that they read by 'sight', but unknown words cannot be read. However, there is evidence that it is not just the overall shape of the word to which the child attends, but also some knowledge of the individual letter shapes in that sequence. When children enter school, and begin formal reading instruction, they move into the next phase.

- **The discrimination-net phase:**

During this phase, a child reads by making use of fragmented cues in words. The overall shape of a word is important (meaning that whole-word reading is being used). Children look for cues matched against learned words. That is, if a word is the same length as a known word, it will be read as that word – irrespective of the actual letters. Or any word

containing a certain letter will be read as a specific known word. At this phase, children rely on a specific pool of words using prominent visual cues to choose the most likely reading of the word. As their reading vocabulary increases, the discrimination-net method of reading becomes difficult and so children move into the next phase.

- **The phonological-recoding phase:**

During this phase the child begins to show evidence of using letter-sound conversion rules (phonics), and begins to be able to read nonwords. There is a vast increase in the number of words the child can read aloud. Children are now using the phonological (nonlexical) route as well as the direct (lexical) route to read, though the phonological route appears to be dominant during this phase. Research has shown that a child's reading ability at this phase is determined more by the ability to use phonics (the phonological route) than by ability to use the direct route (Harris & Coltheart, 1986).

- **The orthographic phase:**

At this phase, it is the spelling of the word that determines how it is read, rather than the sounds of the letters. This allows for reading of homophones and irregularly spelled words, which is necessary for skilled reading, although some use is still made of phonological processing. At this phase, the direct route becomes dominant again.

3.5.4 Dual model of spelling

In addition to the implications of dual route model for the development of reading, the patterns of dysgraphia associated with dyslexia have been used to formulate a model of the major features of the writing process. The rationale guiding this method of developing models is based on two interlocking assumptions:

- that a particular form of dysgraphia serves as empirical evidence for a model of spelling if the observed pattern of errors in spelling performance can be explained in terms of damage to one or more components of the postulated model (Caramazza, Miceli, Villa and Romani, 1987); and
- that any systematic variation in the type of factors that influence word-spelling ability is a reflection of the organisational principles of the spelling system (Goodman and Caramazza, 1986).

By focusing in this way on the relationship between the pattern of spelling errors in patients with neurological deficit and the cognitive mechanisms that give rise to these error patterns, detailed models of the spelling process have been created (Nolan and Caramazza, 1983, Margolin, 1984, Caramazza et al, 1986, Caramazza et al, 1987, Goodman-Schulman and Caramazza, 1987). The unit of analysis provided by these components and their hierarchical structure, yields a powerful and coherent framework within which to investigate and explicate several theoretical and applied issues related to the processes by which normal users of language spelling.

Ellis (1993) proposed that there are two possible routes for spelling a word much like the Dual Route processing model for reading. That is, the spellings for familiar words are stored in the 'grapheme output lexicon'. When the requirement is for a familiar word to be spelled, the spelling is retrieved from this lexicon. Information is also received from the semantic system and speech output lexicon. This aids spelling when the meaning of a word will determine how it is spelled, such as for homophones (Ellis, 1993). This mirrors the direct or lexical route when reading. However, as it is possible to read unfamiliar words, so it is possible to spell unfamiliar words. This process may be likened to the phonological or nonlexical route of reading. That is, the word is broken down into its constituent phonemes (the phoneme level) and these are converted into graphemes which are written down in the correct sequence (Ellis, 1993). This process requires phonological awareness, as it has been defined in this chapter.

This process is accurate for regularly spelled words, but is also the cause of phonic errors on irregularly spelled words (Ellis, 1993).

Given how the cognitive processes when reading and producing written spelling mirror each other, it is possible to suggest that the four phases outlined by Harris and Coltheart (1986) – being the sight-vocabulary stage, the discrimination-net stage, the phonological recoding stage and the orthographic stage) are also applicable when a child is learning to spell, and as such, when spelling, children will rely more on different processes (either lexical or nonlexical) at different phases, with the spelling process becoming ever more sophisticated and accurate.

A possible way of examining the elements of spelling is to look at what distinguishes good spellers from poor spellers. Lennox and Siegel (1998) look at phonological and orthographic processes in these two groups as they learn to spell. They acknowledge that good spelling is reliant on the integration of many skills, such as grammatical and semantic skills. They suggest that through the Dual Route theory, these are mediated by two processes: phonologic and orthographic. It becomes apparent that phonemic and alphabetic awareness, though sometimes referred to by more overarching terms of phonological awareness and orthographic awareness, are of integral importance to reading *and* spelling ability.

It is valuable to outline a procedure for how this comparison could be made. Lennox and Siegel (1998) matched groups of good spellers and poor spellers according to spelling level such that younger good spellers would be on the same level as older poor spellers. If no differences were found between these groups, it may be fair to assume that the difference was time (that is, developmental lags), and that young poor spellers would catch up to older good spellers eventually. This logic is questionable in that developmental lags do not necessarily correct themselves automatically over time, such that early lags may lead to later

difficulties if there is no intervention. Nonetheless, this would support the argument for later qualitative differences if these were found.

While research has shown that although both groups make more mistakes on irregular words than on regular words (Bruck, 1988, cited in Lennox & Siegel, 1998), and that there is no difference between the groups on errors such as consonant digraphs and ambiguous consonants (Invernizzi & Worthy, 1989, cited in Lennox & Siegel, 1998), there is one significant difference. Good spellers make better use of sound-symbol association rules than poor spellers (Lennox & Siegel, 1998). That is, good spellers make better use of phonemic and alphabetic principles than poor spellers. This is further support of the significant role of phonological awareness in spelling.

It has been credited to the influence of Piaget that led us to the belief that *“children learning to read pass through an identifiable series of distinct stages in the acquisition of the skill”* (Ellis, 1993, p.78). From this base, many psychologists have tried to explain reading development through stages models, some of which have already been discussed here. Others include models by Ehri (1993), Marsh, Friedman, Welch & Desberg (1981), Brown, (1990), Henderson and Templeton (1986). However, stage theories are not without criticisms. Ellis (1993) for example argues that reading is not a natural ability but a culturally transmitted skill (Ellis, 1993). Stage models for learning to read and write are not only assuming that all children would develop in the same way, but also that they are *taught in the same way* (Ellis, 1993). This is not a reasonable assumption as there are many different methods – and combinations of methods - to teach reading, as have been discussed. In fact, the stages a child goes through when learning to read is possibly a reflection of the method with which he/ she is taught. Stuart and Coltheart (1988) conducted a longitudinal study in London, of the stages of development that children go through when learning to read. Based on this, they claimed that children do not all pass through the same chain of

stages. In fact, they found that the earliest stage of word recognition for some children included some phonological knowledge.

Furthermore, Lennox and Siegel (1998) point out that many of these stage models separate phonological and orthographic abilities, suggesting that children use one or the other in discrete stages. These authors conducted research on 420 children, aged 6 – 16, examining their spelling errors (Lennox & Siegel, 1998). They report that phonological and orthographic skills developed early on and simultaneously. There was no evidence for any stages that exclusively used one skill, although at certain times children did rely more on one of the skills.

We now turn to interactive models of reading and spelling such as the dual foundation model proposed by Seymour (1990) and the interactive analogy model proposed by Goswami (1986; 1988).

3.5.5 The dual foundation model

Seymour's (1990) proposes that the organisational structure that defines such graphotactic characteristics, and in terms of what information is processed, is derived from a foundational system of phonological awareness of both speech segments and language structure, including the internal organisation of the syllable. Elaboration of this structure is progressive, beginning with the development of an elementary core structure which is systematically augmented by inclusion of more complex forms. In this way, spelling ability draws on a variety of linguistic abilities, which continue to develop with maturation and experience (Fischer et al, 1985).

If a word does not have whole word representation in the graphemic output lexicon (such as an unknown or non word), an abstract phonological representation is assembled in the *phonological output lexicon*, from where it is stored in the *phonological buffer* until it is converted into a graphemic

representation via the *phoneme-grapheme conversion mechanism*. This mechanism operates on the basis that the spellings of words not stored in the graphemic output lexicon can be created by using the phonetic form of the words – this enables the individual to establish a series of graphemic units to assign to a series of phonemes.

Children, who presumably have yet to build up a large store of entries in the graphemic output lexicon, may rely heavily on this stop-gap strategy (Ellis & Young, 1988). The procedure involves the breakdown or segmentation of the phonological form of the word into phonemes or phoneme clusters in the phonological output lexicon. These are held in the phonological buffer ready for the replacement of each phoneme by the appropriate letter or letters according to the corresponding rules of phoneme-grapheme conversion¹⁵, the resultant abstract letter string being stored in the graphemic buffer as it is created.

The dual foundation model is supported by research from case studies documented by a number of authors. Patients RG (Beauvois and Derousne, 1981), TP (Hatfield and Patterson, 1983) and KT (Baxter and Warrington, 1987) were all found to have impairments, which affected the retrieval of lexical representations of words from the graphemic output lexicon. Because these patients had recourse to the alternative strategy of assembling spellings, they were able to produce plausible spellings for nonwords and could still spell many regular words correctly. In addition, it was noted that their errors were misspellings which, when produced sounded like the target word (e.g., CASSEL for castle). Thus they were *phonologically plausible errors* (Caramazza, Miceli and Villa, 1986).

¹⁵ While there is general agreement that these phonological processes work at a subword level, not all theorists accept that graphemes can be assigned to phoneme segments using the alexical correspondence rules of phoneme-grapheme conversion. Some posit a lexical method of retrieving information about the spelling of such segments by analogy with known words (Campbell, 1983). However, mounting evidence from research lends certain validity to the notion of the conversion mechanism being nonlexical.

Dual foundation theory proposes that correspondence rules are based on abstraction of phoneme-grapheme pairs from spelling patterns of known words (Barry and Seymour, 1988; Goodman-Shulman and Caramazza, 1987). The alternative correspondence mappings for each sound are graded from most to least frequently occurring according to a probability relationship between phoneme and grapheme. The assumption is that phonemes will activate all their corresponding spelling patterns according to rules of synaptic weighting demonstrated in biological systems. In these terms, a phoneme-grapheme conversion mechanism capable of generating a plausible spelling for a word would be more effective for words consisting of frequently occurring, rather than infrequent, phoneme-grapheme correspondence mappings. This grading reflects what has variously been termed *regularity*, ambiguity, mapping probability (Goodman-Schulman et al, 1987) or sound-to-spelling contingency (Barry and Seymour, 1988).

The use of this strategy is thought to be a dominant strategy in the spelling process of young children. Thus *phonologically plausible errors* are common in children, especially in beginning spellers and second language spellers (Caramazza, Miceli and Villa, 1986; Adams, 1990).

In a study with normal subjects, Barry and Seymour (1988) found that the majority of the sample produced more second-most common than most common correspondences for the vowels /ei/ and /au/. They explored the possibility that the crucial factor is the distribution in terms of the token measure (the mean frequency of occurrence of words containing each spelling pattern) rather than the type measure (how many words exist with each spelling pattern) upon which his analyses were based. He found this re-analysis made no difference to the results. Goodman-Shulman and Caramazza (1987) has also pointed out that frequency distribution estimates change with syllable position, and suggests that re-analysis of the data in these terms may well yield results that are not anomalous.

In yet another study of the spelling of primary school children (Doctor & Antoine, date unknown), it has been reported that unexpected results occur with regard to the spelling of the /aw/ phoneme, along with several others. Of interest, they found the common factor in these phonemes was the even spread in their probability frequency/weight distributions. Using Hanna et al (1966) probability estimates, Doctor and Antoine noted that some sounds have frequency distributions where one letter is clearly more probable than the rest. For example, the sound /i/ has only one high contingency correspondence, <e>, and so probability weighting was high (69.54%). The second most common correspondence for this sound, <ee>, has a probability weighting that is considerably lower (9.81%). In contrast, /aw/ has three high contingency correspondences, <o>, <a> and <au>, of lesser weight (40.67%, 21.51%, and 19.03%) respectively, with the spread in probability distribution frequencies being more even.

Not enough is yet known about how spelling proficiency develops to be able to address why this occurred. It is, however, proposed that correspondence activation is influenced by application of context-sensitivity rules (Barry, 1988; Goodman-Schulman and Caramazza, 1987).

Scholnick (1988 cited in Goswami & Bryant, 1990) has investigated another aspect of the relationship between phoneme and grapheme. In Scholnick's study, the effect on spelling of increased number of graphemes per phoneme was evaluated using level of mapping ambiguity as an indicator. Thus, while some sounds could be represented by only a few different graphemes, indicating low correspondence mapping ambiguity, other sounds could be represented by many graphemes, indicating high correspondence mapping ambiguity. Scholnick (1988) found in secondary school children that there was a constant pattern of increased ambiguity leading to increased error rate, though differential for vowels and for consonants. The same was found in young spellers, although the

ambiguity effect was not linear because most errors occurred on words in the moderate rather than in the high ambiguity category.

The above studies serve to elucidate a crucial point. While the idea of separate routes for accessed or assembled spelling is supported by empirical evidence, the degree of their autonomy is not resolved. In addition, the extent and nature of interaction between these two systems is a matter of conjecture. Does the spelling of a word rely on parallel processing? Or do the routes process a spelling independently in an on/off system? Some have argued that the phoneme-grapheme to letter conversion plays no role in the skilled spelling of known words (Shallice, 1988). Others assume the use of this strategy is at least partially necessary (Marsh et al, 1980). Scholnick (1988) has suggested that if spelling of familiar words requires the parallel operation of both routes, then there would be a phoneme-grapheme correspondence effect on the spelling of words. Using the ambiguity index, Scholnick's investigation provided support for the hypothesis that both routes contribute in the processing of familiar words. In a follow-up study, Doctor, Antoine, and Scholnick (1989, cited in Goswami & Bryant, 1990) also found additional evidence in support of dual foundation theory in the spellings of primary school children.

In conclusion, the above studies would indicate that we can reject the classical model of spelling which proposes that spelling is totally reliant on speech. However, the intuitive assumption that spelling is assisted by speech would appear to be psychologically valid. In addition, Barry and Seymour (1988) have established a lexical priming effect in the spelling of nonwords, which again suggests an interaction of the two routes.

Caramazza and his colleagues (1983, 1985) have attempted to specify more fully the nature of the interaction, by enlarging on the central role played by the graphemic buffer in the spelling process. They propose interaction is necessary for the purpose of maintaining the contents of the graphemic buffer. Thus,

concurrent with the read-out from the graphemic output lexicon into the graphemic buffer, a corresponding phonological form is selected and placed in the phonological buffer, so that both the graphemic and phonemic forms of the word become available simultaneously. It is further postulated that after auditory/phonetic analysis, an *auditory input* may proceed directly in to the phonological buffer, short-cutting the processes described above.

The implications of the above research are as follows. In English orthography, the phonemic route for spelling (which involves analysing words into its constituent phonemic elements and then converting these into their appropriate graphemic equivalents) is far from simple. This is particularly the case where vowel sounds are concerned, because there are often various ways of graphemically representing a particular phoneme. In this case reference must be made back to the lexical entry which provides word specific spelling information. In this way it is possible to check which of the graphemic alternatives is the appropriate one for that particular word. If the spelling of the whole word is stored, then the direct route for spelling can operate, i.e., directly from the lexical entry not via a phoneme conversion stage. As with reading, efficient spelling probably relies on the additive effects of both spelling routes.

3.5.6 Comparison of the dual route model and the dual foundation model

Seymour's (1987) information-processing model of reading and spelling development is largely based on his criticisms of Frith's dual route model. Seymour's dual foundation model consists of three parts: a visual processor, a phonological processor and a semantic processor. The visual processor is concerned with peripheral features enabling the identification of graphemes and morphemes (units of meaning, for example, unhappily has three morphemes: un+happy+ly) and relays this information to the phonological and semantic processors. The phonological processor processes both graphemes and morphemes and includes both a lexical system for storing whole word forms and

a non-lexical system for the manipulation of phonemes, while the semantic processor processes the meanings of morphemes.

The dual foundation model differs from the dual route model in that it proposes that word recognition is achieved by a single framework which can work out pronunciations for both words and nonwords. Seymour has subsequently expanded his model to allow for the simultaneous development of visual and phonological processes as necessary foundations for later orthographic processing (Seymour & Evans, 1994). The orthographic processor is viewed as part of the visual system and is specialised for the analysis of print and writing.

According to Seymour's model, visual processing may be analytic, breaking down words into segments, or holistic, blending together multi-letter units to form words. Phonological awareness is necessary for the development of the phonological processor, which contains a phonemic store and which assembles segments of speech into words or nonwords. Phonological awareness is also necessary for the ability of the visual processor to segment or blend words. Thus Seymour's dual foundation model represents a move away from the dual route account of reading and spelling in the direction of a single route approach as modeled by connectionist theories.

The dual-route model can also be criticised for the way in which it accounts for the role of memory in the process of learning to read and spell, and in particular in how it conceptualises the manner in which sight words are learned. According to dual-route theory, rote memory underlies the learning of irregularly spelled words. Although memory is clearly involved, Ehri (1992) questions whether memory process is a rote process.

3.5.7 Interactive analogy models

Goswami (1986) argues that the process of making analogies is a powerful force in early reading and spelling development, and that this in turn is related to children's sensitivity of onset-rime units in words. Phonological awareness is important here because it enables children to form categories of words that share common onsets and rimes, and later, to make connections between these categories and words that share common spellings (Goswami, 1986). Reading and spelling by analogy involves applying one's knowledge of sight words to read unfamiliar words that are analogous to the sight words¹⁶ which have been stored in our mental lexicons. For example, having the word "beak" in the mental lexicon may help the child to read and spell a similar but unfamiliar word "peak". Thus students read and spell unfamiliar words by recognising how words have similar spelling and pronunciations to words they already know how to read.

Goswami's findings indicate that beginning spellers can use an analogy strategy early in their spelling development (Goswami, 1986; Muter, 1998). Analogies are used because they make the orthography of the English language more accessible to beginners, in that it is easier for them to segment and blend subsyllabic units consisting of onsets and rimes (e.g., /p/-ik/ in *peak*) than to segment and blend phonemic rimes (e.g., /p/-/i/-/k/). However, beginning learners need to have some analytic recoding skill¹⁷ to perform the operations involved in analogising. Novices who lack sufficient recoding skill are less apt to read and spell new words by analogy to known words. They are also more prone to apply phonetic cue strategies and mistake new words for known words because the two words share the same letter cues (Ehri, 1998), thereby resulting in phonologically plausible errors.

¹⁶ Sight word reading involves the process of reading words that have been read several times before, by accessing information about the words in memory. The term *sight* indicates that sight of the word triggers that word in memory, including information about its spelling, pronunciation and meaning. Before students can read by analogising, students must first acquire a sizable store of sight words whose constituent letters are fully represented in memory.

Ehri (1992) presents a rather different perspective in which she lays more emphasis on the importance of smaller units of speech (phonemes) as a foundation for the child's early reading and spelling skills. Although recognising the role of analogies in reading and spelling, Ehri sees this as a process that depends on prior learning of a basic stock of associations between letters in a word and their represented phonemes, sight words and a degree of phonological awareness (Ehri, 1992; Hulme & Joshi, 1998). She argues that the ability to recognise rather than to generate letter-sound associations is a crucial one, for this is what determines how easy it is to retrieve words in memory from the visual forms they see (Hulme & Joshi, 1998). Setting up a "visual-phonological" route (Hulme & Joshi, 1998) into memory involves forming specific connections between the visual cues seen in a word and its corresponding pronunciation held in memory.

The process outlined here is different from letter sound decoding by the indirect route in the dual-route theory. In the latter account, children consciously assign letters sequentially to sound and hold these sounds in memory for blending and pronunciation. By Ehri's account, children automatically activate partial cues to a word's spelling from existing knowledge of letters and sounds. Partial cues concerning the overlap between a word's pronunciations and the sounds of its letters are sufficient to enable the association between the printed form of a word and its pronunciation (Ehri, 1992). However, the retrieval of this information may not always be done correctly thus, children may remember in the what letters makes up a word, but will confuse the position of the letters e.g. the word LENGTH may be spelled as *lentgh*.

Both Goswami and Ehri argue for the role of analogies in early reading and spelling, but there is a difference in emphasis as to the level of phonological analysis that is important, and also a difference in emphasis on the stage at which analogies come into play. An analogy mechanism, as described by both

¹⁷ Blending skill needed to combine new onsets with old rimes; and, sufficient memory for letters

Goswami and Ehri, employs the use of a single lexical system. In this way, interactive analogy models are similar and can be related to the connectionist models of reading and spelling, which are outlined below.

3.5.8 Connectionist models¹⁸

Connectionism challenges some core assumptions of traditional models of reading and spelling. Specifically connectionist theory challenges the assumption that the basic unit of information processing is the symbol, as well as the assumption that knowledge is represented in a propositional framework, with the corollary view that cognitive behaviour is rule-based (Metsala & Brown, 1998).

Within this relatively new framework for explaining cognitive processes, the association between input and output pairs is emphasised, without making reference to explicit rules. For example, Rumelhart and McClelland (1986) simulated the acquisition of the past tense forms in English, employing a simple pattern of associator that learned associations between verb stems and past tense verbs. This is in contrast to psycholinguistic approaches, which make reference to underlying competence (i.e., rule-based knowledge). This early model provides one demonstration of how simulation could generate rule-like behaviour through learning regularities of the environment without the explicit incorporation of rules into the system.

Connectionist models were developed because of findings that the systems of neural connections in the brain appear to be distributed in a parallel array, in addition to serial pathways (Metsala & Brown, 1998). As such, different types of mental processing are considered to be distributed throughout a highly complex

in sight words.

¹⁸ Detailed and lucid accounts of the connectionist approach to spelling are provided by Quinlan (1995) and Brown & Loosemore (1995). Another powerful model is the restrictive-interactive model of Perfetti (1991) which emphasizes the use of multiple sources of information in parallel for both reading and spelling.

neuron network, which enables parallel as well as serial processing (Lezak 1997, Metsal & Brown, 1998).

All connectionist models share a set of assumptions about the nature of neural computation: its connectivity, its representation of knowledge, and the rules that govern learning. As connectionist systems do not use symbols nor rules to represent knowledge, the only sense with which they embody a cognitive architecture is their strong commitment to distributed knowledge and a loose commitment to the notion that the models are connected somewhat analogous to the way the brain is wired (Scholnick, Nelson, and Miller, 1999).

Connectionist systems, sometimes referred to as neural networks or parallel distributed processes (PDP), consist of many individual elementary nodes or units, each of which have some degree of activation. Nodes are connected to each other in such a way that active units can either excite or inhibit other units. Connectionist networks are dynamic systems that propagate activation among units until a stable state is reached. Information or knowledge is represented in the system not by any particular unit, but rather by the pattern of activation over a large set of units, any one of which may participate to some degree in representing any particular piece of knowledge. McClelland (1995) succinctly characterized the essence of these models:

"...Information processing takes place through the interactions of large numbers of simple, neuron – like processing units, arranged into modules. An active representation-such as the representation one may have of a current perceptual situation, for example, or of an appropriate overt response – is a distributed pattern of activation, over several other modules, representing different aspects of the event or experience, perhaps at many levels of description...The knowledge in a connectionist system is stored in the connection weights: it is they that determine what representations we form when we perceive the world and what responses these representations we form will lead us to execute. Such knowledge has several characteristics: First, it is inchoate, implicit, completely opaque to verbal description. Second, even in its implicit form it is not necessarily

accessible to all tasks; rather it can be used only when the units it connects are actively involved in performing the task. Third, it can approximate symbolic knowledge arbitrarily closely, but it may not; it admits of states that are cumbersome at best to describe by rules; and fourth, its acquisition can proceed gradually, through a simple, experience driven process (p.158).

Because connectionist systems are essentially learning systems, the two step approach to modeling conceptual development (such as transition models) has not been used. Instead, connectionist modelers have focused on models that learn constantly, and they attempted to illustrate that different distributions of connectivity among nodes of their networks correspond to different knowledge levels in children. The earliest applications were in the area of language acquisition (e.g., Rumelhart & McClelland, 1986), but more recent models have begun to examine cognitive development and problem solving (Scholnick et al, 1999).

Thus, when relating connectionist models to that of reading and spelling, three basic principles must be remembered: (a) the representation of information is distributed (not local); (b) memory and knowledge for specific things are not stored explicitly, but stored in the connections between units; and (c) learning can occur with gradual changes in connection strength. These changes take place through experience and learning (Lezak 1997, Metsal & Brown, 1998). We cannot conceptualize development as a process which proceeds through the completion of each individual subsystem which then forms the basis for the development of another subsystem, as stage theorists propose (e.g. Marsh *et al*, 1981; Frith, 1985). Rather the different components of the reading, writing and spelling systems develop conjointly and are linked in a complex network. The most important tenet within this framework is that different types of information (orthographic, phonological and semantic) are not processed independently of one another. Skilful reading and spelling are the products of the co-ordinated and highly interactive processing of all three types of information in a network.

In other words, within this network, individual units may be clustered to form a separate layer (i.e., a subpopulation of units) – for example, input (orthographic patterns), output (phonological patterns), and hidden layers (which connect these two types of units, probably using semantic information). Units in these networks are interconnected both within and between layers, with connections of variable strengths (Lezak 1997, Metsal & Brown, 1998). These multiple connections allow the activity of one unit both to influence and be influenced by the activity of other units in the network. It is the adjustment of connection strengths in proportion to the discrepancy between an actual pattern of activity and the desired (target) pattern that underlies learning. In this way, the patterns of activity across one layer of the network (e.g. input–written words) can become associated with specific patterns of activity across a second layer (e.g., output–pronunciations). The network comes to learn the statistical properties of the associations between input and output activation patterns, giving rise to rule-like behaviour, without explicit rules being built into the network (Metsal & Brown, 1998).

An important outcome of the interactive ‘connectionist’ processes involved in reading and spelling is redundancy (Perfetti, 1985; Ehri, 1998). Each word is processed not just in one or another single way but in multiple ways operating simultaneously. A word may be identified through one source but its identity may be confirmed by other sources, thus creating redundancy in the system. For example, a particular word may be identified by sight because lexical access is fast operating. World knowledge and linguistic knowledge may immediately confirm that the word fits syntactic and semantic expectations. Graphophonic knowledge may verify that the word’s pronunciation corresponds to its spelling pattern. In this way, reading and spelling accuracy is maintained at a high level by multiple sources of knowledge operating in parallel (*ibid.*). Thus, reading and spelling occurs through the updating of connection strengths in the network and by setting of activation after a word or nonword has been presented.

In the present study, the Phonic Inventories are clearly linked to Frith's Stage Model (1985) of reading and spelling. Appendix B attempts to provide an explanation of how the stages in Frith's model fits with the levels of the Phonic Inventories.

3.6 Implications for the current study

It is evident from the literature review that dyslexia is a concept which is differently understood and variously defined by both professionals and teachers, and that it can be defined either in terms of its congenital and physiological basis, or functionally as related to underlying cognitive processes. There is, however, consensus that early diagnosis of children with functional differences to other children is of paramount importance, and that priority needs to be placed on establishing procedures which can be used to identify children likely to be learning disabled.

One problem with the proliferation of research in the area has been a lack of agreement on a theoretical as well as a definitional level. This has not assisted teachers in the classroom to find practical solutions to the problems of the need for early identification of children with learning problems, as well as screening procedures which can be used in group teaching situations in the classroom.

However, it is most often the teacher who first notes that a child has a problem with school work (Wadlington & Wadlington, 2005), and it is the child with difficulties with school work who may be experiencing learning difficulties relating to the acquisition of reading, writing and spelling. This research has proceeded from the assumption that functional description of the processes of reading, writing and spelling are likely to be those which are most useful to teachers. Similarly, what is likely to be most useful to teachers are instruments which can be used to with groups of children, to identify those children in the group with high potential of having a learning disability.

Coltheart, Masterson, Byng, Prior and Riddoch (1983) have noted that there is a close similarity between the reading and spelling performance of both acquired and developmental dyslexics, supporting the view that tests of both reading and spelling may be useful for diagnosing or screening learning disabilities.

In relation to the Phonic Inventories, based on the literature covered thus far, the following assumptions about reading and spelling and about the use of this assessment instrument can be stated: Reading and the production of written language are sequential and integrative activities. They require not only the development of the ability to recognise and remember words in their written form, but also the ability to use various memory systems sequentially and integratively. Training of the competencies involved in reading and spelling requires a process of mediating the form and structure of words, a process in which the multi-sensory associations and memories required to reproduce the form and structure of words are developed, and a process in which the abilities to use written language sequentially and integratively are modelled. In addition to a rule system which can be applied in analysing and creating words, sentences and paragraphs, both short and long-term memory for the structure of words is integral in the reading and spelling process.

The underlying premise of the Phonic Inventories is that once a child has reached a level of readiness for reading and, in particular, has established a level of phonological awareness, the child can successfully move to activities of greater complexity. These involve activities aimed at establishing the alphabetical principle, as well as activities which aim to develop the functional integrities required to process and encode written text.

The establishment of an assessment and measurement instrument which incorporates all the aspects discussed above is especially necessary in South Africa's educational system which sometimes fails to effectively deal with the unique challenges presented by our children's individual and complex reading

and spelling needs, particularly those of dyslexic children. In essence, there is not only value in studying the alphabetical skills used by a dyslexic child, but also of children without learning difficulties.

The focus of the current study therefore is to determine whether:

- the Phonic Inventories are a valid and reliable screening tool; and
- the spelling errors made by children who have been diagnosed as having learning disabilities are different from those made by children in the mainstream;

The implication of the findings of the research reported in this paper are that if found reliable and stable over the long term, the Phonic Inventories, through the identification of the types of spelling errors made by children, can provide useful information to teachers for screening purposes - to identify those children in their classes most likely to have functional difficulties with reading and written language. Once such children are identified, they can be referred for more in-depth investigation of the cognitive and language deficits which accompany their functional problems. At the same time, the profiles of errors made by the child can be used for teaching purposes, to develop instructional programmes which can target the areas of difficulty manifested by individual children.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 Research questions guiding this study

The aim of this study was to compare the performance of children with and without learning difficulties on the Phonic Inventories. The study has been operationalised as follows:

Research question one: How reliable are the three levels of the Phonic Inventories as a screening tool when used in full-time remedial and mainstream classrooms?

This question addressed the issue of whether the test was potentially reliable and stable over time. This evidence formed a basis for establishing that the test is content and construct valid.

Data were analysed from the use of the Phonic Inventories in their administration in 2001. The internal consistency and split half reliability of the three levels of the test was estimated. Cronbach's alpha was calculated to establish the reliability of the three levels of the test. The data were also analysed to compare whether similar results and patterns of errors were demonstrable in both the 1979 data and the 2001 data.

Hypothesis one: A high reliability coefficient in the Phonic Inventories Levels One, Two and Three will be achieved in the 2001 data set.

Hypothesis two: The three tests which make up the Phonic Inventories will show demonstrable long term stability as evidenced by similar results and patterns of errors in both the 1979 and 2001 datasets.

Research question two: Are there particular types of spelling errors made by children in full-time remedial classrooms, as opposed to children in mainstream classrooms? Are the differences statistically significant?

This question addressed the issue of whether the test was potentially able to discriminate well between children who had been previously diagnosed as learning disabled and children in mainstream programmes, as a basis for establishing its validity (particularly content validity, construct validity and concurrent validity).

The patterns of spelling errors made by children between the ages of seven and thirteen who were in regular mainstream school classrooms were compared with those of dyslexic children (defined as children with a history of learning difficulty who have been previously diagnosed as having a learning disability affecting reading, writing and spelling). The patterns of spelling errors made by children from Grades 2 to 7 were established by classifying the type of error made on the tests which make up the Phonic Inventories, in relation to the types of letters misspelled and the position of the word in which the error occurs.

These data were then analysed statistically to establish whether the frequency of errors on the different error types or error categories of the Phonic Inventories made by children with learning difficulties are greater than the frequency of errors made by children without learning difficulties on the same tests. Data from the pilot study conducted in 2001 was first examined. The types of errors made by mainstream and remedial children were compared. A similar analysis was then conducted for the 1979 data.

Hypothesis three: Learners in mainstream schools and remedial schools make the same types of errors on each of the three levels of the Phonic Inventories but the frequency of children in full time remedial education is significantly more than children in full time mainstream education.

Research question three: Is there a difference in frequency of errors made by younger as opposed to older children? Are these differences similar for children in full-time remedial classrooms as opposed to children in mainstream classrooms? Are these differences statistically significant?

This question addressed the issue of whether younger children make more errors than older children (i.e., whether the Phonic Inventories can discriminate the progress made by children in response to learning at school).

This study compared the types of errors made on the Phonic Inventories by children at different age groups in both mainstream and remedial classrooms. It focused on the frequency of errors on different error types on the three levels of Phonic Inventories, and attempt to establish whether the frequency of errors made by children who have been previously diagnosed as being learning disabled is greater than the frequency of errors made by children in the mainstream. These analyses examined the errors made by children at each grade level from Grades 2 to 7.

Data from the pilot study conducted in 2001 were examined first. The types of errors made by mainstream and remedial children will be compared. A similar analysis was then conducted for the 1979 data.

Hypothesis four: In mainstream schools, the number of errors made by children in mainstream classes decreases as grade level increases in primary school. A similar pattern will be found with children in full-time remedial education.

Research question four: On the basis of examination of data from children in mainstream and remedial classrooms, are the Phonic Inventories content, convergent and construct valid?

Content and convergent validity will be established by correlating the error scores yielded by each level of the Phonic Inventories with a standardised spelling test (the Schonell One Word Spelling Test Form A).

Construct and convergent validity will be argued if it was found that error scores on the Phonic Inventories were able to discriminate between children in mainstream classrooms and children previously diagnosed as learning disabled, who are in full-time remedial education.

The argument for content and construct validity was based on convergence between a number of analyses. Trends from data from the 2001 pilot study was examined first. The types of and frequencies of errors made by mainstream and remedial children were compared. A similar analysis was then conducted for the 1979 data. The trends in these two datasets were then examined against the findings from Grasko (2005), who also compared children in mainstream classrooms and children previously diagnosed as learning disabled, using phonic inventory and spelling test data drawn in 2004.

Hypothesis five: Learners who were tested in 1979 and who scored high on the Schonell Graded Spelling Test will attain low scores on the Phonic Inventories (i.e., few errors will be attained on the Phonic Inventories). Thus, the Phonic Inventories have a high content, concurrent and construct validity.

Hypothesis six: Children with learning difficulties in 1979 have dissimilar profiles to learners in the mainstream group in 1979. Similarly, for the 2001 dataset. Based on their ability to discriminate between learning disabled and mainstream children, the Phonic Inventories also have construct validity as a diagnostic screening test.

4.2 Research design

This study can be classified as an ex post facto non-experimental study designed for cross-validation purposes. It has formed part of a larger longitudinal study currently being conducted by Prof. C. Potter of the University of the Witwatersrand (see Appendix A).

To supplement the findings of this study and establish the longitudinal reliability and validity of the Phonic Inventories, the results from the 2001 data set have been compared to those achieved by learners tested in different schools in 1979. The research questions and hypotheses of the study are addressed in table 11.

4.2.1 Samples

4.2.1.1 2001 study

The 2001 study involved a relatively large mixed gender stratified sample of learners from three Johannesburg schools: Parkview Junior Primary School (Grades 1 to 3), Parkview Senior Primary School (Grades 4 to 7) and Japari Remedial School (Grades 1 to 7). In total there were 510 participants with ages ranging between seven and thirteen. Tables 2 and 3 disaggregate this number by school and grade.

Table 2: Number of learners per school in 2001

School	Frequency	Percent
Parkview Primary	136	26.7
Parkview Senior	231	45.3
Japari	143	28.0
Total	510	100.0

Table 3: Total number of learners per grade per school in 2001

Grade	Statistics	Group	
		Mainstream	Remedial
Grade 1	Frequency	75	-
	%	20.4	-
Grade 2	Frequency	45	2
	%	12.3	1.4
Grade 3	Frequency	16	16
	%	4.4	11.2
Grade 4	Frequency	83	19
	%	22.6	13.3
Grade 5	Frequency	42	44
	%	11.4	30.8
Grade 6	Frequency	54	24
	%	14.7	16.8
Grade 7	Frequency	52	38
	%	14.2	26.6

The learners from the Parkview Junior and Senior schools were all in a mainstream class, following a normal government school programme. Each of the learners at Japari Remedial had had been through the school's multi-disciplinary assessment process, and had been diagnosed as learning disabled, and requiring full-time remedial education. This meant that the sample was made up of primary school children from two groups: one group in mainstream and one group in full time remedial education.

As shown by Table 2 and 3, the mainstream sample was larger than the remedial sample, but given the relative sizes of the schools, this was to be expected. What is more important is that the sample size of both the mainstream and remedial groups was sufficient for all the required analyses.

Each of the contrast groups were drawn from schools in the same geographic area of Johannesburg (in within 5 kilometers of each other). This implied that the schools included in the study are likely to have served the communities living in these areas, and also to have had similar access to those resources available to communities living in the northern suburbs of Johannesburg. The populations of interest for this study were learners in mainstream education and learners in full

time remedial education. Given these considerations relating to matching, it is likely that the learners attending the schools in which this study was conducted were representative of these experimentally accessible populations in the northern suburbs of Johannesburg.

As tabulated in Table 4, there was a more or less even gender split with boys accounting for 55% of the sample and girls for 43%. No gender information was available in 2% of the sample.

Table 4: Total number of learners per gender in 2001

Gender	Mainstream		Remedial	
	Frequency	Percent	Frequency	Percent
Male	176	48.0	104	72.7
Female	181	49.3	39	27.3
Missing	10	2.7		
Total	367	100.0	143	100.0

Table 5 shows the distribution of learners in terms of ethnicity.

Table 5: Number of learners per ethnicity in 2001

Ethnicity	Mainstream		Remedial	
	Frequency	Percent	Frequency	Percent
White	181	49.3	96	67.1
Black	94	25.6	22	15.4
Indian	70	19.1	16	11.2
Coloured	12	3.3	5	3.5
Missing	10	2.7	4	2.8
Total	367	100.0	143	100.0

4.2.1.2 1979 study

The remedial learners for the 1979 pilot study were drawn from a group of children involved in full time remedial education at Norwood remedial school in Johannesburg (N = 74). As with the 2001 study, the 1979 study involved a mixed gender stratified sample consisting of children from Grades 2 to 7, who had all

been through the school's multi-disciplinary assessment process, and had each been diagnosed as learning disabled, and requiring full-time remedial education. The post-test scores of this sample were then compared with a mixed gender stratified sample of learners from Emmarentia primary school (N = 207), drawn from Grades 2 to 7, using data obtained by the class teachers and the remedial/learning support teacher at the school. Each of the children in this sample was in a mainstream class, following a normal government school programme. The frequency of learners is presented in table 6 below.

Table 6: Number of learners tested in 1979

Group	Frequency	Percent
Mainstream	207	73.7
Remedial	74	26.3
Total	281	100.0

As the classes at Norwood Remedial School were smaller (between eight and ten children per classroom) than at Emmarentia Primary School (between twenty four and thirty five children per classroom), the remedial school data were treated in three groups (Grades Two/Three; Grades Four/Five; and Grades Six/Seven).

It will thus be noted from the tables that follow that the mainstream sample was far larger than the remedial school sample. The mainstream sample was also based on a single class at each grade level, while the remedial school data were based on an aggregate consisting of a number of different smaller classes.

Table 7a: Number of learners tested in 1979 disaggregated by grade

Group	Grade	Frequency	Percent
Mainstream	2	36	17.4
	3	33	15.9
	4	34	16.4
	5	37	17.9
	6	34	16.4
	7	33	15.9
	Total	207	100.0
Remedial	2 or 3	27	36.5
	4 or 5	28	37.8
	6 or 7	19	25.7
	Total	74	100.0

In relation to the gender breakdown, there was a more or less even gender split in the mainstream group with boys accounting for 51% of the sample and girls for 49%. In the remedial group, just over two thirds of the sample were boys and 32% were girls.

Table 7b: Total number of learners per gender in 1979

Gender	Mainstream		Remedial	
	Frequency	Percent	Frequency	Percent
Male	105	50.7	32	68.1
Female	102	49.3	15	31.9
Total	207	100.0	47	100.0

In terms of ethnicity, there were no African students in the segregated white schools in the South African education system of the time.

4.2.2 Instruments

The pilot study of 1979 was based on administration of two instruments: the Phonic Inventories (all three levels) and the Schonell Graded Spelling Test. In the 2001 study only the three levels of the Phonic Inventories were administered. Detailed descriptions of both instruments are presented below.

4.2.2.1 *The Phonic Inventories*¹⁹

The Phonic Inventories consist of three separate spelling tests (or levels).

- Level One consists of a list of 50 words, focusing on simple words, with single vowels and single consonants and consonant blends. Level One is appropriate for Grades 1 to 7.
- Level Two consists of a list of 59 words, focusing on long vowel sounds and consonant blends. Level Two is appropriate for Grades 2 to 7.
- Level Three consists of a list of 48 words, focusing of polysyllabic words. Level Three is appropriate for Grades 3 to 7 for mainstream schools and Grades 4 to 7 for remedial schools.

Each level takes approximately twenty minutes to administer (though this can vary - many of the children in the remedial school environment had difficulties with organisation and rate of work, implying that a period of thirty minutes or longer was required for group administration of each test).

As mentioned in Section 2.4, the Phonic Inventories were not originally designed as normative instruments, but were intended to be ipsative in character. This implies that their primary purpose was for establishing the patterns of errors made by individual children, rather than for the purpose of comparing one child to another, or for establishing where a child's score lies in relation to a normative group of other children. The instruments are thus designed to highlight the way in which individual children use the alphabetic principle and to what extent commonly used phonic rules form part of an individual child's repertoire.

For each level, each of the words are read out loud, embedded in a shorter sentence or phrase, and then read again. The child writes the words underneath

¹⁹ Refer to Annexure C for a copy of the Phonic Inventories.

each other on an A4 lined page, which is divided up the middle by folding. When the first column is completed, the child then writes in the second column. This allows for space for each word to be analyzed for integrities and errors and also enables the patterns of errors and their position in the words to be established informally by scanning, and then by formal error analysis involving clustering and tallying (refer to Annexure D for coding sheet).

In this study the error scoring procedure was used to establish a number of categories of errors made by individual children, which were then aggregated to form categories of error made by their class as a whole. The levels of competence of and patterns of errors made by children in both mainstream public schools and in full-time remedial education were then examined using the error scores established by means of the Phonic Inventories in both the 1979 and the 2001 studies (refer to Section 2.4 for more information).

4.2.2.2 *The Schonell Graded Spelling Test*

This is a standardized spelling test developed in 1932. The test consists of a list of 100 graded words, which are read out, then read in a sentence, and then repeated in isolation. Each child then writes the word on an A4 sheet of paper. The test is graded by level, based on words of increasing difficulty, and is administered in lines of five words. In individual administration, once a child has made errors on all of ten words (i.e. in two lines of five words), the test is normally discontinued. In group administration the teacher normally walks around and determines visually the point at which children in the group are all making errors. This was the procedure used for group administration in 1979.

Both the Schonell test and the Phonic Inventories are A Level tests (as categorized by the Human Sciences Research Council (HSRC)) and can therefore be administered by teachers, researchers or research assistants.

4.2.3 Data collection procedure

4.2.3.1 *For the 2001 study*

Administration of the tests was done in the last quarter of the year 2001. The procedure followed varied for the mainstream schools (Parkview Junior School and Parkview Primary School) and for the remedial school (Japari Remedial School) and so the procedure followed for each group will be outlined separately.

1. For the mainstream schools

In the mainstream schools, the process began with a meeting with the principal of each school. In attendance was the school principal, the researcher and the research supervisor. The purpose of this meeting was to introduce ourselves and the prospective study. It was also to set dates and times for data collection to ensure as small a disruption to the school and teaching as possible. Both principals gave full support to the research.

At Parkview Junior School (Grades 1 to 3), it was decided that the teachers themselves should administer the tests as this would be less disruptive for the young children. The researcher dropped off test packs (one per class) containing a letter to the teacher as well as the tests relevant to their class, with instructions for each test, inside an A3 envelope. Grade 1 completed Phonic Inventory 1; Grade 2 completed Phonic Inventories 1 and 2 and Grade 3 completed all three Phonic Inventories.

These were dropped off at the school, and were then circulated from the main office. After the teachers had administered all the relevant Phonic Inventories, they were instructed to collect all the tests, and place them back inside the A3 envelopes, to seal the envelopes and hand them back to the main office for collection. The researcher collected the tests one month later. A good response

was received by the most of the teachers. However, out of the nine teachers at Parkview Junior Primary, three did not manage to administer the tests, thereby leaving only children in six of the nine classes as part of the sample.

At Parkview Senior Primary School, a similar process was adopted. The complete Phonic Inventories, (i.e., Levels 1, 2 and 3) were administered to all the children in Grades 4, 5, 6, and 7. Out of the 12 classes, again three classes were not given the test as three teachers failed to administer the tests, despite their initial co-operation. This in itself is seen as a limitation of the study as the total population of both schools is not part of the study which may have representivity issues.

2. For the remedial schools

There was a pre-existing relationship between Professor Potter and the principal of Japari Remedial School, which has been involved in the implementation of the Targeted Revisualization Programme for a number of years. Given this, Japari administers the Phonic Inventories to all the children at the school biannually.

It was therefore decided to brief the staff of Japari Remedial School at morning staff meeting at which the researcher was introduced to the teachers and the proposed study was presented to the teachers and the school principal. There was also an opportunity for the teachers to ask questions. Once this meeting had taken place, a date and time was set, and the researcher picked up the most recently administered tests from the school. These tests were collected at the end of the year. However it was found that very few tests were done with Foundation Phase: No Grade 1 data were available and only two Grade 2 learners wrote the Phonic Inventories. This severely limited the sample in the remedial school in this phase. In the Intermediate Phase, no Grade 3 learners wrote level 3 of the Phonic Inventories.

4.2.3.2 For pilot study 2 (1979)

For the 1979 pilot study, Potter (1979) administered the three levels of the Phonic Inventories to the two groups of learners himself. Owing to the poor personal organizational skills and slow writing speed of the remedial group, the children were able to complete only one level at a time comfortably in one 40 minute lesson. The mainstream group was able to complete two levels in a 40 minute lesson.

4.3 Data organization and scoring

Once all the tests in the 2001 study (organised in envelopes by class and school) had been collected, they were scored and coded by the researcher. This was done over a period of three months in 2002.

Scoring of errors in the three Phonic Inventories was done using a specially designed notation, enabling errors categorised in an error grid (refer to Annexure D). The output of these tests was thus a summary of spelling errors made by each child, categorised by error type and frequency. These data could then be used as either a profile of errors for purposes of remediation, and could also be combined with information from the error profiles of other children to establish the dominant types of errors made on a group or class level.

The aim was thus to yield information of direct use to planning instruction, as opposed to merely yielding a total score of right-wrong answers. If a child had spelt a word incorrectly, then the types of errors the child had made were noted. These were then tallied and this information coded for further analysis. The data yielded by the scoring process were thus frequencies of each error type made for each of the three levels of the instrument. An outline for how errors were scored is provided in Table 8 below.

Table 8: Codes for scoring errors on the Phonic Inventories (Grasko, 2005)

Error type	Explanation	Examples
Initial consonants	This type of error refers to times when the child has written the incorrect first consonant of a word which is based on use of a single consonant at the beginning of the word. This type of error thus refers only to the <i>initial</i> consonant and so should not be confused with blends/clusters, when the first sound is created by more than one consonant working together. *note distinction from consonant/ sound confusion *note distinction from wrong word *note distinction from letter reversal	/got/ = /jot/ any /f/ spelt as /ph/ or /th/ /s/ spelt as /f/ or /th/ /t/ spelt as /ch/ etc
Initial blends or clusters	This refers to errors made with the spelling of the first letters of a word where the first sound is made by either a blend of consonants working together (e.g. /cl/, /dr/, /fl/, /fr/) or from a cluster of consonants which work together to make a single sound (e.g. /th/, /sh/, /ch/). The error may take the form of the use of the wrong letters or the omission of letters. *note distinction from wrong word *note distinction from letter reversal	/th/ = /t/ /sch/ = /sh/ /str/ = /st/ /scr/ = /sk/ /scr/ = /skr/ /sk/ = /sc/
Medial vowel	A medial vowel error relates to the writing of single (short) vowel sounds in the middle of a word. It relates to the writing of an incorrect vowel or set of vowels to represent a short vowel sound in the medial (middle) part of a word.	/bed/ = /bad/ /swell/ = /swill/
Medial vowel digraph	This category involves errors made in the middle of words based on long vowel sounds, which require use of more than one vowel in combination. In addition, vowel digraphs occurring at the beginning of a word (e.g. earth) or at the end (e.g. die) will be scored under this category, as well as Mrs E, which changes a short vowel in a medial position in a word to a long vowel sound. Also included in this category are long vowel sounds made by vowels which are followed by a /r/ and changed by it (e.g. /ar/, /er/, /ir/, /or/, /ur/). This is thus a catch-all category, designed to indicate the rule systems used by the child in writing long vowel sounds. *note distinction from long and short vowel confusion	/please/ = /plese/ /heard/ = /herd/ /earth/ = /erth/ /pain/ = /pane/ /pane/ = /pan/ /far/ = /fa/
Ending consonants	An ending consonant error is scored when the child has made a mistake with the final consonant of a word when the last sound of a word is made by a single consonant. This may take the form of use of a wrong letter or an omission. *note distinction from consonant/ sound confusion *note distinction from ending blends/clusters.	/d/ = /t/ /t/ = /d/ /glad/ = /glal/ /glad/ = /glat/ /pram/ = /pra/
Ending blend or	This type of error refers to mistakes made in spelling consonant blends, where	/hedge/ = /hej/

Error type	Explanation	Examples
cluster	two separately sounded consonants are used at the end of a word (e.g. /nd/, /nt/, /st/), as well as consonant clusters, where two consonants work together to make a single sound at the end of a word (e.g. /ss/, /ll/, /ff/, /ck/, /th/, /tch/). The /dge/ blend as in /hedge/ is also included in this category. The error may take the form of a wrong letter or the omission of a letter. Alternatively, an extra letter may be added in. *note distinction from ending consonants *note distinction from letter reversals	/quick/ = /quik/ /stretch/ = /streth/ /length/ = /lenth/ /length/ = /lengh/ /cake/ = /cacke/
Long and short vowel confusion	This may refer to mistakes made between single vowels and vowel digraphs. What is important is if the child has spelled either a long vowel sound when a short one is required or spelled a short vowel sound when a long one is required. This refers in many cases to misuse of the letter /e/ (Mrs E) at the end of a word (Mrs E changes the vowel in a word to a long vowel sound). *if the child makes a medial vowel error and a long/ short vowel error, both should be scored (e.g. /spare/ = /sper/) *note distinction from missing /e/ in other errors	/here/ = her/ /rule/ = /rul/ /spare/ = /spar/ /like/ = /lik/ /far/ = /fare/
Consonant/ sound confusion	This refers to errors between consonants	/c/ = /k/
Reversals/ transposals	This refers to errors where the child either reversed the letters when writing them down, or switched sections of a word	/p/ = /b/ /boat/ = /atbo/
Errors with prefixes	This type of error is especially evident in Level Three which examines how children write polysyllabic words; this error is scored when a child makes a mistake on the prefix of a word. This may be a spelling error of the prefix, or an error in how the prefix works with the word, such as writing the prefix and the root word as 2 words.	/remark/ = /rimark/ /remark/ = /re mark/
Errors with suffixes	This type of error is also commonly found in Level Three. The category involves a number of different kinds of errors. The first is if an error is made in writing the suffix, involving incorrect spelling of the suffix. The second type of error refers to how the suffix is attached onto the word (for example, if it is written as 2 words). A third way is if the rules for attaching the suffix are not followed. These rules may involve dropping the last letter, doubling a letter or changing the last letter. NB the morphological endings added to a root word (e.g. /-ing/, /ed/, /-er/ and /-s) are included in this category. The doubling rule affects the adding of a morphological ending in root words based on a short vowel (e.g. hop becomes hopping through the doubling of the last consonant before the adding of the morphological ending /-ing/).	1. /ly/ = /le/ /ness/ = /niss/ /live/ = /eve/ /tion/ = /shin/ 2. /happily/ = /hapily/ /happily/ = /happely/ /hoping/ = /hopeing/

Error type	Explanation	Examples
Syllabication errors	Syllabication as a term refers to being able to analyse, recognise and write the syllables within a polysyllabic word. (I.e. a word with more than one syllable). It thus involves the ability to match the different parts of the word as spoken with the different parts of the word as written. An example would be the word /confusion/. This has three syllables, corresponding to the way the word is spoken and written. The first two syllables can be split between the prefix and the root word (i.e. between /con/ and /fusion/). Also, the word can be split between the root and the suffix (i.e. between /fu/ and /sion/). The ability to analyse and write polysyllabic words affects reading, writing and spelling. There are also some rules which children need to know in order to write polysyllabic words (e.g. the doubling rule affecting the use of double consonants when adding and ending after a short vowel).	postman/ = /post man/ bird/ = /birad/ hoping/ = /hopping/ bigger/ = /biger/
Other errors	Other errors are scored for any spelling mistake made by the child that cannot be classified by any of the above error types. Some common types are: 1. Wrong word. The child may write another word from the sentence read out, the child may have misheard the word, and written something similar, or the child may have misunderstood the context and written another spelling of a homophone, or the child may write a completely different word. 2. Illegible words. Some words may be impossible to read, either because the child has written 2 or 3 obscure letters, or the handwriting is indistinguishable. 3. If the child has added a /e/ on the end of a word (an overgeneralization of the use of Mrs E) this is unnecessary and does not affect the vowel sound. 4. If the child has left off a /e/ that does not affect the vowel sound, it is scored here.	/find/ = /finde/ /please/ = /pleas/

As mentioned, different types of words were included in the different levels of the Phonic Inventories. Level One focused on words with short vowel sounds, Level Two focused on words with long vowel sounds and Level Three focused on polysyllabic words. As a result, some error types were expected to occur more frequently on one or other level of the instrument. The aim of the analysis as a whole was ipsative, based on an attempt to identify the types of errors made by children. One was looking in particular for types of errors which are recurrent.

These may indicate that the child is using a rule for spelling which is different to that conventionally used in spelling the English language.

The aim was also to identify the position within words where the child makes errors, as this may indicate phonemic difficulties with remembering the sequence of sounds in a word, and/or sequencing problems affecting the encoding of written output. The error categories have thus been set up to allow these types of indicators to be identified. The error types thus refer to errors made, as evidence of the ways in which the child applies spelling rules in spelling different types of words incorrectly. The assumption is that each child has developed his/ her own rule system, which in turn links to the development of the phonological system, and in particular phonemic awareness. The aim was thus to identify the stage of phonological development a particular child had reached, as the basis for building the phonological system further.

The 1979 pilot study used the same coding system and error classification discussed below, with the exception of the “other” category. This category was introduced after the pilot study for the reason that there were sometimes errors made by particular children, which were idiosyncratic and did not fall readily into the other categories. These were recorded in this section of the error analysis sheet so as to reflect a particular child’s weaknesses, or particular letter/sound usage or confusions.

4.3.1 Classification of errors

In both studies, errors were classified by considering the form of the target word against the form of the word the child has written. Thus, if a word was based on a short vowel sound which required the use of a single vowel /a/ (e.g. /cat/), and the child used a vowel digraph /ae/ (the child writes /caet/), this was scored as a medial vowel error, affecting the use of the short vowel sound. If a word required

an initial blend /th/ (e.g. 'this') and the child spelt the word with one consonant /t/ (writing /tis/), this was scored as an initial blend error.

Each error was scored only once, and fitted into one category. For example, it was possible that certain long and short vowel errors could potentially be scored under medial vowel digraph error. Any individual error could only be scored once per word. This was a necessary scoring condition, so ensure that the error types were not double loaded. The error type scoring had to be mutually exclusive.

Suberrors were also classified in the 2001 study but not the 1979 study. This was done to determine exactly what errors were made on the word. For example, on the word 'match', if a learner wrote it as 'mach', the ending blend of /-tch/ was given a unique code, which was different from the ending blend of /-ngth/ in the word 'length'.

Punctuation errors were not scored on the Phonic Inventories. If a child used an apostrophe /-s/ for a plural, it was assumed that the spelling rule of using a /-s/ on the end for plurals had been correctly applied, no error was scored as no letter had been left out of the word. If the child wrote down an apostrophe /-s/ instead of /-es/, however, then a suffix error was recorded, for the reason that a letter had been left out. The same was reasoning was applied for hyphenated words – specifically for suffixes. Where no letter was omitted, hyphenation errors were ignored. If the child wrote two words instead of one, however, then this was marked as a suffix error.

If no errors were made on a word, this was also coded.

4.4 Data coding

Once all the tests were marked and coded, the scripts all the data were entered into an MS Excel spreadsheet. From this point, each child was given a number

as a link back to their scripts, should data need to be checked at a later date. This list of numeric identifiers were kept separately from the actual scripts to ensure confidentiality. No identifying information appears in the data, and so individual child performance is kept confidential. The reporting is focused only on overall trends.

The data entered into the spreadsheet was according to the list of variables in this study as outlined in Tables 9 and 10 for the 2001 study and the 1979 study respectively.

Table 9: Variables in the 2001 study

Variable	Range	Scale of measure
Biographical		
School	Parkview Junior (code 1) Parkview Senior (code 2) Japari Remedial (code 3)	Nominal
Group	Mainstream (code 1) Remedial (code 2)	Nominal
Grade	Grade 1 (code 1) Grade 2 (code 2) Grade 3 (code 3) Grade 4 (code 4) Grade 5 (code 5) Grade 6 (code 6) Grade 7 (code 7)	Ordinal
Gender	Boy (code 1) Girl (code 2)	Nominal
Age	In years	Interval
Ethnicity	White (code 1) African (code 2) Indian (code 3) Coloured (code 4)	Nominal
Test variables		
Phonic Inventory Level	Level 1 (code 1) Level 2 (code 2) Level 3 (code 3)	Nominal
Word	Each of the words on the Phonic	Nominal

Variable	Range	Scale of measure
	Inventories across all 3 levels (see Appendix C)	
Error	No error (code 0) Initial consonant (code 1) Initial blend (code 2) Medial vowel (code 3) Medial vowel digraph (code 4) End consonant (code 5) End blend (code 6) Long short vowel confusion (code 7) Consonant/ sound confusion (code 8) Reversals/ transposals (code 9) Prefix errors (code 10) Suffix errors (code 11) Syllabification errors (code 12) Other errors (code 13)	Nominal
Level 1 score	0-50	Interval
Level 1 percent	0-100	Interval
Level 2 score	0-59	Interval
Level 2 percent	0-100	Interval
Level 3 score	0-48	Interval
Level 3 percent	0-100	Interval
Test total	157	Interval
Test total percent	0-100	Interval
Error 1	No error (code 0) Type 1 error made in any word (code 1)	Nominal
Error 2	No error (code 0) Type 2 error made in any word (code 1)	Nominal
Error 3	No error (code 0) Type 3 error made in any word (code 1)	Nominal
Error 4	No error (code 0) Type 4 error made in any word (code 1)	Nominal
Error 5	No error (code 0) Type 5 error made in any word (code 1)	Nominal
Error 6	No error (code 0) Type 6 error made in any word (code 1)	Nominal
Error 7	No error (code 0) Type 7 error made in any word (code 1)	Nominal

Variable	Range	Scale of measure
Error 8	No error (code 0) Type 8 error made in any word (code 1)	Nominal
Error 9	No error (code 0) Type 9 error made in any word (code 1)	Nominal
Error 10	No error (code 0) Type 10 error made in any word (code 1)	Nominal
Error 11	No error (code 0) Type 11 error made in any word (code 1)	Nominal
Error 12	No error (code 0) Type 12 error made in any word (code 1)	Nominal
Error 13	No error (code 0) Type 13 error made in any word (code 1)	Nominal

Suberrors were also coded and captured in the 2001 study but they were not analysed. They are therefore not discussed in the paper.

Table 10: Variables in the 1979 study

Variable	Range	Scale of measure
Biographical		
School	Emmarentia Primary (code 1) Norwood Remedial (code 2)	Nominal
Group	Mainstream (code 1) Remedial (code 2)	Nominal
Grade	Grade 1 (code 1) Grade 2 (code 2) Grade 3 (code 3) Grade 4 (code 4) Grade 5 (code 5) Grade 6 (code 6) Grade 7 (code 7) Grade 2 or 3 (code 8) Grade 4 or 5 (code 9) Grade 6 or 7 (code 10)	Ordinal
Test variables		
The Schonell Graded Score	0-100	Interval
Initial consonants	Frequency	Interval
Initial blends	Frequency	Interval
Medial vowel	Frequency	Interval

Variable	Range	Scale of measure
Medial vowel digraphs	Frequency	Interval
Ending consonants	Frequency	Interval
Ending blends	Frequency	Interval
Reversals	Frequency	Interval
Vowel confusion	Frequency	Interval
Consonant/sound confusion	Frequency	Interval
Prefix errors	Frequency	Interval
Suffix errors	Frequency	Interval
Syllabification	Frequency	Interval
TOTAL PI ERRORS	Frequency	Interval

The 1979 dataset does not distinguish the error categories by levels of the Phonic Inventories. Instead, a combined result on each of the errors for each of the three Phonic Inventory levels was recorded.

4.5 Data cleaning

Prior to any analysis, it was necessary to clean the data set. As mentioned earlier, all data were entered into an Excel spreadsheet. This was then imported into SPSS, a Statistical Package for the Social Sciences for data analysis.

The process of data cleaning involved checking whether there were any data errors. In the 2001 dataset, there were three duplicate entries. These were then deleted from the dataset. Patterns of missing values were also checked to ensure that they were all at least missing at random, and not the result of a systematic error.

- There were 10 missing values for the Gender variable. This made up 2% of the total sample (see Table 4).

- There were 56 missing values for Age. This made up 10.9% of the total sample.
- For Ethnicity, there were 14 missing values. This made up 2.7% of the total sample (see Table 5).
- For the test scores, no missing values were found unless a learner was not tested (e.g. a grade 2 learner did not write level 2 of the Phonic Inventories).

There were no missing data in the 1979 dataset.

4.6 Data analysis

4.6.1 Summary statistics

Summary statistics were computed for all the biographical and test variables. Since these variables were either nominal or ordinal, the statistics run were frequencies, presented as percentages. This served the purpose primarily of describing the sample and the dataset and comparing the frequency of errors made by two groups (i.e., remedial group and the mainstream group) for both datasets.

4.6.2 Reliability analysis

Reliability is the correlation of an item, scale, or instrument with a hypothetical one which truly measures what it is supposed to. Reliability of the Phonic Inventories in this study will be estimated in the following ways:

1. **Internal consistency:** Estimation based on the correlation among the variables comprising the set (typically, Cronbach's alpha). Cronbach's

alpha²⁰ is the most common form of internal consistency reliability coefficient. Thus, Cronbach's alpha was calculated on the 2001 dataset. Specifically, it looked at the following factors which are characteristic of Cronbach's alpha:

- i. *Alpha if deleted.* SPSS computed "Cronbach's Alpha if Item Deleted," which gave the researcher an option to drop items with high coefficients in this column as another way to improve the alpha level. This may suggest the possibility that it does not measure the construct to which it was directed.
- ii. *The item-total correlation.* This is the Pearsonian correlation of the item with the total of scores on all other items. A low item-total correlation means the item is little correlated with the overall scale and the researcher should consider dropping it.
- iii. *Negative alphas.* A negative Cronbach's alpha indicates inconsistent coding or a mixture of items measuring different dimensions, leading to negative inter-item correlations.

2. ***Split half reliability***, which measures *equivalence*, is also called *parallel forms reliability*. It is administering two equivalent batteries of items measuring the same thing in the same instrument to the same people. The four coefficients generated in this study to measure split half reliability are: Cronbach's alpha for each form, the Spearman-Brown coefficient, the Guttman split-half coefficient, and the Pearsonian correlation between the two forms (aka, "half-test reliability"). Some authors label split-half reliability as a subtype of internal consistency reliability.

²⁰ See Anastasi & Urbina, 1997.

4.6.3 Tests of significance

To establish if the differences between the classification groups and levels in the 2001 dataset were statistically significant, t-tests were run. Before running any t-tests, it was necessary to check whether the data were normally distributed. This was done through plots and histograms of the *Test Total Percentages* and for the individual level percentages (i.e., *Level 1 Percent*; *Level 2 Percent* and *Level 3 Percent*).

These graphs revealed that in both the mainstream group and the remedial group, the data were skewed to the left and therefore not normally distributed (see graphs 2, 3 and 4 in next chapter). This meant that a nonparametric version of an independent t-test had to be run. A Mann Whitney was run and the results are discussed in Chapter 5. Given that the statistical difference between the two sample groups was established for the test overall and for each of the individual levels of the test, no statistical differences between patterns of errors for each word was conducted as this would be redundant.

4.6.4 ANOVA analysis

ANOVA analyses were also run to test of the statistical significance of the differences among the mean scores of grade levels and the total scores on each level between the two groups: mainstream and remedial. Before analysis, it was necessary to check the homogeneity of variance. This was done through Levene's statistic.

4.6.5 Post hoc analysis

After analysing the results from the ANOVA, it was necessary to determine which test score means per grade and per group varied. This was done using the Bonferoni multiple comparison test. The Bonferroni test was used because it is a

simple method that allows many comparison statements to be made (or confidence intervals to be constructed) while still assuring an overall confidence coefficient is maintained and is valid for equal and unequal sample sizes – as is the case in this study.

4.6.6 Odds ratio test

To determine whether an identified difference in the frequency of errors between the mainstream group and the remedial group was a real one, or whether it could have occurred by chance, an odds ratio test was run for each of the 13 error categories. The odds ratio can be used as an estimate or relative risk when the occurrence of the factor is rare.

4.6.7 Correlation statistics

To check the content validity and by implication convergent and construct validity, the total number of errors recorded for Level One and Level Two of the Phonic Inventories in 1979 were correlated with the scores achieved by the same learners on Schonell's Spelling Test.

The table below summarises statistical analyses used to answer the four research questions in this study.

Table 11: Statistical techniques used to answer the four research questions of the current study

	Research question	Statistical technique/s used	Variables used
1	How reliable are the three instruments of the Phonic Inventories as a screening tool when used in classrooms?	1.1 Internal consistency: - Cronbach's alpha - Item means (or difficulty values) - Item test correlation statistics (or discrimination values)	2001 dataset: - 50 items on Level One of the Phonic Inventories. - 59 items on Level Two of the Phonic Inventories. - 48 items on Level Three of the Phonic Inventories.
		1.2 Split half reliability: - Cronbach Alpha for each form - Pearsonian Correlation Between Forms - Spearman-Brown Coefficient - Guttman split half coefficient	2001 dataset: - 50 items on Level One of the Phonic Inventories. - 59 items on Level Two of the Phonic Inventories. - 48 items on Level Three of the Phonic Inventories.
2	Are there particular types of spelling errors made by children with a learning difficulty, as opposed to children of the same age who have no learning difficulty	2.1 Descriptive statistics (mainstream vs. remedial) - Means - Standard deviation - Frequency of errors (highest frequency of errors observed) - Ratio of errors (mainstream: remedial)	2001 dataset - Test total percent - Level 1 percent - Level 2 percent - Level 3 percent - Errors on test overall - Errors on Level 1 - Errors on Level 2 - Errors on Level 3 - Group
		2.2 Test of significance: - Mann Whitney	2001 dataset: - Test total percent - Level 1 percent - Level 2 percent - Level 3 percent

	Research question	Statistical technique/s used	Variables used
		<i>2.3 Odds ratio test</i>	<i>2001 dataset:</i> - Total number of errors on each error category in Level 1 - Total number of errors on each error category in Level 2 - Total number of errors on each error category in Level 3
3	What is the difference in frequency of errors made by children who are younger versus those who are older?	<i>3.1 Summary statistics (mainstream vs. remedial)</i> - Means - Standard deviation - Frequency of errors per grade level - Ratio of errors per grade level (mainstream: remedial)	<i>2001 dataset:</i> - Test total percent - Level 1 percent - Level 2 percent - Level 3 percent - Errors on test overall - Errors on Level 1 - Errors on Level 2 - Errors on Level 3 - Group - Grade
		<i>3.2 ANOVA and Bonferoni post hoc analysis</i>	<i>2001 dataset:</i> - Test total percent - Group - Grade

	Research question	Statistical technique/s used	Variables used
		3.3 Odds ratio test	2001 dataset: - Total number of errors on each error category in Level 1 per grade per group - Total number of errors on each error category in Level 2 per grade per group - Total number of errors on each error category in Level 3 per grade per group
4.	On the basis of the longitudinal data from mainstream and remedial samples, are the Phonic Inventories content, convergent and construct valid?	2.1 Descriptive statistics (mainstream vs. remedial) - Frequency of errors (highest frequency of errors observed) - Ratio of errors	2001 vs. 1979 dataset - Errors on test overall - Group
		4.2 Pearson correlation between the Schonell Graded Spelling test and the Phonic Inventories	1979 dataset - The Schonell Graded score - Total PI errors

CHAPTER 5

FINDINGS

5.1 Reliability of the Phonic Inventories

As discussed in Chapter 4, the reliability of each of the levels of the Phonic Inventories was established by calculating indices of two types of reliability: internal consistency and split half reliability. This section presents the findings of each one separately for each of the three levels of the Phonic Inventories using the 2001 dataset.

5.1.1 Internal consistency

5.1.1.1 Level One

Level One of the Phonic Inventories consisted of 50 items. A total of 510 learners responded to all the items in this level.

The overall reliability of Level One as indicated by the Alpha coefficient was 0.937. By convention, a lenient cut-off of .60 is common in exploratory research; alpha should be at least .70 or higher to retain an item in an "adequate" scale; and many researchers require a cut-off of .80 for a "good scale."²¹ Therefore, with an upper level of 1 this coefficient of 0.937 is very high and would suggest that the Level One of the Phonic Inventories has good reliability.

Ideally, tests should have a spread of easy, medium and difficult items. As can be seen from table 12, almost all the items (82%) on Level One of the Phonic Inventories were easy to very easy in terms of its difficulty level (refer to appendix

²¹ See Gronlund, 1995.

E for difficulty values²² and item test coefficients for each of the Level One items of the Phonic Inventories). Only four items (8%) were difficult or very difficult (i.e., *hedge*, *length*, *strength* and *stretch*). When the data were disaggregated by group, similar results were evident. Mainstream learners found *hedge*, *length*, *strength* and *stretch* the most difficult while remedial learners struggled even more with these exact same words but also struggled with *cliff* and *shall*.

Table 12: Item distribution across difficulty levels for Level One

Difficulty level	Range	Number of items	%
Very easy	.90 to 1.0	20	40
Easy	.70 to .89	21	42
Medium	.50 to .69	5	10
Difficult	.30 to .49	1	2
Very difficult	Less than 30	3	6

In terms of the item total correlation (or discrimination value²³), 34 items on the test (68%) attained item-total correlations of between 0.422 and 0.672. This may suggest that these words, highlighted in *yellow* in appendix E, may be discriminating well across the difficulty levels.

Items highlighted in *blue* (in appendix E) showed values in the lower to upper 0.300 and may therefore be discriminating sufficiently well. However, two items (i.e., *on* and *pat*) attained item total correlation values of below 0.200. This indicates that these items were poor at discriminating between good and poor

²² Where the score for an item can be 0 or 1, the average score is the simplest index which give an indication of how difficult the item is. This index is known as the difficulty value of the item. The difficulty value of a dichotomous item is defined (see for instance Van den Berg and Vorster, 1982, Huysamen, 1980) as the ratio of candidates who answered the item correctly to all the candidates. The higher the value of the ratio, the easier the item. A value of 0.5 is considered most appropriate, but the inclusion of easier and more difficult items would also be favourable. In this study the ratio is expressed as a percentage so that the difficulty value of an item is taken as the percentage of learners who answered the item correctly.

²³ This is the correlation between the right/wrong answers that learners get on a given item and the total scores that learners get on the overall test. Values range between -1 and 1. A large correlation means that good learners got item write and poor performing learners got the item wrong. A low correlation implies that learners who get the item correct tend to do poorly on the overall test and good learners on test overall got item wrong. Items between 0.4 and 0.6 are good functioning items as they discriminate well between good and poor performers (Barnard, 1989; Gronlund, 1995).

performing learners. Added to this, the fact that almost all learners, in either the mainstream or the remedial group, got these items correct (very easy category) also suggests that these are poor items and should therefore be considered for exclusion. These do not seem to have a significant negative effect on the overall reliability of the scale, since the Cronbach Alpha value remains at 0.937 should these problematic items be deleted. Similarly for words where item total correlations were less than 0.300 (see words highlighted in *pink* in appendix E). However, there is value of including these words because easy (or buffer) items often make the learners taking the test more confident and therefore more comfortable with continuing with the test. Literature suggests that self-perception influences academic and scholastic performance, and that children do well at tasks which they perceive to lie within their self-efficacy. In other words, it gives children the impression that they can do the test before proceeding to things they cannot do.

None of the items had negative values therefore both the reliability and validity of the test were not comprised by any of the words in Level One.

To further support the argument that Level One of the Phonic Inventories was able to discriminate between mainstream and remedial learners, the researcher examined the top quartile (75%) and bottom quartile (25%) scores using the four difficult to very difficulty items. The statistics revealed that learners achieving mean scores in the third quartile were able to correctly answer all these difficult and very difficult items whilst learners who performed in the first quartile could not.

5.1.1.2 Level Two

Level Two of the Phonic Inventories consisted of 59 items. A total of 337 learners responded to all the items in this level.

The overall reliability of Level Two as indicated by the Alpha coefficient was 0.914. As with Level One, this is a very high coefficient and is therefore suggestive that this level had good reliability.

In comparison to Level One, Level Two has a slightly lower overall Cronbach Alpha coefficient²⁴. However, noteworthy to this comparison is that according to the statistical literature, the consensus is that the more items there is on a test the more reliable the test is (Gronlund, 1995, 1998). This does not seem to be emerging from the current data. Level One had fewer items than Level Two and yet Cronbach's Alpha was slightly higher in Level One than in Level Two. Nevertheless Cronbach's Alpha was still very high for Level Two.

Table 13 shows the spread of the items in Level Two according to difficulty levels. Appendix F provides presents the item difficulty values as well as the discrimination values for each of the items in Level Two. Possible problematic items are highlighted and discussed below.

Table 13: Item distribution across difficulty levels for Level Two

Difficulty level	Range	Number of items	%
Very easy	.90 to 1.0	32	56
Easy	.70 to .89	14	25
Medium	.50 to .69	9	16
Difficult	.30 to .49	2	4
Very difficult	Less than 30	0	0

Table 13 shows that again, almost all the items (91%) on Level Two of the Phonic Inventories were easy to very easy in terms of its difficulty level. In fact two items (i.e., *day* and *boy*) achieved a perfect score (1.00) signifying that all learners got these items correct. About one sixth (16%) of the total number of

²⁴ In running the reliability statistics it was discovered that each of the following component variables had zero variance and was therefore removed from the analysis: go and we

items in this level were of medium difficulty, while only two items (4%) were difficult (i.e., *stroll* and *spare*). None of the items were found to be very difficult.

At a group level, the remedial group struggled the most with *stroll*, *though*, *roar*, *spare*, and *calm* (see appendix F). Mainstream learners struggled significantly less in comparison but seemed to struggle the most with *spare* and *stroll* and to some extent on the word *deer*.

In terms of the item total correlation 26 items (46%) attained item-total correlations of between 0.417 and 0.615. This suggests that these 26 words, highlighted in *yellow* in appendix F, may be discriminating well across the difficulty levels.

Items highlighted in *blue* had values ranging between 0.320 and 0.396 and may therefore be discriminating sufficiently well across the difficulty values.

Items highlighted in *pink* had item total correlations of less than 0.300. These items may not be functioning adequately in discriminating between high and low scoring learners since these values range from 0.204 to 0.296. Additionally these items had a predominantly very easy difficulty level. Again, as with Level One, the researcher is not recommending that these items be removed from the test. She is merely flagging them as items which do not necessarily distinguish between learners which are considered good performers (or learners without any learning difficulties) and poor performers (or learners with learning difficulties potentially).

However, seven items (highlighted in *green* in appendix F) attained item total correlation values of below 0.200. This indicates that these items were very poor at discriminating between good and poor performing learners. Additionally, almost all learners, in either the mainstream or the remedial group, got these items correct. Again this suggests that these are poor items and should therefore be considered for exclusion. If these 'problematic' items are deleted from the

test, this does not seem to have a significant negative effect on the overall reliability of the scale, since the Cronbach Alpha value remains at 0.913. As with Level One, the inclusion of such buffer items is useful as it gives learners the impression that they can do the test. However, it may be worthwhile to remove two items (*day* and *boy*) as all learners regardless of whether they are experience barriers to learning were able to correctly spell these words. They may be regarded therefore as redundant items.

As with Level One, to further support the argument that Level Two of the Phonic Inventories is able to discriminate between mainstream and remedial learners, the researcher examined the top quartile (75%) and bottom quartile (25%) on the difficult to very difficulty items. Again, using the difficult items on the test, the statistics revealed that only learners achieving mean scores in the third quartile were able to correctly answer these difficult items whilst learners who performed in the first quartile could not.

As with Level One, none of the items had negative values therefore both the reliability and validity of the test are not comprised by any of the words in Level Two.

5.1.1.3 Level Three

Level Three of the Phonic Inventories consisted of 48 items. A total of 288 learners responded to all the items in this level. Fewer learners wrote this level because only learners from Grade 3 upwards were required to write it.

The overall reliability of Level Three as indicated by Cronbach Alpha was 0.905²⁵. This is a very high coefficient and is therefore suggestive that this level had good reliability as did Level One and Level Two.

In comparison to Level One and Level Two, this value of 0.905 was the lowest reliability coefficient. This can perhaps be explained by the fact that there were fewer items on this level (48 as opposed to 50 and 59 items in Level One and Level Two respectively).

As with the previous Levels, the item difficulty values as well as the discrimination values are shown in appendix G. The item distribution across the difficulty levels for Level Three are tabulated below. Possible problematic items are highlighted and discussed.

Table 14: Item distribution across difficulty levels for Level Three

Difficulty level	Range	Number of items	%
Very easy	.90 to 1.0	22	47
Easy	.70 to .89	17	36
Medium	.50 to .69	6	13
Difficult	.30 to .49	2	4
Very difficult	Less than 30	0	0

The statistics again show that almost all the items (83%) on Level Three of the Phonic Inventories are easy to very easy in terms of its difficulty level. Thirteen percent (13%) of the total number of items in this level were of medium difficulty, while only two items (4%) were difficult (i.e., *happily* and *happiness*). Again this supports the assertion that Level Three of the Phonic Inventories has discrimination ability.

Although none of the items were found to be very difficult, at a group level, the remedial group struggled the most with *happiness*, *happily*, *activity*, *reactionary*, *hoping* and *remarkable*. Mainstream learners struggled significantly less in comparison to remedial learners but struggled with *happiness*, *happily*, *chopped* and to some extent on the word *hoping*. Only learners in the 75th percentile

²⁵ In running the reliability statistics it was discovered that the following component variable had zero variance and was therefore removed from the analysis: play.

were able to correctly answer the two difficult items on Level Three of the Phonic Inventories.

In terms of the item total correlation, 25 items on the test (57%) attained item-total correlations of between 0.402 and 0.668. This suggests that these 25 words, highlighted in *yellow* in appendix G, may be discriminating well across the difficulty levels.

Items highlighted in *blue* in appendix G had values ranging between 0.303 and 0.391 and are therefore appear to discriminate sufficiently well across the difficulty values.

The three items highlighted in *pink* in appendix G had item total correlations of less than 0.300. These items may not be functioning adequately in discriminating between high and low scoring learners since these values range from 0.248 to 0.288. Attention is drawn to the word *hoped*, in that in comparison to the other two words (*remark* and *stronger*) in this *pink* category, this was the most difficult for learners in either the mainstream or remedial group.

Eleven items (highlighted in *green* in appendix G) attained item total correlation values of below 0.200. As with the other levels, this indicates that these items are very poor at discriminating between good and poor scoring learners. Additionally, almost all learners, in either the mainstream or the remedial group, got these items correct. Again this suggests that these are poor items and should therefore be investigated further. The Cronbach Alpha will be 0.905 if these 'problematic' items are deleted from the test which means that their exclusion from the test will probably not have a significant negative effect. However given how this test is structured (with word families) it makes little sense to remove these items. The only exception is the *post* family where all words associated with *post* were identified as being too easy and with low discrimination levels. These included the following words: *post*, *poster*, *postman*, and *postbox*.

As with Level One and Level Two, none of the items had negative discrimination values therefore both the reliability and validity of the test were not comprised by any of the words in Level Three.

5.1.2 Split half reliability

5.1.2.1 Level One

Ideally in order to obtain a good estimate of the reliability of a test one would need to administer the test twice to the same group of people and then correlate the two sets of results. However this was not done for this study. One way to get around this is through the Cronbach's alpha as shown above. Another is to split the items into two groups and then to compare these groups as if they were two separate administrations of the same survey.

When Level One is split into to equal forms different estimates of the reliability coefficients were produced. Form A (or the first 25 words of Level One) had a Cronbach Alpha of 0.833 while Form B (or words 26 to 50 of Level One) had a Cronbach Alpha of 0.915. Both forms had a correlation coefficient with an upper level of 1, which is very high and therefore suggests that both forms have good reliability. The *Correlation Between Forms Coefficient* of 0.832, *Spearman Brown Correlation* of 0.908 and the *Guttman Split-Half Coefficient* of 0.834 further supports this statement.

5.1.2.2 Level Two

When Level Two is split into to equal forms, Form A (or the first 30 words of Level Two) had a Cronbach Alpha 0.812 while Form B (or the last 29 items of Level Two) had a Cronbach Alpha of 0.869. Both forms had a high Cronbach Alpha coefficient. This suggests that both forms in Level Two have good reliability. This is again supported by the *Correlation Between Forms Coefficient*

of 0.809, *Spearman Brown Coefficient* of 0.894 and the *Guttman Split-Half Coefficient* of 0.829, with both coefficients in the upper level bracket (close to 1).

5.1.2.3 Level Three

When Level Three is split into two equal forms, Form A (or the first 24 words of Level Three) had a Cronbach Alpha of 0.765 while Form B (or the last 24 items of Level Two) showed a Cronbach Alpha of 0.885. This is again supported by the *Correlation Between Forms Coefficient* of 0.736, *Spearman-Brown Coefficient* of 0.848 and the *Guttman Split-Half Coefficient* of 0.836, with all coefficients in the upper level bracket (close to 1). These statistics show that both forms in Level Three had a high Cronbach Alpha which suggests that both these forms had good reliability. These statistics were the lowest in comparison to the previous two levels however, the coefficients are above 0.700 which is still indicative of good reliability when this level is split in half and compared.

5.1.3 Correlations between the Phonic Inventories and the Schonell Graded Spelling Test

At face value, the Phonic Inventories appear to be measuring one construct, spelling. The teachers who administered the test as well as the learners who wrote the tests agreed that Phonic Inventories were a spelling test. This meant that the test had good face validity²⁶. However, face validity is merely a judgment call and is not a sufficient measure of validity. For this reason, the current study examined two types of validity: (i) content²⁷ and construct²⁸ validity.

²⁶ This pertains to whether the test “looks valid” to the examinees who take it, the administrative personnel who decide on its use and the other technically untrained observers (Anastasi & Urbina, 1997).

²⁷ Content validation involves the systematic examination of the test content to determine whether it covers a representative sample of behaviour domain to be measured (Anastasi & Urbina, 1997).

²⁸ Construct validity of a test is the extent to which the test may be said to measure a theoretical construct or trait. In this case, the construct is “spelling” (Anastasi & Urbina, 1997)

In the earlier pilot studies of 1978 and 1979, the Phonic Inventories were supplemented with the Schonell Graded Spelling test. The Schonell Graded Spelling test was therefore a validation measure for the Phonic Inventories.

To assess how valid the Phonic Inventories were a correlation between the score attained on the Schonell Graded Spelling test and the total number of errors attained on the Phonic Inventories was conducted. According to Anastasi & Urbina (1997), correlations between a new test and a similar earlier test can be evidence that the new test measures approximately the same general area of behaviour as other tests designated by the same name, which in this case is a spelling test.

The correlation coefficient of $-.780$ indicates that there was a fairly strong negative association between the results of the Schonell Graded Spelling test and the Phonic Inventories. This result is significant at the 0.01 level. This means that the more errors were made on the Phonic Inventories the lower the score on the Schonell Graded Spelling test was. This was expected because learners without difficulties with spelling should have a high score on the Schonell Graded Spelling Test and a low score for the total number of errors recorded on the Phonic Inventories. Conversely, a learner with some level of learning or spelling difficulties will have a low score on the Schonell Graded Spelling Test and a high score for the total number of errors recorded on the Phonic Inventories.

When the correlations are done separately for remedial and mainstream groups, Pearson's correlation coefficient increases dramatically for the remedial group. A correlation coefficient of -0.890 was attained which is very high. For the mainstream group, as shown in the same table, the correlation coefficient was not as high as the remedial group but this was still high (-0.773). These coefficients were significant at the 0.01 level.

These high correlations may therefore suggest that the Phonic Inventories have a strong association with an already reliable, valid and normed spelling test (i.e., the Schonell Graded Spelling test) which then suggests that the Phonic Inventories are both content and construct valid in that they are both tapping into the same domain. Put differently, they are both measuring the construct of 'spelling'²⁹.

However, there is also the issue of whether the Phonic Inventories measure exactly the same construct as a conventional spelling test, which normally provides a more or less score which can then be linked to learner performance, age or grade at school. This issue is examined in the next section.

5.2 Learner performance on the Phonic Inventories

5.2.1 Introduction

This section of the report describes the percentage score for the Phonic Inventories overall and on each of the three levels of the Phonic Inventories and compared these between the mainstream and remedial groups. The 2001 data were used.

5.2.2 Performance overall

5.2.2.1 *Comparison by group*

²⁹ It should be noted that according to Anastasi & Urbina (1997), the correlations between different tests which purport to measure the same construct should be moderately high but not too high. The coefficient of -0.780 falls very nicely into the moderately high classification. This is important is that if the Phonic Inventories correlated too highly with an already available test (such as the Schonell Graded Spelling test), without such added advantages as brevity or ease of administration, then the Phonic Inventories would have been a needless duplication. This however appears not be the case.

The summary statistics shown in the table below clearly shows that the mainstream group performed significantly better than the remedial group in each of the three levels of the Phonic Inventories. While the most of the learners in the mainstream group performed in the 77 to 98% bracket, learners in the remedial group achieved scores within the 44 and 86% bracket. Additionally, higher standard deviation scores were observed in the remedial group in each of the three levels of the Phonic Inventories. This is within expectation as the remedial group is made up of learners with different learning difficulties.

However, noteworthy is the fact that the mean percentage score steadily decreased as learners progressed through the different levels regardless of whether a learner was in the mainstream or the remedial group. Thus Level One was the easiest followed by Level Two (although the means were very similar to Level One) and then a more drastic drop is observed in Level Three. The rate of decline is more distinct in the remedial group as can be seen in table 15 below.

Table 15: Summary statistics of mean percentage scores between all levels of the Phonic Inventories

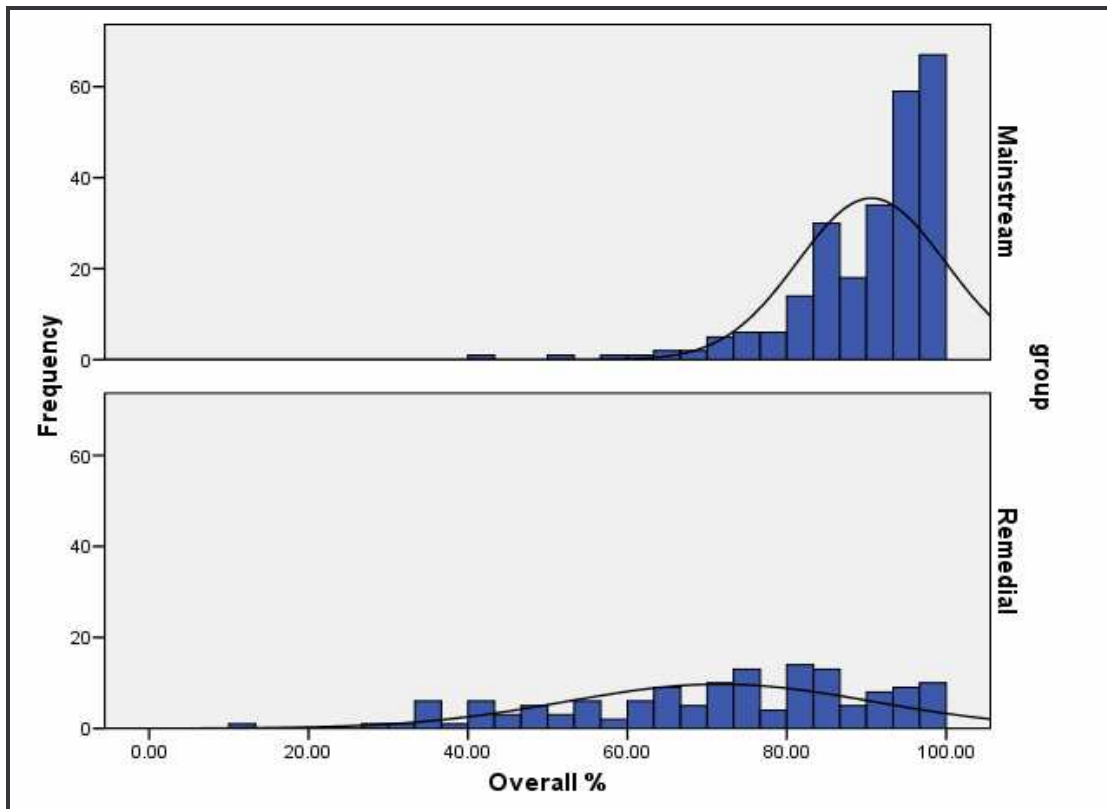
		Level 1		Level 2		Level 3	
		Mainstream	Remedial	Mainstream	Remedial	Mainstream	Remedial
Mean		90.6073	71.5603	89.9334	71.3668	84.4130	44.8286
Std. Deviation		9.25012	19.28892	10.06885	22.12841	15.54812	40.68913
Skewness		-1.671	-0.606	-1.570	-1.833	-1.544	-0.093
Minimum		42.00	12.00	50.85	0.00	0.00	0.00
Maximum		100.00	100.00	100.00	98.31	100.00	100.00
Percentiles	25 th	86.00	59.00	84.75	63.56	77.08	0.00
	50 th	94.00	76.00	93.22	76.27	89.58	58.33
	75 th	98.00	86.00	96.61	86.44	95.83	82.29

In Level One, the percentage score of the person in the 25th percentile in the mainstream group was 86% while it was 98% for the person in the 75th percentile. These scores are significantly higher than for the remedial group where scores of 59% and 86% respectively. A similar pattern was evident for Levels Two and Three. Additionally, the median (50th percentile) of the remedial group was lower than the first quartile of the mainstream group at all three levels

of the Phonic Inventories. This suggests that the Phonic Inventories was able to discriminate between mainstream and remedial learners. This may also be an indicator that the Phonic Inventories may have some degree of concurrent validity.

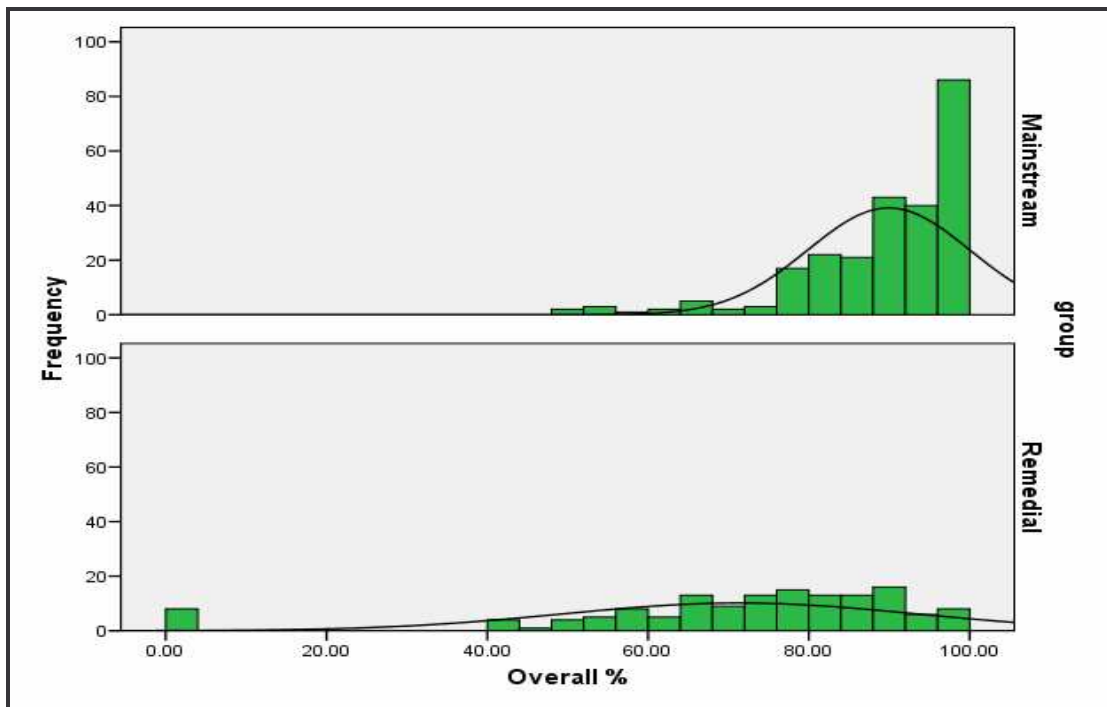
To determine whether the data are normally distributed, the skewness³⁰ was examined. This was done by the skewness statistic as shown in table 15 above and through a histogram shown in graphs 1, 2 and 3 below.

Graph 1: Histogram showing distribution of overall mean percentage scores for both the mainstream and remedial group in Level One

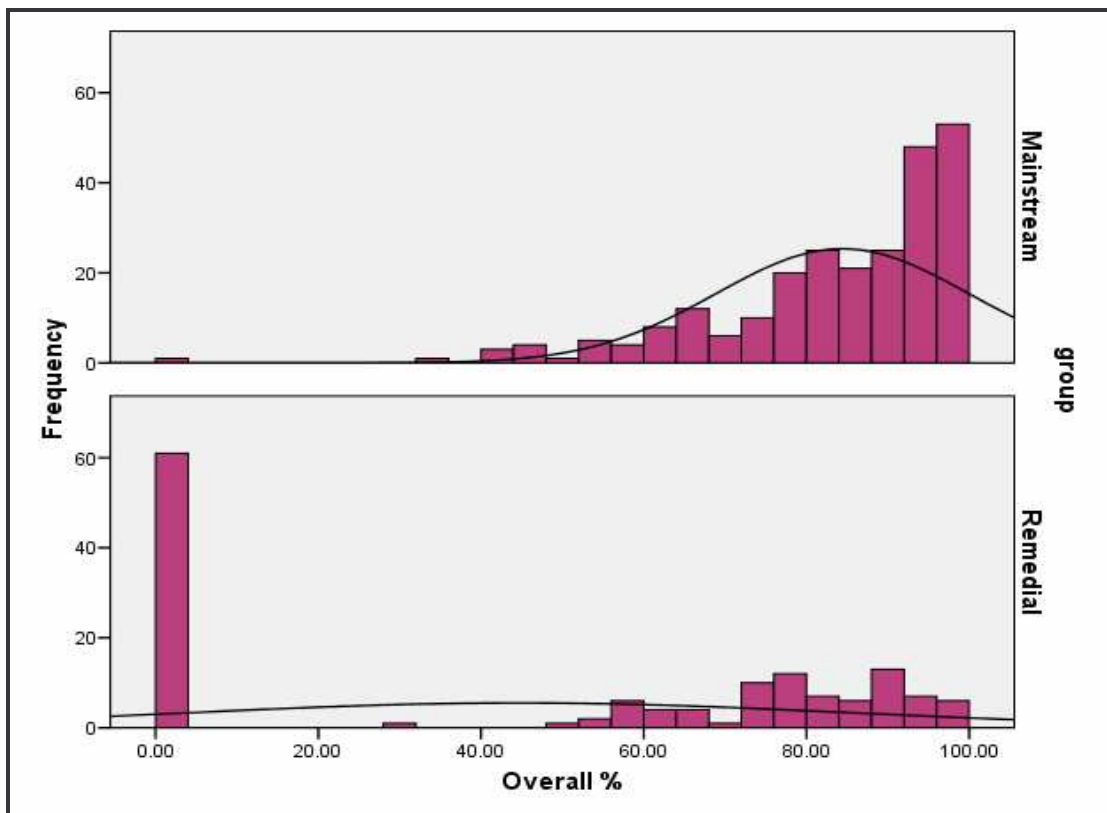


³⁰ Skewness characterizes the degree of asymmetry of a distribution around its mean. As the skewness statistic departs further from zero, a positive value indicates the possibility of a positively skewed distribution (that is, with scores bunched up on the low end of the score scale) or a negative value indicates the possibility of a negatively skewed distribution (that is, with scores bunched up on the high end of the scale). Values of 2 standard errors of skewness (ses) or more (regardless of sign) are probably skewed to a significant degree (Keller & Warrack, 2000).

Graph 2: Histogram showing distribution of overall mean percentage scores for both the mainstream and remedial group in Level Two



Graph 3: Histogram showing distribution of overall mean percentage scores for both the mainstream and remedial group in Level Three



According to the graphs above, it is clear that the data were not normally distributed for both groups. The mainstream group was skewed to a significant degree to the left which means the scores bunched up on the high end of the scale. This tells us that many learners in the mainstream group appear to have mastered the spelling skills which the three levels of the Phonic Inventories tap into and are therefore able to achieve high test scores.

For the remedial group, the data for Level One and Two were also skewed to the left but not to the same extent as the mainstream group. For Level Three, the skewness statistic of $-.093$ suggests that the data were normally distributed. However, as shown in the histogram there were a large number of remedial learners who obtained a zero score which affects the normality curve to some extent. Added to this, zeros were not treated as outliers and therefore not excluded from the analysis. The rationale was that the score of zero was important for understanding how remedial learners were struggling.

Given that both groups were not normally distributed, any tests of significance or T-tests done (to determine whether the difference in mean percentage scores between the mainstream and the remedial group was statistically significant) was to be nonparametric in nature. In this case, a Mann Whitney test was run. This is the equivalent of the parametric Independent Samples T-test.

Table 16: Mann Whitney test statistics³¹ for the overall test percentage scores on the Phonic Inventories

	Level 1 %	Level 2 %	Level 3 %	Test total %
Z	-10.429	-10.592	-9.679	-11.011
Asymp. Sig. (2-tailed)	.000	.000	.000	.000

a. Grouping Variable: group

The test statistics in table 16 above show that there was a low probability value ($<.05$). This suggests that the differences between the mean percentage scores

³¹ Grade 1 and Grade 2 was excluded due to the fact that the sample size in the remedial group did not allow for valid comparisons to be made ($n=0$ and 2 respectively).

of the two groups (i.e., the mainstream and remedial groups) were indeed statistically significant. When the data were disaggregated by level, similar results emerged.

5.2.2.2 Comparison by grade

At a grade level, the results seem to suggest that there was a steady incline in mean percentage scores for learners in mainstream group from Grade 3 onwards³². Similarly for the remedial group but the magnitude of the mean percentage scores was significantly less in comparison to the mainstream group. However, there was some leveling of the data between Grade 5 and Grade 6 mean percentage scores in both groups as well. These statistics suggest that the higher the grade level³³ (or the older a learner is) in either the mainstream or the remedial group the more likely learners are able to achieve high scores (above 80%) on the test as a whole.

The standard deviation is just as important as the mean. As can be observed from table 17, in the mainstream group the standard deviation goes down the higher the grade level while the remedial group shows slightly higher standard deviation scores than the mainstream group (except in grade 4). These statistics suggest that mainstream learners may be making similar mistakes therefore contributing to lower standard deviation scores across the board and especially in higher grade levels, while in the remedial group the variation is more haphazard: in Grade 3 is less spread out while Grade 6 shows the highest variability, although sample size of the remedial group in these grades may be affecting the results.

Although the remedial group experienced more variability than the mainstream group in all grade levels, in grade 4 the inverse was experienced. This was also

³² *Ibid*

³³ This was used as the proxy for age.

the grade where the highest variability was noted for the mainstream group. It is not clear why these results emerged. However, one possibility is that the sample size may have contributed towards this anomaly.

Table 17: Grade level comparisons between mainstream and remedial group learners of mean percentage scores on the Phonic Inventories

Group	Statistics	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7
Mainstream	Mean	73.9252	84.9321	89.5056	91.3482	94.7207
	N	16	83	42	54	52
	Std. Deviation	10.22677	10.64844	8.89747	8.22361	6.08368
Remedial	Mean	30.5732	44.4854	64.9826	64.6762	83.7244
	N	16	19	44	24	38
	Std. Deviation	13.44336	5.82323	18.36221	21.84499	12.73429

These summary statistics above reveals that there were differences in mean test scores between the different grades. To check whether these differences were statistically significant a One Way ANOVA was run. The results for each level are discussed below.

Level One

For Level One in both mainstream and remedial groups, there was a difference in overall mean test scores between grades (mainstream $F=14.378$, $p\text{-value}=0.00$, $df=4$; Remedial $F=24.828$, $p\text{-value}=0.00$, $df=4$)³⁴.

Post hoc analyses reveal that, on the whole, for Level One for the mainstream group there is a statistically significant difference at a 0.05 level between the total test means at each grade level, except for the following³⁵:

³⁴ Refer to appendix H for detailed ANOVA tables

³⁵ *Ibid*

Mainstream group

- There is no statistically significant difference between grade 7 and grade 5.
- There is no statistically significant difference between grade 6 and grades 5 and 4.
- There is no statistically significant difference between grade 5 and grade 4.

Remedial group

- There is no statistically significant difference between grade 7 and grades 6 and 5.
- There is no statistically significant difference between grade 6 and grade 5.
- There is no statistically significant difference between grade 4 and grade 3.

Level Two

For Level Two a difference in overall mean test scores between grades was evident (mainstream $F=18.238$, $p\text{-value}=0.00$, $df=4$; Remedial $F=14.883$, $p\text{-value}=0.00$, $df=4$)³⁶.

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Post hoc analyses reveal that on the whole, for the mainstream group, there is a statistically significant difference at a 0.05 level between the total test means between the grade level, except for the following³⁷:

³⁶ Refer to appendix I for detailed ANOVA tables

³⁷ *Ibid*

Mainstream group

- There is no statistically significant difference between grade 7 and grades 6 and 5.
- There is no statistically significant difference between grade 6 and grade 5.
- There is no statistically significant difference between grade 5 and grade 4.

Remedial group

- There is no statistically significant difference between grade 7 and grade 5.
- There is no statistically significant difference between grade 6 and grades 5 and 4.
- There is no statistically significant difference between grade 5 and grade 4.

Level Three

For Level Three in both mainstream and remedial groups, there was a difference in overall mean test scores between grades³⁸ (mainstream $F=27.375$, $p\text{-value}=0.00$, $df=3$; Remedial $F=7.840$, $p\text{-value}=0.01$, $df=2$)³⁹.

Post hoc analyses reveal that for Level Three there were statistically significant differences at a 0.05 level between all the grades in the remedial group, except between grades 6 and 5. However, for the mainstream group there is a difference in all grades, except between grades 7 and 6 and between grades 6 and 5⁴⁰.

³⁸ Grade 4 excluded in this level as there was only one respondent.

³⁹ Refer to appendix J for detailed ANOVA tables

⁴⁰ *Ibid*

5.3 Error analysis

5.3.1 Introduction

Having described the overall general trend in terms of the mean percentages for the Phonic Inventories as a whole and for the three Levels of this instrument, as well as establishing that the instrument at all levels is a reliable one, we can now turn to examining the errors made by learners in both the 1979 and 2001 datasets.

As described in Chapter 4, each of the words on the three levels of the Phonic Inventories we coded using 13 error codes:

1. Initial consonants;
2. Initial blends or clusters;
3. Medial vowel;
4. Medial vowel digraphs;
5. Ending consonants;
6. Ending blend or cluster;
7. Long and short vowel confusion;
8. Consonant/sound confusion;
9. Reversals/transposals;
10. Errors with prefixes;
11. Errors with suffixes;
12. Syllabication errors; and
13. Other⁴¹

This section of the report will compare the frequency⁴² of each of these errors made by learners in the mainstream group with those made by learners in the

⁴¹ This error category was introduced into the Phonic Inventories after the 1979 pilot as is therefore not included in the 1979 error analyses.

remedial group. All frequencies were converted into percentages to allow for comparisons between the two groups.

The ratio of the frequency of errors made by mainstream learners versus the ratio of the frequency of errors made by remedial learners are also provided. Ratios were calculated using the following formula:

$$\text{Ratio} = \left[\frac{\text{Frequency of errors in remedial group}}{\text{Frequency of errors in mainstream group}} \right]$$

To determine whether this difference between the mainstream and remedial group was a real one, or whether it could have occurred by chance, an odds ratio test⁴³ was run for each of the 13 errors.

The results (using the 2001 dataset) are presented per level according to the following categories:

- Frequency of errors on the Phonic Inventories across grade levels
- Frequency of errors on the Phonic Inventories overall by grade level

Following this, a comparison of the frequency of errors between the 1979 and the 2001 datasets is presented across the three levels of the Phonic Inventories across the different grade levels.

⁴² Data were re-organised such that each learner multiplied by total number of words on Level One, Level Two and Level Three separately of the Phonic Inventories.

⁴³ The relative risk estimate is a measure of association between the presence or absence of a factor and the occurrence of an event.

5.3.2 Level One

5.3.2.1 Frequency of errors across grade levels

Table 18 below tabulates the frequency of errors made on Level One of the Phonic Inventories.

Table 18: Comparisons between mainstream and remedial group learners of frequency of errors on Level One of the Phonic Inventories across grade levels (reflected as a % of the total number of errors on Level One)

Error	Mainstream	Remedial	Ratio	Odds Ratio	95% Confidence Interval	
					Lower	Upper
Initial consonants	0.6%	0.7%	1.1	1.869	.954	3.663
Initial blends or clusters	2.4%	11.0%	4.5	7.346 ^(*)	4.621	11.678
Medial vowel	5.9%	10.2%	1.7	5.788 ^(*)	3.632	9.222
Ending blend or cluster	24.7%	36.1%	1.5	6.392 ^(*)	2.479	16.484
Long & short vowel confusion	0.2%	0.3%	1.4	3.066 ^(*)	1.090	8.625
Consonant/sound confusion	0.6%	2.9%	5.1	15.892 ^(*)	7.966	31.704
Reversals/transposals	0.0%	0.2%	8.0	12.851 ^(*)	1.565	105.555
Other	0.6%	3.3%	5.6	15.157 ^(*)	7.396	31.063

^(*) Significant at 0.05 level since the CI does not include 1

The frequency statistics (i.e., non-shaded columns in table 18) revealed that learners in both the mainstream and remedial group make the highest number of errors with ‘ending blends/clusters’ on Level One of the Phonic Inventories. While in mainstream group, the resulting figure is almost 25%, in the remedial group the frequency is 1.5 times more resulting in a figure of 36.1%. There were also relatively high frequencies on ‘initial blends/clusters’ and ‘medial vowels’ in both groups.

No errors were observed on Level One for the following categories: medial vowel digraphs and errors with prefixes in both groups. On ending consonants errors, errors with suffixes and syllabication errors none of the learners in the mainstream group made errors reflecting these categories while in the remedial group the number was insignificant (n=1, 1 and 5 respectively). Consequently, these categories are not reflected in table 18.

These frequency statistics revealed an interesting trend: mainstream and remedial learners seem to be making the same kinds of errors on Level One, particularly ending blend/cluster errors. This is supported by the Spearman's rho coefficient⁴⁴ of 0.946 which was found to be significant at a 0.01 level. This positive and strong coefficient suggest that errors made by mainstream and the errors made by remedial and mainstream learners were positively correlated and that the order of errors made by mainstream learners was the same as those made by learners in the remedial group.

Having established that the same types of errors are made by learners regardless of whether they are in mainstream or remedial education, we now turn to the magnitude of the errors. This is shown by the odds ratio test (see shaded columns in table 18 and table 19).

⁴⁴ Spearman's rho is a rank-order correlation coefficient which measures association at the ordinal level. This is a nonparametric version of the Pearson correlation based on the ranks of the data rather than the actual values.

Table 19: Odds ratio statistics on Level One of the Phonic Inventories across grade levels

Error	Group	Odds ratio	Comment
Initial consonants	Mainstream	0.697	The relative risk of making an initial blend error is almost twice as likely among the remedial learners than among mainstream learners
	Remedial	1.303	
	Total	1.869	
Initial blends or clusters	Mainstream	0.295	The relative risk of making an initial blend/cluster error is more than 7 times as high among the remedial learners than among mainstream learners
	Remedial	2.164	
	Total	7.346^(*)	
Medial vowel	Mainstream	0.318	The relative risk of making a medial vowel error is almost 6 times as high among the remedial learners than among mainstream learners
	Remedial	1.839	
	Total	5.788^(*)	
Ending blend or cluster	Mainstream	0.238	The relative risk of making an ending blend error is more than 6 times as high among the remedial learners than among mainstream learners
	Remedial	1.518	
	Total	6.392^(*)	
Long and short vowel confusion	Mainstream	0.563	The relative risk of making a long/short vowel confusion error is more than 3 times as high among the remedial learners than among mainstream learners
	Remedial	1.728	
	Total	3.066^(*)	
Consonant/sound confusion	Mainstream	0.302	The relative risk of making a consonant sound confusion error is more than 15 times as high among the remedial learners than among mainstream learners
	Remedial	4.805	
	Total	15.892^(*)	
Reversals/transposals	Mainstream	0.403	The relative risk of making a reversal error is more than 12 times as high among the remedial learners than among mainstream learners
	Remedial	5.179	
	Total	12.851^(*)	
Other	Mainstream	.315	The relative risk of making an 'other error' is more than 15 times as high among the remedial learners than among mainstream learners, implying that remedial learners are more likely to make spelling errors which do not fall into the above categories.
	Remedial	4.769	
	Total	15.157^(*)	

^(*) Significant at 0.05 level

Therefore, for mainstream learners the odds of making an initial consonant error was 0.768. The odds of making the same error by the remedial group was 1.434. The ratio of these two odds are called an odds ratio. For error 1 then, we have an odds ratio of: $1.434/0.768 = 1.867$. In other words, the relative risk of making an initial blend error is almost twice as likely among the remedial learners than among mainstream learners. However, this was not statistically significant at the 0.05 level.

In the remaining error types revealed even higher odds ratio scores, and all were found to be statistically significant. Thus for initial blends or clusters, medial

vowels and ending blends or clusters, the odds ratio tests were between 5.785 and 7.348, while for sound or consonant confusion, reversals or transposals and other it was above 12. This suggests that remedial learners make the same types of errors as mainstream learners but the probability of making the error is generally higher among remedial learners than for mainstream learners, especially in terms of consonant sound confusion and reversals and/or transposals.

5.3.2.2 *Frequency of errors by grade levels*

It is important to compare the frequency of errors made by both groups by grade levels. This is because Level One of the Phonic Inventories were directed mainly for the lower grades where less difficult or complex words are included. At the descriptive level the data in appendix K provides the frequency score for each of the error types in Level One of the test.

Since Level One of the Phonic Inventories was directed mainly for the lower grades where less difficult or complex words are included, the expectation is that the higher grades will do significantly better than the lower grades on Level One. An analysis of the frequency of errors by grade revealed that in the mainstream group the frequency of errors increased from grade 3 to 4, then dropped in grade 5 and then remained at more or less the same level in grade 6 and 7, except for errors with long and short vowels (error 7) and initial consonants (error 1) where the frequency shot up in grade 7. Generally grade 4 learners in the mainstream group made the most amount of errors while grades 5 and 6 made the least. With the exception of error 5, the remedial group showed less variation as one progressed up the grade levels.

Generally, the data suggest, to some degree, that more errors are made in the early stages of primary school than in the later stages of primary school. Therefore, the sum of the frequency of errors in grades 3 and 4 in the

mainstream group was more than the sum of the frequency of errors made in grades 5, 6 and 7. The same was evident in the remedial group. The One Way ANOVA discussed in the previous section also suggests that this may be the case for each of the levels overall, i.e., the test score increased as the grade levels went up. By implication this means that there were less errors made by learners in the higher grades than in the lower grades.

5.3.3 Level Two

Table 20 below tabulates the frequency of errors made on Level Two of the Phonic Inventories.

Table 20: Comparisons between mainstream and remedial group learners of frequency of errors on Level Two the Phonic Inventories across grade levels (reflected as a % of the total number of errors on Level Two)

Error	Mainstream	Remedial	Ratio	Odds Ratio	95% Confidence Interval	
					Lower	Upper
Initial consonants	0.0%	0.1%	-	-	-	-
Initial blends or clusters	0.5%	1.2%	2.6	4.971 ^(*)	2.485	9.947
Medial vowel	0.4%	1.7%	4.1	8.039 ^(*)	4.034	16.020
Medial vowel digraph	19.6%	26.0%	1.3	8.104 ^(*)	3.412	19.248
Ending consonants	0.0%	0.2%	5.0	9.535 ^(*)	1.102	82.478
Ending blend or cluster	4.0%	5.2%	1.3	4.431 ^(*)	2.796	7.021
Long and short vowel confusion	1.5%	2.6%	1.7	.744	.455	1.217
Consonant/sound confusion	6.7%	8.6%	1.3	3.785 ^(*)	2.228	6.432
Reversals/transposals	0.3%	0.9%	3.3	7.047 ^(*)	2.755	18.204
Errors with suffixes	0.5%	1.6%	3.4	6.822 ^(*)	3.659	12.721
Other	7.5%	11.3%	1.5	6.063 ^(*)	3.351	10.972

^(*) Significant at 0.05 level since the CI does not include 1

The frequency statistics (non-shaded columns in table 20) shows that learners in both the mainstream and remedial group made the highest number of errors with 'medial vowel digraphs' on Level Two of the Phonic Inventories. The mainstream group attained a frequency rate of 19.6%. The remedial group, with the frequency rate of 26.0% was 1.3 as likely as the mainstream group to make this

type of error. The frequency of errors on the ending blends/clusters (which was the most frequent error identified in Level One) diminished in this level in comparison to Level One, but still remains one of the high frequency errors. Moreover, the remedial group continues to be 1.3 times as likely to make this type of error than the mainstream group.

The Spearman's rho coefficient of 0.959 showed that there was a strong positive correlation between the errors made by mainstream and remedial learners on Level Two of the Phonic Inventories. This correlation was significant at the 0.01 level. This suggests that the order of errors made on Level Two of the Phonic Inventories by mainstream learners was the same as those made by learners in the remedial group.

In terms of the magnitude of errors made, the odds ratio test (as reflected by the shaded columns in table 20) suggest that the remedial group may be more vulnerable to making errors with ending consonants (9.5 times more likely), medial vowels and medial vowel diagraphs (8 times more likely on both error types), reversals or transposals (7 times more likely) and errors with suffices (6.8 times as likely). Also, the frequency of errors on medial vowels has also diminished in comparison to Level One in both groups however the odds ratio has shot by from 5.8 in Level One to 8.0 in Level Two. This suggests that the probability of learners with learning difficulties making this error on Level Two of the Phonic Inventories was significantly higher than learners without learning difficulties, while in the mainstream group this likelihood dropped.

Table 21: Odds ratio statistics on Level Two of the Phonic Inventories across grade levels

Error	Group	Odds ratio	Comment
Initial blends or clusters	Mainstream	0.448	The relative risk of making an initial blends or cluster error is almost 5 times as high among the remedial learners than among mainstream learners
	Remedial	2.229	
	Total	4.971^(*)	
Medial vowel	Mainstream	0.376	The relative risk of making a medial vowel error is more than 8 times as high among the remedial learners than among mainstream learners
	Remedial	3.027	
	Total	8.039^(*)	
Medial vowel digraphs	Mainstream	.194	The relative risk of making a medial vowel digraph error is more than 8 times as high among the remedial learners than among mainstream learners
	Remedial	1.576	
	Total	8.104^(*)	
Ending consonants	Mainstream	.413	The relative risk of making an ending consonant error is more than 9 times as high among the remedial learners than among mainstream learners
	Remedial	3.936	
	Total	9.535^(*)	
Ending blend or cluster	Mainstream	0.373	The relative risk of making an ending blend or cluster error is more than 4 times as high among the remedial learners than among mainstream learners
	Remedial	1.653	
	Total	4.431^(*)	
Long and short vowel confusion	Mainstream	1.217	The relative risk of making a long and short vowel error is 0.7 times less likely among the remedial learners than among mainstream learners
	Remedial	.906	
	Total	.744	
Consonant/sound confusion	Mainstream	0.390	The relative risk of making a consonant / sound confusion error is more than 3 times as high among the remedial learners than among mainstream learners
	Remedial	1.476	
	Total	3.785^(*)	
Reversals/transposals	Mainstream	0.417	The relative risk of making a reversal error is more than 7 times as high among the remedial learners than among mainstream learners
	Remedial	2.942	
	Total	7.047^(*)	
Errors with suffixes	Mainstream	0.388	The relative risk of making an error with suffixes is more than 6 times as high among the remedial learners than among mainstream learners
	Remedial	2.645	
	Total	6.822^(*)	
Other	Mainstream	0.388	The relative risk of making an 'other error' is more than 6 times as high among the remedial learners than among mainstream learners, implying that remedial learners are more likely to make spelling errors which do not fall into the above categories.
	Remedial	2.645	
	Total	6.822^(*)	

^(*) Significant at 0.05 level

These results again show that that there was a high incidence of spelling errors of particular types of errors made by children in the remedial group on Level Two of the Phonic Inventories. Mainstream learners appear to have made the same kinds of errors but at a significantly lower rate.

5.3.3.1 *Frequency of errors by grade levels*

Level Two of the Phonic Inventories was designed mainly for grades 2 and up and was more difficult than Level One (Potter, 2001). At the descriptive level the data in appendix L, shows that the medial vowel digraph error was made the most frequently by learners in both mainstream and remedial groups across all grade levels. This was followed by errors in the 'other' category, then consonant sound confusion, long and short vowel confusion and ending blend errors. This order was the same in each of the grades and groups.

As with Level One, the data suggest, to some degree, that more errors were made in the early stages of primary school than in the later stages of primary school. Therefore, the sum of the frequency of errors in grades 3 and 4 in both the mainstream and remedial groups was more than the sum of the frequency of errors made in grades 5, 6 and 7. The One Way ANOVA discussed in the previous section again suggest that this may be the case for each of the levels overall, i.e., the test score increased as the grade levels increase.

5.3.4 Level Three

Table 22 below tabulates the frequency of errors made on Level Three of the Phonic Inventories. For this level, grade 3 learners were excluded from this analysis as data were only available for one grade 3 learner in the remedial group.

Table 22: Comparisons between mainstream and remedial group learners of frequency of errors on Level Three the Phonic Inventories across grade levels (reflected as a % of the total number of errors on Level Three)

Error	Mainstream	Remedial	Ratio	Odds Ratio	95% Confidence Interval	
					Lower	Upper
Initial blends or clusters	1.0%	1.1%	1.1	3.508 ^(*)	1.229	10.011
Medial vowel	7.4%	8.5%	1.1	5.469 ^(*)	2.682	11.150
Medial vowel digraph	0.2%	0.5%	2.8	1.071	.277	4.141
Ending consonants	0.6%	0.5%	0.8	2.338 ^(*)	1.054	5.187
Ending blend or cluster	6.2%	8.7%	1.4	3.486 ^(*)	2.048	5.935
Long and short vowel confusion	1.5%	0.1%	0.1	.208 ^(*)	.062	.695
Consonant/sound confusion	0.4%	1.9%	4.3	13.892 ^(*)	4.984	38.719
Reversals/transposals	0.0%	0.1%	-	-	-	-
Errors with prefixes	0.0%	0.2%	-	-	-	-
Errors with suffixes	6.4%	14.6%	2.3	1.878 ^(*)	1.095	3.222
Syllabication errors	7.6%	16.2%	2.1	1.275	.714	2.278
Other	2.3%	3.7%	1.6	1.809 ^(*)	1.073	3.050

^(*) Significant at 0.05 level since the CI does not include 1

The frequency statistics shows that learners in both the mainstream and remedial group made the highest number of errors on four types of errors on Level Three of the Phonic Inventories: syllabication, suffixes, ending blends/clusters and medial vowels. As with the previous levels, the remedial group was more prone to making these errors than the mainstream learners. None of the groups made errors on initial consonant sounds. Interestingly, the mainstream group made more errors on long and short vowel than did remedial learners. The reason for this is not clear.

The Spearman's rho of 0.906 again shows that there was a positive and strong correlation between the order of errors made the mainstream group and the remedial group. Put differently, the same kinds of errors are being made in the same order by learners in the mainstream and remedial groups. This correlation was significant at a 0.01 level.

In relation to how much more remedial learners are vulnerable to making these errors on Level Three of the Phonic Inventories, the odds ratio test show that the

probability of making errors on consonant / sounds is almost 14 times as high among learners in remedial learners than by learners in mainstream group. The probability of making errors in medial vowels and long and short vowels is about five times higher among remedial learners than in mainstream learners.

Table 23: Odds ratio statistics on Level Three of the Phonic Inventories across grade levels

Error	Group	Odds ratio	Comment
Initial blends or clusters	Mainstream	0.461	The relative risk of making an initial blend or cluster error is more than 3 times as high among the remedial learners than among mainstream learners
	Remedial	1.616	
	Total	3.508	
Medial vowel	Mainstream	0.257	The relative risk of making a medial vowel error is more than 5 times as high among the remedial learners than among mainstream learners
	Remedial	1.406	
	Total	5.469^(*)	
Medial vowel digraphs	Mainstream	.951	The relative risk of making an error 4 error is 1.02 times as high among the remedial learners than among mainstream learners
	Remedial	1.019	
	Total	1.071	
Ending consonants	Mainstream	0.567	The relative risk of making a medial vowel digraph error is more than 2 times as high among the remedial learners than among mainstream learners
	Remedial	1.325	
	Total	2.338^(*)	
Ending blend or cluster	Mainstream	.414	The relative risk of making an ending blend or cluster error is more than 3 times as high among the remedial learners than among mainstream learners
	Remedial	1.442	
	Total	3.486^(*)	
Long and short vowel confusion	Mainstream	3.721	The relative risk of making a long and short vowel confusion error is more than 0.2 times less likely among the remedial learners than among mainstream learners
	Remedial	.773	
	Total	.208^(*)	
Consonant/sound confusion	Mainstream	.271	The relative risk of making a consonant/sound confusion error is more than 13 times as high among the remedial learners than among mainstream learners
	Remedial	3.769	
	Total	13.892^(*)	
Errors with suffixes	Mainstream	.622	The relative risk of making a suffix error is almost 2 times as high among the remedial learners than among mainstream learners
	Remedial	1.169	
	Total	1.878^(*)	
Syllabication errors	Mainstream	.833	The relative risk of making a syllabication error is 1.3 times as high among the remedial learners than among mainstream learners
	Remedial	1.063	
	Total	1.275	
Other	Mainstream	.651	The relative risk of making an 'other error' is 1.8 times as high among the remedial learners than among mainstream learners, implying that remedial learners are more likely to make spelling errors which do not fall into the above categories.
	Remedial	1.177	
	Total	1.809^(*)	

^(*) Significant at 0.05 level

In this level of the Phonic Inventories, the statistics support the conclusions of Level One and Two which states that both groups make the same kinds of errors but the frequency is higher among remedial learners.

5.3.4.1 Frequency of errors by grade levels

Level Three of the Phonic Inventories was the most difficult and was designed for use with learners in grade 3 or higher (Potter, 2001). It was thus used for these grade levels in this study. The descriptive statistics in appendix M show that grade 4 learners in the mainstream group made the most errors with medial vowels. From grade 5 up to grade 6, mainstream learners made the most errors with syllabication followed by medial vowel errors, ending blends and suffix errors. In grade 7, syllabication and suffix errors were the most frequently occurring error and medial vowels and ending blend or cluster errors was less so.

The remedial group also had the most errors in suffixes, syllabication as well as with medial vowels and ending blends. However, in comparison to the mainstream group the magnitude of errors made by the remedial learners was substantially larger than the mainstream group. Although not the most frequently occurring error at the grade 4 level, learners in the remedial group at this level were also ten times more likely to make errors on initial blends or clusters than mainstream learners. In grade 5, the frequency of errors with these error categories diminished both in terms of actual frequency percentages and ratios. Ending blends or cluster errors was also made much more frequently by grade 4 remedial learners. Reversals and transposals were consistently evident in grades 5 and 6 in the remedial group. The same was not true of mainstream learners.

Generally, the same kinds of errors were made in more or less the same order in each of the grades but the magnitude of errors made by the remedial group was larger than the mainstream group.

In terms of the logic used in constructing Level Three of the test, the doubling rule after a short vowel was used as the basis for testing the ability to add to and build out from a root word. The fact that both remedial and mainstream learners had difficulty with this was expected more in the early stages of primary school, as this is a higher order spelling skill which may not have been taught and learned before Grade Four. Unfortunately, since data from Grades 2 and 3 were excluded from the analysis in this section, the researcher is unable to state with certainty whether this is the case.

Once again one must bear in mind that this level of the test had a high level of reliability, so it would appear to be measuring one thing and measuring it well.

5.3.5 Comparison of frequency of errors between 1979 and 2001 datasets

As mentioned previously, the Phonic Inventories were developed on the basis of two pilot studies. The first involved a pilot study conducted in 1978 with 16 learners in a combined grade 4/5 classroom at Crossroads remedial school in Johannesburg. This was a mixed gender sample consisting of children who had all been through the school's multi-disciplinary assessment process, and had each been diagnosed as learning disabled, and requiring full-time remedial education.

Professor Potter was at this stage in his career the class teacher as well as supervisor of the educational programmes of each of these children. The first two levels of the Phonic Inventories were developed for use with this class, as a way of providing detailed diagnostic information on the alphabet knowledge and phonological/phonic skills of each of the children.

The aim of remedial intervention was to attempt to assure equivalence between the spelling development of the remedial learners relative to children in equivalent mainstream classes. For this reason, the post-test scores of the

remedial sample were compared with two mixed gender samples of learners from Emmarentia Primary school in 1978, using data obtained by the remedial/learning support teacher at the school. Each of the learners in the comparison samples was in a mainstream class, following a normal government school programme at either grade 4 or grade 5 levels.

Certain of the children in the mainstream sample were found to be weak in spelling. This information was thus used as an indicator of possible learning difficulties, and the children were then drawn into remedial programmes organised by the class teachers and the remedial/learning support teacher.

In 1979, a second pilot study was conducted. The Phonic Inventories were administered to a group of children in grades 2 to 7 involved in fulltime remedial education at Norwood remedial school in Johannesburg (N = 74). A third level of the Phonic Inventories was developed for use with this sample, as a way of providing detailed diagnostic information on the advanced phonological/phonics skills and the syllabification skills of each of the children.

The post-test scores of this sample were then compared with a mixed gender stratified sample of learners from Emmarentia Primary school (N = 207), drawn from grades 2 to 7, using data obtained by the class teachers and the remedial/learning support teacher at the school. Following the second pilot study, Level Three of the Phonic Inventories was revised. It was then further revised during fifteen years of clinical use. The form of the third level of the Phonic Inventories subsequently used for this current study and by Grasko in 2004 (see Grasko, 2005) was thus substantially different to that used in the 1979 pilot study.

The form of the first two levels, however, remained very similar. Minor modifications were made to the first two levels after the second pilot study, as well as over the fifteen year period they were used clinically. These changes

involved the substitution of homophonic words where it was evident that a number of children were not familiar with a particular word. Where this was found to be the case, more familiar words with similar rimes were substituted (e.g. tame substituted for blame; beer substituted for deer).

Given changes in the instruments over time, it was necessary not only to check the diagnostic ability of the Phonic Inventories at all levels, but also to establish whether the profiles of errors made by learners with learning disabilities in 1979⁴⁵ were similar to profiles of errors made by learners with learning disabilities in 2001. Profiles of learners in the mainstream in 1979 were also compared to the 2001 dataset to determine whether similar patterns of errors were evident.

These findings are presented in the next section.

5.3.5.1 Comparison of frequency of errors across grade levels

Unlike the analysis presented for the 2001 study which looked at each level of the Phonic Inventories separately (see Sections 5.3.2, 5.3.3 and 5.3.4), the comparison of frequency of error types across grade levels in this section was for the Phonic Inventories as a whole i.e., the total number of errors made on a specific error type for Levels One, Two and Three combined.

⁴⁵ The 1978 dataset was not used as Level Three was not yet established.

Table 24: Comparison of frequency of errors across grade levels for the 1979 and the 2001 datasets

Error	1979		2001	
	Mainstream	Remedial	Mainstream	Remedial
Initial consonants	1.4%	2.7%	0.6%	0.5%
Initial blends	10.0%	15.3%	3.6%	7.7%
Medial vowel	3.7%	9.8%	12.2%	11.1%
Medial vowel digraphs	39.6%	34.3%	19.1%	15.2%
Ending consonants	2.1%	3.1%	0.5%	0.3%
Ending blends	32.4%	25.6%	33.4%	28.6%
Reversals	1.4%	1.6%	1.8%	2.4%
Vowel confusion	0.8%	0.8%	7.4%	7.6%
Consonant/sound confusion	0.3%	0.3%	0.3%	0.7%
Prefix errors	0.6%	0.4%	0.0%	0.1%
Suffix errors	2.8%	2.5%	5.5%	7.8%
Syllabification	4.9%	3.5%	6.0%	7.8%
Other	-	-	9.6%	10.2%

In the 1979 dataset, the most frequently occurring errors in both the mainstream and remedial group were medial vowel digraphs and ending blends. Initial blend and medial vowel errors were also evident in both groups in the 1979 dataset. The 2001 dataset showed similar patterns across the grade levels in both the mainstream and remedial group – ending blend, medial vowel digraph and medial vowel errors were most commonly observed in the 2001 dataset.

Interestingly, the remedial group of 2001 made slightly less initial consonant errors than the mainstream group. The same was not observed in the 1979 dataset. This may be explained by the presence of a coding error.

However, it should be noted that Level Three was substantially revised after the 1979 pilot, which may have influenced the results, the extent of this was not determinable from the 1979 dataset provided to the researcher. Also, the Phonic Inventories were administered to different set of schools in the different studies. An alternative explanation may be due to the historical context in which the tests were administered. Thus, in 1979 all the learners who were tested were white and were taught in English, which was probably the learners' first language (or

home language) in the majority of cases. In 2001, 22 years after the second pilot and 15 years after apartheid, the home language of learners was not necessarily English which meant that they were being taught in language not spoken at home. Nevertheless, the table above shows that there are cross validated trends between the 1979 and the 2001 datasets.

To check whether the two independent samples (1979 and 2001) were statistically significant, a Mann-Whitney test was run. The statistics revealed that there were no statistically significant differences between the two groups as large significance values (>0.05) emerged ($p=0.786$ for the mainstream 1979 and 2001 dataset and $p=0.957$ for the remedial 1979 and 2001 dataset). In other words, the same kinds of errors were being made in both the 1979 and 2001 datasets.

To check how strongly the two datasets were linked a Spearman correlation was run for the separate groups: mainstream and remedial. A positive correlation coefficient of 0.748 was found for the mainstream group in 1979 and 2001. A slightly lower correlation coefficient of 0.713 was observed for the 1979 and 2001 remedial group. Since 0.748 and 0.713 are relatively close to 1, this indicates that the frequency of errors made by the mainstream and remedial group respectively in 1979 and frequency of errors made by the mainstream and remedial group respectively in 2001 were fairly strongly and positively correlated. In both cases, the correlation coefficient was statistically significant at the 0.01 level, which suggests that the correlation was significant and the two variables (1979 and 2001) were linearly related.

These analyses therefore suggest that the overall trends in both the mainstream and remedial groups in 1979 and 2001 are convergent, indicating that the types of errors made in the Phonic Inventories have been stable over time. In addition, it would appear that the instrument is able to pick up the same kinds of errors in both the mainstream and remedial groups at two different points in time. This would suggest that the instrument has long term validity, based on the apparent

similarity between the profiles of high number of errors in similar error categories, as well as the high correlations shown above.

CHAPTER 6

DISCUSSION

6.1 Introduction

Like reading, spelling is a written language skill that draws upon an individual's repertoire of linguistic knowledge, including phonological awareness, and knowledge of orthography, vocabulary, morphological and semantic relationships; and mental orthographic images (Apel & Masterson, 2001; Apel, Masterson, & Niessen, 2004). Each of these areas of linguistic or "word study" knowledge contributes to spelling success (Treiman & Bourassa, 2000) and a deficit in any one of these areas of word study knowledge will manifest as a specific pattern of misspelling. Accordingly, the analysis of an individual's spelling errors can be used to identify underlying linguistic deficits.

In Chapter 3, a literature review revealed that a number of skills are important to spell:

- **Phonological Awareness:** Individuals rely upon the phonological awareness skills of phoneme segmentation, sequencing, discrimination, and identification during the spelling or "encoding" process. They use phonological segmentation skills when spelling by breaking down words into smaller units such as syllables and phonemes then linking these smaller units to their written forms. Individuals also use sound sequencing skills to map the letters to sounds in the correct order and they use phoneme discrimination and identification skills to perceive differences between speech sounds (e.g., between the short vowel e and short vowel i sounds) and to recognize that a difference in sound signals a difference in meaning.

- **Orthographic Knowledge:** Individuals also draw upon their orthographic knowledge during the encoding process. Specifically, individuals draw upon their knowledge of sound-letter relationships and knowledge of letter patterns and conventional spelling rules to convert spoken language to written form (Ehri, 2000; Treiman & Bourassa, 2000). Orthographic knowledge includes knowledge of specific letter-sound relationships (e.g., the / k /sound can be represented by the letters c, k, ck, cc, lk, ch, que); knowing which letter patterns are acceptable (e.g., the / k /sound is almost always spelled with the letter k at the end of a word after a long vowel sound); and understanding sound, syllable, and word position constraints on spelling patterns (e.g., the / k /sound at the beginning of a word is never spelled with the letters ck, cc, lk).
- **Vocabulary:** Individuals use vocabulary knowledge to accurately store and retrieve the correct spelling of words. The knowledge of word meaning is particularly important for the correct spelling of homophone words (e.g., flour and flower). Vocabulary knowledge is also helpful to correctly spell the wh consonant digraph because the / w / sound at the beginning of question words (e.g. when) is always spelled with the letters wh.
- **Morphological Knowledge & Semantic Relationships:** Individuals also rely upon their morphological knowledge and knowledge of semantic relationships when spelling inflected or derived forms of words (Carlisle, 1995). Specifically, individuals rely upon their knowledge of letter-meaning relationships of individual morphemes (i.e., suffixes, prefixes, base words, and word roots), their understanding of semantic relationships between a base word and related words, and their knowledge of modification rules when adding prefixes and suffixes.

Inflected words contain suffixes that provide information about time or quantity without changing the meaning or class of the words (e.g., play played; chimp chimps). Derived words contain affixes (prefixes or suffixes) that change the meaning and sometimes the class of words (e.g., play–playful; strong–strongly). When an individual is required to spell an unfamiliar word (e.g., remarkable), knowledge of the base word (i.e., remark) and certain word endings (e.g., -able) can help the student spell the unfamiliar word correctly. An individual draws upon knowledge of rules for modifying base words to correctly spell inflected and derived forms of words. Individuals also draw upon knowledge of semantic relationships and rules for modifying words to spell irregular plural nouns, irregular past-tense verbs, contractions, and possessive nouns. Knowledge of word parts and related words becomes increasingly important as individuals begin to spell words of greater length and complexity.

- **Mental Orthographic Images:** Individuals need to develop clear and complete mental representations of previously read words. These mental images of words, also known as mental orthographic images (MOIs), are stored in an individual's long-term memory after repeated exposure to them in print (Ehri & Wilce, 1982; Glenn & Hurley, 1993). Inadequate MOIs are often formed when individuals use inappropriate reading strategies such as partial cue analysis, a process whereby the student guesses the identity of a word after decoding only the first letter(s) of the word. Clearly and completely developed MOIs allow individuals to quickly recall and correctly spell words and word parts. Individuals must rely upon the mental image of a word when phonological awareness and knowledge of orthography, vocabulary, word parts, and related words are not sufficient to correctly spell a spelling pattern within a word (e.g., dear not dere, hurt not hert, spare not spair).

Both children (and adults) use these different types of language knowledge

throughout spelling development (Treiman & Bourassa, 2000). The amount that each area contributes to spelling development differs depending on an individual's literacy experiences and the complexity of the words needing to be spelled. Initially, phonological awareness skills play a large role in early spelling development, yet other linguistic knowledge, such as orthographic knowledge and rudimentary morphological knowledge, may also be contributing factors (Treiman & Bourassa, 2000). With additional experiences and learning, spelling development may be positively affected through a deeper understanding and increased use of orthographic, morphological, and semantic knowledge and a larger number of clear mental orthographic images. At any point in spelling development, an individual's spelling reflects his or her linguistic knowledge and literary capabilities at that moment in time. Accordingly, an individual's misspellings are the "window" to underlying linguistic deficits.

It is possible to identify an individual's linguistic deficits through spelling error analysis because a specific pattern of misspelling is associated with each specific type of linguistic deficit (Potter, 2001; Potter, Grasko, Pereira, 2006; Wasowicz, 2007). Analyses of an individual's spelling errors can reveal underlying deficits in phonological awareness, and in knowledge of orthography, vocabulary, morphological and semantic relationships, and mental orthographic images.

The Phonic Inventories were established for this exact reason: to aid teachers in identifying any linguistic deficits or weakness through a three level spelling test to determine which alphabetic rules the learner has or has not acquired with the aim of establishing the rule system used by the learner in reading and writing. The analysis of errors made on the instrument can provide insight into the learner's own rule system, which can then form the basis for targeting additional alphabetic rules.

The main purpose of this study was to investigate how reliable and valid the Phonic Inventories were and to determine whether it was an effective tool for discriminating between learners with and without learning difficulties. The remainder of this chapter will now look at each of the research questions separately and provide evidence to confirm and disconfirm the hypotheses put forward.

6.1.1 Revisiting the research questions

6.1.1.1 How reliable are the three levels of the Phonic Inventories as a screening tool when used in full-time remedial and mainstream classrooms?

This question addressed the psychometric properties of the three levels of the Phonic Inventories. This was done by examining the overall reliability of the tests using the 2001 dataset. This was checked by looking at two types of reliability: internal consistency and split half reliability. The overall reliability of Level One, Two and Three as indicated by Cronbach's Alpha coefficient was 0.937, 0.914 and 0.905, respectively. The literature on item analyses (see Gronlund, 1998) suggests that for an item to be considered part of a "good scale" that an alpha of .80 should be achieved. Given that the coefficient were above 0.9 in all three levels, this shows that each level of the test (and by implication the test overall) does in indeed have good reliability. This was verified by checking the split half reliability coefficients (i.e., correlation between forms coefficient, Spearman Brown coefficient and Guttman Split Half coefficients), which all revealed coefficients of above .80 for Levels One and Two and above 0.70 for Level Three. Therefore, these statistics suggest that the three levels of the Phonic Inventories are indeed reliable.

Apart from looking at the overall reliability of the test, the aim of the psychometric analyses was to analyse the items and to report on the analysis. The main

purpose of an item analysis is to explore the “performance” of the items as building blocks of the instrument, i.e. to identify which items are “good” in the sense that they make a contribution to the overall test and which items are “poor” in the sense that they do not make a positive contribution to the test. In Classical Test Theory, the two main statistics that are computed are the item difficulty and the item discrimination index.

In terms of *item difficulty*, which indicates what proportion of learners answered the item correct, item means (or difficulty values) for each of the items in the three tests revealed that almost all the items in Level One, Two and Three were easy to very easy. However, there were also a few items which learners in found to be difficult as well. Generally a spread of items across difficulty levels is ideal but it should be noted that the test was not designed to be an ability test. Instead it is an assessment tool. Therefore, too many difficult items would have defeated the original purpose of the instrument.

The item discrimination index basically indicates whether the learners who scored high overall answered the item correct while the learners who scored low overall answered the item incorrect. The item total correlation statistics (or discrimination value/index) showed that for each of the levels, majority of items attained discrimination values of above 0.2. This suggests that on the whole, the tests may be discriminating between good and poor performing learners across the difficulty levels.

Using these statistics, the researcher was also able to highlight problematic items for each of the levels. A total of 20 items (two in Level One, 7 in Level Two and 11 in Level Three) appeared to be very easy and did not add value in terms of discriminating between good and poor performers (discrimination values of less than .20 were revealed). When excluded it did not have a significant impact on the overall reliability of the test. The decision on whether to include or exclude them needs to be considered. For Levels One and Two, it would mean that the

tests would be shorter which means less time would be spent on administering the test. For Level Three however, because the test was designed and structured with word families, it makes little sense to remove them, except with the post word family where all words associated with the root word 'post' was too easy and had low discrimination levels. However, there is merit in leaving these items in: it may make learners who are writing the test more confident and comfortable with continuing with the test

Overall, the three levels of the Phonic Inventories have good reliability statistics. Thus, hypothesis one is verified.

The second hypothesis was that the three tests which make up the Phonic Inventories show demonstrable long term stability as evidenced by similar results and patterns of errors in both the 1979 and 2001 datasets.

This was done by comparing the frequency of error types across grades levels for the Phonic Inventories as a whole (i.e., the total number of errors made on a specific error type for Levels One, Two and Three combined). The analyses was not done for each level because the 1979 study did not split the data into the three levels. Thus, in the 1979 dataset, the most frequently occurring errors in both the mainstream and remedial group were in medial vowel digraphs, ending blends, initial blends and medial vowels. The 2001 dataset revealed similar patterns across the grade levels in both the mainstream and remedial group – ending blends, medial vowel digraphs and medial vowel errors were the most commonly observed errors made in the 2001 dataset. A Mann Whitney test revealed that there were no statistically significant differences between the two groups as large significance values were observed. This suggests that the same kind of errors were being made in both the 1979 and 2001 datasets. Grasko's study of 2004 also revealed that ending blend errors, initial blend errors, medial vowels, medial vowel digraph were the prominent type of errors made in Level One and Two and to some extent in Level Three. Therefore, because similar

patterns of errors were found in three separate datasets at three different points in time which used the Phonic Inventories (1979, 2001 and 2004), there is evidence to suggest that there is stability over time. This suggests that the Phonic Inventories have convergent validity. Therefore hypothesis two is also confirmed.

6.1.1.2 *Are there particular types of spelling errors made by children in full-time remedial classrooms, as opposed to children in mainstream classrooms?*

This question addressed the issue of whether the test is potentially able to discriminate well between children who have been previously diagnosed as learning disabled and children in mainstream programmes, as a basis for establishing its validity (particularly content, construct and concurrent validity). This was checked by comparing learner performance scores for the 2001 remedial and mainstream groups.

The descriptive statistics revealed that the mainstream group performed significantly better than the remedial group in each of the three levels of the Phonic Inventories. While most of the learners in the mainstream group performed in the 77 to 98% bracket, learners in the remedial group achieved scores within the 44 and 86% bracket. This was expected as the remedial group was comprised of learners already diagnosed as having a learning difficulty. A Mann Whitney test was run and revealed that the differences between the mean percentage scores of the two groups were statistically significant.

However, the question on whether the test was able to discriminate between children who have been previously diagnosed as learning disabled and children in mainstream programmes was answered by comparing the percentage scores of the 25th and 75th quartile. Thus for Level One, the percentage score of the person in the 25th quartile in the mainstream group was substantially higher than

for the person at the 25th position in the remedial group (86% versus 59%). The percentage score of the person in the 75th quartile in the mainstream group was 98% while it was 86% for the remedial group. A similar pattern was evident for the remaining two levels of the Phonic Inventories. Additionally, the median percentage score for the remedial group was lower than the first quartile of the mainstream group at all three levels. This logic was again followed but only using the difficult to very difficult items on each level of the test. The statistics revealed that learners achieving mean scores in the third quartile were able to correctly answer all these difficult and very difficult items whilst learners who performed in the first quartile could not. This suggests that the Phonic Inventories were able to discriminate between mainstream and remedial learners at least in the first and last quartiles.

However, this is not enough to establish the discriminatory power of the test. Therefore, an examination of the frequency of errors on the 13 error types made by learners in both groups was undertaken for each level of the Phonic Inventories separately.

The frequency statistics revealed that learners in both the mainstream and remedial group make the highest number of errors with 'ending blends' on Level One. Notable frequencies were also recorded for medial vowel errors and initial blends or clusters. Grasko's research revealed almost identical findings: the most proportionally common error type in Level One was ending blends followed by initial blend errors and then medial vowels (Grasko, 2005). Both studies show that mainstream and remedial learners make the same kinds of errors on Level One. A Spearman's rho correlation of 0.946 shows that the errors made by remedial and mainstream learners were positively correlated and that the order of errors made by mainstream learners were the same as those made by the remedial learners. However, although the frequency statistics showed that the same kinds of errors are made by learners regardless of their group, the frequency of errors made by the remedial group was significantly more than the

mainstream group and that this pattern continued up the grade levels. Therefore the odds of making an error on ending blends, medial vowel and initial blends was higher about 6 or 7 times more likely by a learner in the remedial group (or a learner who is experiencing a learning difficulty). Although not a frequently occurring error, the odds of a learner in the remedial group making consonant / sound confusion errors, reversals / transposals and other errors was more than 11 times more likely than the mainstream group.

For Level Two, the most frequently occurring error in either the mainstream or remedial group was in the medial vowel digraph error type. The second highest scoring error type in either the groups was in consonant / sound confusion error type. The frequency of errors made in ending blends decreased in comparison to Level One but continued to be a high scoring problem area in both groups. There was also a high number of errors recorded in the 'other' category. These results support the findings from Grasko (2005) where the most common error types were medial vowel digraphs, ending blends, medial vowels and the other error type. Again, Spearman's rho showed that the order of errors made on Level Two of the Phonic Inventories by mainstream learners was the same as those made by the learners in the remedial group. However, the odds of a remedial learner making these errors was significantly higher than the mainstream group, particularly with ending consonants, medial vowels, medial vowel digraphs, reversals / transposals or suffix errors.

In terms of Level Three, the most frequently occurring error type in both groups was in syllabication, suffixes, ending blends and medial vowels. Errors in the former two error types are perhaps indicative of a problem or unfamiliarity with compound words. Grasko's research also showed higher incidence of syllabication and suffix errors (Grasko, 2005). The order of errors made at this level was the same for mainstream and remedial learners (as indicated by Spearman's rho of 0.906). As with previous levels, the remedial group was more prone to making these errors than were the mainstream learners. However,

according to odds ratio test, remedial learners were the most vulnerable to making consonant / sound confusion errors (almost 14 times more likely).

It was hypothesized that learners in mainstream schools and remedial schools would make the same types of errors of each of the three levels of the Phonic Inventories but the frequency of children in full-time remedial education is significantly more than children in full-time mainstream education. Given the results discussed above, this hypothesis is confirmed.

It is argued therefore that based on the evidence presented so far, all of which is supported by Grasko's research, the three levels of the Phonic Inventories have good discriminatory power between the remedial and mainstream learners. This may also be an indicator that the Phonic Inventories may have some degree of concurrent validity – and that they can be used for distinguishing remedial learners from a pool of mainstream learners. The instrument would thus appear to have potential for use in classrooms as a screening instrument.

It should be noted however, that there is a possibility that the mainstream sample was not a 'pure' sample in that it may have contained unidentified 'remedial' children. Given the statistically significant differences in the performance of children from mainstream and remedial schools, additional research would be valuable in which the Phonic Inventories are applied with other instruments to establish if it is able to identify those children in a group situation who have learning difficulties. Additional research with pre-screened samples (in which children with learning difficulties have already been identified) would also be valuable. The aim of conducting cross-validations of this nature would be to establish if the Phonic Inventories have even stronger discriminatory power.

6.1.1.3 *Is there a difference in the frequency of errors made by younger as opposed to older children and are these differences apparent in mainstream and remedial groups?*

This question addressed the issue of whether younger children make more errors than older children and whether the Phonic Inventories can discriminate the progress made by children in response to learning at school. This research question was investigated in the same way as discussed in section 6.1.1.2, except that the results were disaggregated by grade level.

The statistics showed that there was a steady increase in the mean percentage scores for learners as they progress through different grades regardless of whether they were in the mainstream or remedial group. By implication this means that fewer errors were made in the higher grades. A one way ANOVA determined that there were differences in mean test scores between the different grades, although post hoc analyses revealed that these differences were largely at the lower levels (grade 3 and 4) and less at the higher levels (grades 5, 6 and 7).

Since Level One of the Phonic Inventories was directed mainly for the lower grades where less difficult or complex words are included, the expectation is that the higher grades will do significantly better than the lower grades on Level One. This was indeed found to be true as the highest mean percentages were attained on this level in both groups. An analysis of the frequency of errors by grade revealed that in the mainstream group the frequency of errors increased from grade 3 to 4, then dropped in grade 5 and then remained at more or less the same level in grade 6 and 7, except for errors with long and short vowels (error 7) and initial consonants (error 1) where the frequency shot up in grade 7. Generally grade 4 learners in the mainstream group made the most amount of errors while grades 5 and 6 made the least. With the exception of error 5 (ending consonants), the remedial group showed less variation as one progressed up the grade levels. These data suggest, to some degree, that more errors are made in the early stages of primary school than in the later stages of primary school. Therefore, the sum of the frequency of errors in grades 3 and 4 in the

mainstream group is more than the sum of the frequency of errors made in grades 5, 6 and 7. The same was evident in the remedial group.

For Level Two, which was directed mainly for grades 2 and up and was more difficult than Level One (as it was made up of more complex spelling rules and words with long vowels and medial vowel digraphs), the most frequently occurring error across all grades and in both groups was the medial vowel digraph error type which was followed by consonant sound confusion, long and short vowel confusion and ending blend errors. However, as with Level One, the sum of the frequency of errors in grades 3 and 4 in both the mainstream and remedial groups was more than the sum of the frequency of errors made in grades 5, 6 and 7.

In relation to Level Three, which was the most difficult and was only administered to grade 3 learners or above, grade 4 learners in the mainstream group made the most errors with medial vowels. From grade 5 up to grade 6, mainstream learners made the most errors with syllabication followed by medial vowel errors, ending blends and suffix errors. In grade 7, syllabication and suffix errors were the most frequently occurring error and medial vowels and ending blend or cluster errors was less so. The remedial group also had the most errors in suffixes, syllabication as well as with medial vowels and ending blends. Although not the most frequently occurring error at the grade 4 level, learners in the remedial group at this level were also ten times more likely to make errors on initial blends or clusters than mainstream learners. In grade 5, the frequency of errors with the error category diminishes both in terms of actual frequency percentages and ratios. Ending blends or cluster errors was also made much more frequently by grade 4 remedial learners. Reversals and transposals were consistently evident in grades 5 and 6 in the remedial group. The same was not true of mainstream learners.

Overall, the results of this study indicate that the same kinds of errors are made in more or less the same order in each of the grades but the magnitude of errors made by the remedial group is larger than the mainstream group. Also the frequency of errors diminished, to some extent, in the higher grades for each of the levels.

It is likely that the unequal sample sizes in this research may have affected the results. However, it is noteworthy that Grasko, in her study using the Phonic Inventories in 2004, found a similar pattern of results indicating the discriminatory power of the Phonic Inventories, particularly at higher grade levels in primary school. Grasko suggested that the steady decrease in the number of key errors made by the mainstream sample could be used not only as an indicator of grade attained, but also that high incidence of particular kinds of errors were an indicator of learning difficulties, particularly at higher grades in primary school (Grasko, 2005).

The convergence between the current study and Grasko's findings would thus indicate a firm trend occurring across two similar datasets gathered at different points in time. The findings presented above would thus provide evidence to confirm hypothesis four. Further research into this area also needs to be considered.

6.1.1.4 On the basis of the examination of data from children in mainstream and remedial classrooms, are the Phonic Inventories content, convergent and construct valid?

Two hypotheses were proposed under this research question, with the first stating that learners who were tested in 1979 and who scored high on the Schonell Graded test will attain low scores on the Phonic Inventories. The high correlation coefficients attained for the total population and separately for mainstream and remedial groups, indicates that there was a fairly strong

negative association between the results of the Schonell Graded Spelling test and the Phonic Inventories and the three levels thereof. This means that the more errors were made on the Phonic Inventories the lower the score on the Schonell Graded Spelling test.

This result would be expected because learners without difficulties with spelling should have a high score on the Schonell Graded Spelling Test and a low score for the total number of errors recorded on the Phonic Inventories. Conversely, a learner with some level of learning or spelling difficulties will have a low score on the Schonell Graded Spelling Test and a high score for the total number of errors recorded on the Phonic Inventories.

It should also be noted that similar evidence of high correlations between the Phonic Inventories and previously standardised spelling tests (the Standard Graded Spelling test for learners in grades in lower primary school up to Grade Three, and Schonell Graded Spelling Test for learners in higher primary school) were reported by Grasko (2005). The convergence between these results and the results reported in this research would thus suggest that hypothesis five is confirmed.

In particular, the high correlations found in this research indicate that the Phonic Inventories have a strong association with an already reliable, valid and normed spelling test (i.e., the Schonell Graded Spelling Test). This evidence would also suggest that the Phonic Inventories are both content and construct valid in that they are both tapping into the same domain. Put differently, both the Phonic Inventories and previously standardised spelling tests both measure the construct of 'spelling'. The Phonic Inventories, in addition, provide detailed information about the kinds of errors made by children when spelling.

Additional evidence concerning the longitudinal or convergent validity of the Phonic Inventories was also examined, by analysing whether children with

learning difficulties in 1979 had dissimilar profiles to learners in the mainstream group in 1979. The same was also done with the 2001 dataset.

In the 1979 dataset, the most frequently occurring errors on the test overall (i.e., Levels One, Two and Three combined) in both the mainstream and remedial group were medial vowel digraphs and ending blends. Initial blend and medial vowel errors were also evident in both groups in the 1979 dataset. The 2001 dataset showed similar patterns across the grade levels in both the mainstream and remedial group – ending blend, medial vowel digraph and medial vowel errors were most commonly observed in the 2001 dataset. A Mann Whitney determined that these two independent samples (1979 and 2001) were not statistically significant which suggests that the same kinds of errors were being made in both the 1979 and 2001 datasets and a Spearman correlation revealed that two groups (1979 and 2001) were linearly related.

The results from the analysis of these two datasets were also strongly convergent with Grasko's findings, which revealed similar errors being made by mainstream and remedial learners on each of the levels (Grasko, 2005). Therefore, because similar patterns of errors were found in three separate datasets at three different points in time which used the Phonic Inventories (1979, 2001 and 2004), there is evidence to suggest that there is stability over time. This suggests that the Phonic Inventories have convergent validity and therefore that hypothesis six is confirmed.

However, one cannot ignore the historical context in which the tests were administered. For example, in 1979 all the learners who were tested were white and were taught in English, which was probably the learners' first language (or home language) in the majority of cases. In 2001, 22 years after the second pilot and 15 years after apartheid, the home language of learners was not necessarily English which meant that they were being taught in language not spoken at

home. Further research into this arena is needed, especially in a society such as South Africa where there are 11 official languages.

6.1.2 A consolidated view

Overall, it is concluded that, based on the statistics presented so far, the three levels of the Phonic Inventories have high internal consistency reliability as well as high split half reliability. They also have high face validity but more importantly, they are content, construct and convergent valid. Also, because the Phonic Inventories are able to discriminate between mainstream and remedial learners well, and between grades to some extent, they can be used as a diagnostic screening test to provide a profile of the errors made by mainstream learners in the process of learning to spell.

This type of usage would allow teachers or researchers to collect and analyse a child's spelling for patterns of errors. Those both with a high frequency of errors, as well as with a high frequency of errors of particular types, would be those children likely to have other accompanying linguistic deficits, and to have learning difficulties interfering with the child's acquisition of spelling and/or reading. The linguistic deficits or problem areas could then be identified through more broad-based assessment.

Once this had been completed, the professional would then have a clear roadmap, not only of the child's assets and difficulties, but also of the specific types of error made by the child. These could then form targets for systematic instruction or remediation of spelling and related linguistic skills.

This prescriptive and targeted method of assessment is very different from standardized spelling tests such as *The Test of Written Spelling-4* (TWS-4; Larsen, Hammill, & Moats, 1999) or the *Wide Range Achievement Test-4* (WRAT-4; Glutting & Wilkinson, 2005), which quantify spelling performance

relative to peers. It is also very different from Stage Theory and spelling inventories (e.g., Bear, Invernizzi, Templeton, & Johnston, 2000) that describe what letter patterns a student can and cannot spell. A prescriptive assessment goes beyond these other measures by using error analysis to determine *why* a student misspells words (i.e., what are the underlying linguistic deficits) and precisely what *type* of word study instruction is needed.

It is thus argued on the basis of the evidence presented in this chapter that the Phonic Inventories are a reliable and valid instrument, which could be incorporated into the classroom in ongoing assessment. It could be used for screening, diagnosis as well as to monitor progress, and in particular to note changes, improvements and ongoing areas of difficulty. It is also suggested that there is good potential for the Phonic Inventories to work in this way, as it is relatively quick and easy to administer. It has been found that teachers can competently administer and score the instrument with little training. The instrument also has good face validity, can be administered to a whole class at one time, is synchronous with classroom activities and tasks, so would not be stressful or unusual for the teachers or the learners and as has just been mentioned, is sensitive to change and gives simple direction to areas of difficulty.

However, it should be noted that the Phonic Inventories do not provide conclusive evidence of learning difficulties. The instrument is best used in conjunction with other tests, and may also have value as a screening instrument. The Phonic Inventories, used in the way just described, would identify children who would need to be more fully assessed. This would allow for easy and ongoing identification of children potentially at risk for learning difficulties with minimal resources and expense rather than for diagnosing a problem.

6.1.3 Linking the Phonic Inventories to the literature

The Phonic Inventories involve three separate spelling tests, given with the aim of establishing the rules the child uses in writing (i.e., how the child uses the alphabetical principle in creating words). The first inventory enables identification of errors made with words containing short vowel sounds, and various beginning and ending consonant blends and clusters. The second inventory enables identification of errors made with words containing long vowel sounds based on vowel diphthongs and digraphs, while the third level enables identification of errors made when adding morphological features to root words, involving prefixes and suffixes.

Using these carefully constructed word lists that represent specific types of spelling knowledge used throughout the spelling-acquisition process and a theoretically grounded error analysis methodology, it is possible to collect and analyze an individual's spelling for patterns of errors and to determine the linguistic deficits that are interfering with that individual's spelling and reading. The Phonic Inventories therefore have the potential to pick up on problems in five key skills:

- **Phonological awareness:** When phonological awareness skills are weak or underdeveloped, spelling is negatively affected in very predictable ways. Typically, individuals with poor phonological segmentation skills will delete letters and syllables, usually omitting letters for less salient phonemes, especially those that occur in internal locations and in unstressed syllables, (e.g., *plese* for *please*). Individuals with poor sound sequencing skills commonly reverse the sequence of letters when spelling. Letters reversals most commonly occur for liquids and nasals in a word or syllable sequence (e.g., *forst* for *frost*). Individuals with poor phoneme discrimination and identification skills are likely to spell distinct vowel sounds with the same letter (e.g., *bun* and *ban* both spelled *ban*),

and add letters for phonemes that do not occur in a word (e.g., *ment* for *met*).

- **Orthographic Knowledge:** Individuals whose orthographic knowledge is deficient often spell words incorrectly because they fail to recognize accepted spelling conventions. As such, the misspellings of individuals with orthographic knowledge deficits are predictably characterized by “illegal” substitutions (e.g., *mas* for *match*), non-allowable letter sequences (e.g., *kwick* for *quick*) and violation of word position constraints (e.g., *hedj* for *hedge*).
- **Vocabulary:** Individuals who have trouble applying vocabulary knowledge will confuse the spelling of homophone words (e.g., *dear* for *deer*) and parts of other words in which the correct spelling is determined by word meaning (e.g., the / w / sound at the beginning of question words *what*, *where*, *when*, *why*, which is misspelled as *w*).
- **Morphological Knowledge & Semantic Relationships:** Deficits in morphological knowledge and knowledge of semantic relationships present their own predictable patterns of misspellings. The misspellings of individuals with these types of deficits are characterized by omission of morphemes (e.g., *walk* for *walked*), phonetic spelling of morphemes (e.g., *talkt* for *talked*), failure to use spelling of the semantically related base word to correctly spell the inflected or derived form (e.g., *react* but *reacsion* for *reaction*), and misspelling of modifications when spelling inflected and derived forms of words (e.g., *happyness* for *happiness*).
- **Mental Orthographic Images:** When mental orthographic images are weak or not fully developed, spelling is negatively affected in very predictable ways. The misspellings of individuals with weak or “fuzzy” mental images of words are characterized by “legal” substitutions (e.g.,

nite for night, bote for boat), misspelling of unstressed vowel sounds (e.g., *markit for market, tabel for table*), and homophone confusions (e.g., *flour* vs. *flower, deer* vs. *dear*).

In terms of the literature on reading and spelling, the 13 error code system proposed by the Phonic Inventories can be linked on a conceptual level to each of these skills. Previous studies have used the instrument both clinically (Sfetsios, 2002; Potter, 2004) as well as for the purposes of organizing and monitoring progress in instruction (e.g., Wilson, 2001; MacReadie, 2001; Abelheim, 2002; Picton, 2002; Retsos, 2002; Ravenscroft, 2002; George, 2002). These studies have also demonstrated that the error patterns yielded by the instrument can be used to develop targeted remediation programmes, leading to substantial improvements in reading, writing and spelling abilities (Els, 2003; 2005; Ravenscroft, 2007).

Ravenscroft (2007) has also demonstrated that the Phonic Inventories have a strong relationship with other scholastic tests measuring reading, writing and spelling abilities, and in addition provide detailed information on the error patterns made by children. However, further research is necessary to establish the relationship between the Phonic Inventories and other psychometric measures. While the current research has shown that the Phonic Inventories are a promising instrument with demonstrated long-term reliability and validity, additional studies are necessary to establish the specific skills measured by the instrument, and how these relate to other psychological factors.

6.1.4 Limitations

Overall, the analyses presented in this research report indicate that the types of error patterns yielded by the Phonic Inventories have the potential to discriminate between learners in mainstream classes and learners previously diagnosed as having learning difficulties. The analyses also indicate that the

instrument is internally reliable as well as stable over time. There would thus appear to be potential for the Phonic Inventories to be used as an instrument for screening for dyslexia in the South African education system.

However, there are a number of limitations to this study. Firstly, and most importantly, the study was conducted with samples of learners at school in the northern suburbs of Johannesburg. These are affluent areas, which may not be representative of other areas in South Africa, nor are the samples likely to be representative of the South African population as a whole. It is also possible that the samples were contaminated, particularly as there may have been a number of children with learning difficulties in the mainstream sample. There may have been children who had learning difficulties and had remained in a mainstream school, or else children with learning difficulties who were unidentified and/or undiagnosed.

As the scope of this study did not allow for pre-testing of the sample, this is a fairly important confounding factor. The assumption was made that most of the children in a mainstream school would not have learning difficulties. This was a necessary assumption, but may have impacted on the results of the study in a number of ways.

Secondly, the tests were all administered in one geographical area, and all within one month (i.e., during the same period of the school year). Using the standard scoring that has been established through this and Grasko's (2005) study, it would be useful to cross-validate the findings in this study against a wider sample and different geographical locations. The schools included in this study are located in a relatively privileged area. It would be useful to include schools from a wider cross section of areas.

Thirdly, in the absence of a test manual, there may have been differences in the way in which the Phonic Inventories were administered, both in 2001, as well as

differences between 1979 and 20001. There were basic standard administration procedures which were probably adhered to. The lists of target words were in a specific order, and were read out to a group of children, both in isolation and within a sentence. However, there were a number of modifications to the instruments between 1979 and 2001, which may have influenced the results of this study.

In addition, other testing errors may also have occurred. There is no guarantee that the teachers did follow the instructions completely. There were instances in the data, for example, where a whole class was missing one word, indicating that it was likely that the teacher left that word out. There may also have been other mistakes in administration (such as mispronouncing a word). There is no way to accurately identify or document these mistakes, nor to know the effect of them.

Future research could account for these differences by ensuring that a set group of people are more formally trained in administering the instrument in a standard way. This would strengthen the findings of future studies, and in particular provide greater inter-tester reliability. An examination of how English mother tongue speakers and first language speakers of English perform on the test is also necessary.

Given the above limitations in this study, it is important to make the following recommendations for future research on the Phonic Inventories as an instrument for screening for dyslexia. Firstly, it would be preferable to pre-test the sample, so as to ensure that there are no children with learning difficulties in the mainstream sample. Also valuable for future research would be to gather much more detailed biographical and socio-economic data on children and their families. This would enable the analyses of patterns in the frequency data to be more detailed and the interpretations more specific.

Such information could include educational background of child and parents, first language of learners, first language of teachers, general spelling ability, general reading ability, general numeric ability, motivation to read, emotional experience of school and the classroom. These are but a sample of factors which may influence a child's spelling ability and so affect how they perform on the Phonic Inventories. This would allow the frequencies to be interpreted with more confidence.

In conclusion, this research provides a basis for recommending the Phonic Inventories as an instrument to be used for mass screening and monitoring of learners on an ongoing basis within the education system. The literature suggests that the use of group screening instruments is likely to be the next trend in assessment and remediation of learning difficulties. The literature also indicates that there is likely to be increased focus on early earlier identification, as well as identification using limited resources.

This research has established a standard approach to scoring the three levels of the Phonic Inventories and has established that the instrument is both reliable and valid. It has also highlighted a number of potential areas in which the instrument could be used in practice, the most relevant being for screening purposes in mainstream schools. This study has also provided indications for further research using the instrument, and in particular indicated the need for the use of the instrument together with other psychometric tests, to establish the nature of the factors it measures.

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