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The Phonic Inventories: using spelling error patterns to identify children with potential learning difficulties

By

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A research report submitted to the Faculty of Humanities, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Arts in Psychology by Coursework and Research Report

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Abstract

The Phonic Inventories are an instrument consisting of three spelling tests. This study explored the potential of this instrument to be used in group administration to identify children with potential learning difficulties. This was done with a sample of full-time mainstream and full-time remedial learners.

A repeated measures ANOVA was used to establish if the Phonic Inventories could distinguish the spelling error patterns of learners in different grades for mainstream and remedial. A distinct pattern of key errors was found, which was similar for mainstream and remedial learners. There were performance changes over grade for mainstream learners but not for remedial learners. This suggests the Phonic Inventories may be measuring an underlying spelling ability which progresses in normal learners and not remedial learners.

A stepwise regression analysis was used to establish whether the Phonic Inventories predict performance on contrast spelling tests. A good degree of fit was found between the tests, suggesting the Phonic Inventories are measuring the same abilities as other spelling tests, with the advantage of providing additional information.

Finally, a discriminant analysis found errors made on the Phonic Inventories to predict group affiliation between the mainstream and remedial group to a good degree.

It was concluded that the Phonic Inventories have strong potential as a group administered screening instrument for identifying children with potential learning difficulties.

(Keywords: dyslexia, learning difficulties, identifying potential learning difficulties, spelling tests, group screening for learning difficulties)

Declaration

I declare that this research report is my own unaided work. It is submitted for the degree of Master of Arts in Psychology by Coursework and Research Report in the University of the Witwatersrand, Johannesburg. It has not been submitted before any other degree or examination in any other university.



Dina Grasko
10 February 2006

Acknowledgements

At the end of a journey
It is wise to reflect
On the crucial elements
Of one's success

To my Mother and my wonderful Grandparents, thank you for your unlimited patience and support.

To Yael, Jonathan and Kevin: because no project can prosper without the necessary resources; varied as these may be.

And to my supervisor, Professor Charles Potter, for frustration and inspiration; both of which I believe to be essential for progress.

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Introduction

The crisis in South African Education

The South African education system has been in a state of crisis since the 1980's (Hartshorne, 1992). Improving the situation will require that the government invest heavily in training teachers (Robinson, cited in Mtshali, 2005). With a need for 20 000 new teachers each year to ensure effective education and learning, and a current graduating class of 9 000, this shortfall is creating grave concerns (Mtshali, 2005).

Currently, there are 350 000 teachers in the system, with a 5% annual attrition rate. This does not factor in the prominent effects of HIV/AIDS (Mtshali, 2005). Moreover, the future is looking worse, not better, with teachers leaving for overseas, and 40% of final year education students wanting to work overseas (Robinson, cited in Mtshali, 2005). Added to this is an issue of access, with 102 colleges – mostly rural - phased out, this means less institutions at which potential teachers can study, as well as an issue of access for rural students. Confounding this is a serious lack of financial aid available (Robinson, cited in Mtshali, 2005).

In fact, such is the concern with educators' workload that this formed the focus of the study commissioned by the Education Labour Relations Council (ELRC), in collaboration with the HSRC's Child, Youth and Family Development (CYFD) Research unit (HSRC Annual Report, 2004/ 2005). The final report of this survey is still outstanding, but the attention given to the topic is apparent.

These issues are not only concerning those at the grass roots level; access to basic primary education is listed as one of the Millennium Development Goals as part of the efforts to eradicate poverty. This is a reaction to the current figure of 100 million children who do not have this access (Majtenyi, 2005). However, this directive is compounded by the number of children requiring primary education ever increasing (Hartshorne, 1996).

Furthermore, there are a number of other factors that influence the system to varying degrees. The first is the history of the influence of religion, specifically the church. Historically, this is especially true for Black children and was a significant influence on the curriculum (Hartshorne, 1999). A second factor is language (Hartshorne, 1996, 1999). This has been used politically in schools, and is still an issue, especially with regards to language of instruction. This relates both to how this policy is decided and enforced as well as how learners and communities react to the language policy. A third factor is politics with regard to creating and maintaining power (Hartshorne, 1999). Education is not only a valuable but also a vital source of power and this ultimately affects education policy. A fourth factor is economics (Hartshorne, 1996, 1999). This is about resources, both with regards to the budget for education as well as how that budget is allocated. A final factor is one of administration or governance (Hartshorne, 1996, 1999). This relates to a shifting of power between provincial and regional authorities and a central authority, possibly creating tension and confusion around allocation of resources and responsibility.

But what is most important is that the importance and subsequent influence of these factors overshadow other factors that perhaps should have more influence, such as learner needs, teacher responsibilities and the curriculum (Hartshorne, 1996). The World Bank Study (1988, cited in Hartshorne, 1992) found that the six factors that most affect the quality of education are: training and use of teachers, textbooks and instructional materials, school buildings and facilities, language of instruction, nutrition and health of the children, and a strong examination system. Although this study did not include South Africa, there is no reason to believe these factors would not be as important in this context. This is especially relevant as it indicates areas that are more important as areas of investment to get the highest return in terms of quality primary education. That is, money spent on primary health care and nutrition may well influence the quality of education as well as instructional materials (Hartshorne, 1992).

And the importance of quality primary education should not be underestimated. Hartshorne (1992) suggests that a quality primary school system would make “the greatest difference to social well-being and economic development of South Africa”

(Hartshorne, 1992: 55). He argues that without a solid foundation, investments in secondary and tertiary education are wasted.

A program such as OLSET's "English in Action" programme, which aims to aid distance teacher learning, development and training at primary school level, is an example of a locally developed initiative which is achieving wide-spread positive results (OLSET in Action, 2003) at a low cost per learner. The positive results of this programme would suggest that it is possible to make a difference even where resources are limited. 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 children with special needs in their classrooms.

The position of learners with special needs

It is in this context that the issue of learner remediation needs to be addressed. An address made by the minister for education, Professor K. Asmal, at the Annual Congress of the South African Association for Education and Learning Disabilities (SAALED), at the University of the Western Cape, on 23 September, 2002 (South Africa Government Information, April, 2005), deals with this issue. He acknowledges that since 1994, the focus of education has been on increased access. Even so, there are an estimated 280 000 learners with special needs who need to be accommodated by the system. Given the context, there is a need for 'new approaches to learning' and 'new ways of assessing learners'. Areas to be restructured are focused on teachers as identifying and dealing with children experiencing learning difficulties. The argument is that these difficulties may be transitory, and if identified early, intervention can prevent terrible results later on, such as being alienated from school and authority or from enjoying learning.

However, the restrictions are limiting. With education already using R60 million per annum (which is 22% of the national budget), it is already costing a large amount, with a system consisting of roughly 12 million children. In addition, it must be noted that although the budget is increasing over time, this is not inline with increasing

school enrolments, meaning that the mean amount allocated per child is actually decreasing over time (Hartshorne, 1996). Furthermore, meeting the needs of children with learning difficulties is likely to be even more expensive, due to the costs relating to both assessment and remediation.

Prevalence of learning disorders

An international survey used extrapolated statistics to estimate the prevalence of learning disabilities around the world. For South Africa, the figure is 751 702 people (Wrong Diagnosis, April, 2005). This figure is for all people, not just children, and does not take genetic, cultural or environmental factors into account. Nonetheless, the figure gives an indication of the prevalence of the problem, into adulthood as well as for school going children.

There are further instances relating to the prevalence of learning difficulties in South Africa today. Speech-language therapist D. Klop from the University of the Western Cape (cited in Caelers, 2004). She 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, 2004).

The seriousness of deficits in learning to read goes far beyond school performance. Research in the USA has shown education is the main opportunity for social mobility and in this light reading difficulty perpetuates social inequalities (Labov, 2003). This is especially a problem where the home language of a learner is different from the language of reading instruction, as well as the result of other contributing factors such as large numbers of children in a class, lack of teaching materials, teachers without sufficient training, parental support for the schools being low and lack of a home tradition of literacy (Labov, 2003). Although these factors are referring to inner-city schools in the USA, it is possible to draw parallels to the educational environment in South Africa.

Rationale for 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 be referred for full assessment. This is the focus of this study.

Aims of this study

The Phonic Inventories are three instruments designed to be administered by teachers. Each instrument is a spelling test focused on a particular level of ability in word building. The instruments have been developed by Professor Charles Potter of the University of the Witwatersrand. They have previously been used intrinsically to establish individual child error profiles and to monitor remediation in a programme called the Targeted Revisualisation Programme (see Appendix E for details of this programme and Appendix C for the Phonic Inventories).

This prior work has been conducted in educational clinics, and has provided indications that these instruments may be able to identify children with dyslexia. This research attempts to study this proposition formally.

Research questions

1. What are the patterns of spelling errors made by mainstream learners on the Phonic Inventories, i.e., children studying in mainstream classes?
2. What are the patterns of spelling errors made by children who have been identified as having specific learning or reading difficulties on the Phonic Inventories, i.e., by children in full time remedial education?
3. Are there differences in the patterns of spelling errors made by mainstream learners and learners with identified learning difficulties on the Phonic Inventories?
4. Does performance on the Phonic Inventories predict performance on the Daniels and Diack spelling test (for grades 1 and 2) and the Schonell graded spelling test (for grades 3 – 7)?
5. Can the patterns of errors children make on the Phonic Inventories predict whether they are in the mainstream or remedial education?

Relevance of this research

There are a number of existing performance tests to assess for dyslexia, specifically, reading, writing and speaking. Given the time taken to undertake individual assessment with a child compared to group assessment and the fact that class teachers normally work with large groups of children, this study focuses on tests of spelling performance. These are designed to be administered to groups and then individually scored and analysed for screening purposes.

Given the detailed account of the education system, it is essential that teachers be able to administer any screening test to a group of children at the same time. This requires a written test, as reading and speaking require each child to be assessed individually, which is too costly in time and money.

It is hypothesised that 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. It is also hypothesised that difficulties in building the type of words used in the Phonic Inventories are associated with the development of phonological awareness. The implications of this study are that analysing patterns of errors made in written language may prove a suitable and practical choice for screening children with potential learning difficulties.

Literature review

Myers and Hammill (1969) suggest there are a variety of understandings associated with the term "learning difficulties". These relate to different areas of development, some refer to the cause of the difficulty (neurological deficit), others to resulting behaviour (for example, functional problems on reading, writing or spelling). Myers and Hammill (1969) suggest the need for an operational definition that could be used in differentiating these children, as well as are descriptive as to the nature of the deficiency. They further suggest the need for one concept which can be used to encompass a definitive understanding of learning disorders.

Dyslexia

In defining dyslexia, there are two possible approaches. The first dates back to the origin of the term, as a congenital disorder associated with the left cerebral hemisphere of the brain. This meant that children who were of normal intelligence in all other respects, had disturbances in learning to read (Hinshelwood, 1917, cited in Seymour, 1986). From this perspective, the literature has focused mostly on reading. The implication of this means that much testing for dyslexia as well as treatment is focused on the child's reading abilities. There are two main approaches to understanding these difficulties with reading. The first is the congenital approach which is focused on the underlying causes of the difficulties and has a well established and comprehensive classification system. The second approach is a functional one, which relies more on thorough understanding on the myriad ways in which dyslexia may manifest, allowing a more flexible classification approach.

The congenital approach

The congenital 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 in is

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.

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 mirror 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: 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).

The functional approach

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: 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." (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*.

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 in 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 judgement 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 (Levine, 1998, cited in 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, 2000, cited in Wadlington & Wadlington, 2005). Teachers' 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.

Normal reading development

This section details normal reading development with the understanding that children with dyslexia will in some way deviate from this norm. In this sense, it is important to understand the baseline against which to compare.

> "The 'simple' view of reading reflects this interdependency of written and spoken language processing by proposing that reading comprehension depends on both decoding or word recognition and linguistic comprehension or understanding of language" (Gough, Hoover & Peterson, 1996, cited in Broom, 2001: 28).

What this view is suggesting is that reading, writing, spelling and speaking all rely on the same underlying processes to some degree. From this, it is reasonable to suggest that the underlying predictors for reading, writing, spelling and speaking will have some common threads, elaborated by the specific skills associated with each ability. For example, reading requires visual abilities while writing requires fine motor skill abilities, but both require the ability to manipulate the codes of written language.

Reading is the decoding and comprehension of written text. It is not foremost a visual process (Smith, 1973), though this is a necessary function for reading to occur. According to Smith (1973) there are two sources of information entailed when reading. The first is from the printed page and accessed by the eyes. This is the visual information. The second source, from the brain, is the non-visual information. This non-visual information is what the reader already knows about language and the meaning about what they are reading. In summary, "reading is the ability to perceive and understand written language and is dependent on a complex cognitive system comprising both *skills* and *knowledge*" (Broom, 2001: 28, *emphasis added*).

Transparent versus opaque codes: the orthography of English

If reading is about accessing the codes of writing, then it is worthwhile examining the roots of the codes in English spelling. English is first an alphabetic language and second a phonetic one. That is, English is written using a set of symbols in a finite alphabet and these symbols correspond to the sounds in English speech. And while this correspondence is not exact, there is a definite structure to the system (Stern & Gould, 1966).

In a transparent alphabetic writing system, it is possible to determine the pronunciation of a word exactly from its spelling (Ellis, 1993). English words such as 'dog' and 'ship' are transparent; words such as 'yacht' and 'colonel' are not. Thus, it is not always possible to predict the pronunciation of a word in English by the way it is spelled. English has an 'opaque' orthography (Broom, 2001). It is telling that English has 26 letters in the alphabet which can be used for written expression but 46 phonemes available for verbal expression (Gough & Wren, 1998). This means that the letters correspond to more than one phoneme each, either individually or in blends. Furthermore, each phoneme has approximately twelve graphical representations (Kessler & Treiman, 2003).

English did begin with a transparent orthography in about 1400 AD (Ellis, 1993). But English is the result from a fusion of many other languages; the British Isles were invaded many times by different groups, merchant travellers introduced foreign words into the language, scholars were influenced by Latin and Greek and the English rule in India absorbed words from that region. Each group contributed words to the English language (Gee & Watson, 1983). The resultant irregular orthography of English was not directly the result of words coming from a variety of languages, but rather the attempts of spelling reformers in the 15th and 16th century. They changed the transparent spelling of English to reflect the language of origin, for example by adding in a silent /h/. This, combined with the way that pronunciations of some words have changed over time has resulted in a nontransparent orthography (Ellis, 1993).

However, there may be an advantage to these irregularities. English has many homophones, such as 'meet' and 'meat' and 'pear' and 'pair' (Ellis, 1993). Because of the different spellings, readers can establish the correct meaning from the spelling (Ellis, 1993), if not always the correct pronunciation. Another benefit to allowing irregular phonetic spelling is for consistency. To convert 'robe', 'rope' and 'rose' to the plural, it is necessary to add a /-s/ on the end. However, if one where to spell the plural phonetically, the result would be /robez/, /ropes/ and /rosiz/. A similar fact applies to the past tense rule for adding /-ed/ (Ellis, 1993). There is a value in this consistency. And although these irregularities present difficulties when learning to read and write, for the expert reader, they have practical value (Bradley, 1913, cited in Ellis, 1993).

So is it clear that written expression and reception of English is different in qualitative ways from verbal expression and reception. But does this actually make English spelling more confusing? Kessler and Treiman (2003) argue that although English orthography is irregular, there is more purpose to spelling than simply phoneme-grapheme correspondence. They explain how the spelling of a word provides more information than its pronunciation, especially as a result of the above mentioned influences on English spelling. They go on to show how seeming 'irregularities' are in fact rule bound, and that children easily learn the cues for correct spelling, for example, how a letters position in a word affects whether it will be doubled or not.

Decoding and comprehension: the context of reading

There are many different ways of reading. Hatt (1976) postulates that different readers will read a text in different ways. How a text is understood is mediated by the reader. There are also different kinds of reading such as skimming, scanning and studying (Ehri, 1998). The *nature* of reading is decoding and recoding the symbols. The *purpose* of reading is deriving meaning from text (Ehri, 1998). There are cues that help readers get meaning from text. These are embedded within the words, the flow of language and structural signals. The text is a collection and organisation of codes and the nature of reading is the reader's interaction with the text.

What does this mean for children who are in the process of learning to read? Resnick and Weaver (1972) note the following which can be understood as a possible explanation:

> "In reading as in other skills, it is probable that the novice performs differently from the expert. Novice readers probably are not only slower, but they probably also attend to different features of text, perceive text in different-sized units, and bring knowledge that is both less extensive and less well structured to the reading activity" (19)

To go back to Smith's (1973) distinction between visual and non-visual information when reading, it becomes apparent that the more non-visual information a reader has,

the less visual information they need to read (for example to recognise words), and conversely, the less non-visual information they have available, the more visual information they will need. This is another reason why novice readers read *differently* to expert readers. Smith (1973) elaborates to say that the more weight given to visual information, the less comprehension will occur. This is relevant to teaching methods that try to focus on meaning and form simultaneously. According to this psycholinguistic approach, it is not possible to engage with meaning before a reader has mastered form to an acceptable level.

This is further substantiated by Broom (2001) who states that although reading requires both decoding and comprehension, these two systems are separate abilities that may function and develop separately. This means a child could read something but not make any meaning of what they have read. Alternatively, a child may be unable to read a sentence, but comprehend it perfectly when it is read to him/ her.

Much emphasis around reading and learning to read has been focussed on individual word reading, and in particular much research has been conducted around individual word recognition (Ellis, 1993). The reason for this is that text reading ability is directly reliant on word reading ability (Ehri, 1998). If children are having difficulties reading some words in a given text, it will affect their reading of the entire text.

For experienced readers, individual word reading is about word recognition. Since this is the desired end state for children learning to read, it is useful to note the factors that affect this skill. As described fully by Ellis (1993), these are:

- familiarity (known words are read faster than unknown words)
- frequency (it is easier to recognise high frequency words)
- age of acquisition (taking into account frequency, words learned earlier in life are more easily recognised)
- repetition (during one task, the more a word is repeated, the more easily it is recognised)
- meaning and context (words are more easily recognised in a relevant context)
- spelling-sound regularity (words with a consistent spelling-sound relationship are read aloud more quickly than other words)

To note, is that interactions of the above factors may influence word recognition in unpredictable ways (Ellis, 1993). It is possible to suggest that this may extrapolate onto spelling. That is, the more frequently a child has been exposed to a word, the more easily the child will spell the word correctly, or hearing a word in context (for example, read out in a sentence) may make it easier for the child to correctly spell that word.

If reading is about word recognition, then it is relevant to look at how this occurs. Ellis (1993) outlines 'a simple model for word recognition in reading':

Any model of reading must start with the visual input of the printed word. This model begins with the 'visual analysis system'. This is responsible firstly for identifying the markings as letters, and which letters they are, and the second is noting the position of each letter in the word. With this information, it is possible for the reader to determine if the word is familiar or unfamiliar. If it is familiar, it is the task of the 'visual input lexicon' (a store that contains representations of familiar words) to identify the word. This recognition is achieved by the *look* of the word, not by its meaning or pronunciation. Becoming familiar with words, and building this lexicon, is part of learning to read. Because the information flow between these units is two-way, the lexicon also serves to aid visual analysis. It is easier to recognise letters embedded in known words.

We have already argued that it is not enough to recognise a word; the reader must know what it means. This is the role of the semantic system. Once a word has been recognised, the semantic system fills in what is known about that word. This is most likely the same semantic system used for understanding speech. Again, there is a two-way flow of information between the semantic system and the lexicon. This means that once a word has been recognised and its meaning established, it primes other words in the semantic group. If they are then read, they will require less information from visual input and will be recognised more quickly. This is semantic priming and is part of the non-visual information required for reading.

The process that has been described may be considered as reading through meaning. Sometimes this is necessary, such as with words that are spelt the same, but have a

different pronunciation depending on their meaning, such as ‘tear’. It is only possible to pronounce this word correctly if the relevant meaning is known. Reading with expression is another feature that relies on reading through meaning. Even so, some reading may occur without semantic involvement, with a direct link from the visual input lexicon to the speech output lexicon (Ellis, 1993).

Finally, phonemes are stored in the ‘phoneme level’ before being articulated. This is a necessary short term memory store as some words have a long sequence of phonemes that cannot be said all at once. Therefore, they sit in the phoneme level while they are spoken. It may even be that the words that have been read, but not yet spoken are stored in the phoneme level. This is argued because of the ‘eye-voice span’, the name for the fact that when a person reads aloud, their eyes are a few words ahead of the words they are saying.

In summary, it is clear that the nature of reading is a cognitive process made up of at least two parts. One part interfaces with the text and the other with the knowledge already possessed by the reader. Both parts are required for skilled reading. Added on to this are the auxiliary cognitive functions required for skilled reading, such as visual abilities, long term and short term memory.

The reader

Hatt (1976) explains that readers can be distinguished from non-readers by four attributes: literacy, access to reading matter, certain minimum environmental conditions (such as enough light) and time to read. For the purposes of this review, the answer is more definite. The ‘reader’ is the child learning to read. The child may be learning to read in a mainstream school or the child may be learning to read in a remedial school.

A full discussion of dyslexia has already been provided. However, and especially in South Africa, the context of the reader is of outmost importance and should never be left out of the definition of the reader. Hatt (1976) speaks of the desire to read, the opportunity and the physical context that allows for reading. These are important

considerations. They may be understood differently for the child learning to read, who must have adequate instruction, and sufficient resources to enable the child to learn.

Furthermore, it is important how the child and the text come together. When this happens, it is buffered by the education system, the syllabus and the teacher. The nature of this coming together may be examined by methods of instruction. Methods of teaching reading can be classified according to principle methods, such as the Alphabetic Method, the Phonic Method and the Look and Say or Whole Word Method and contextualized or meaningful approaches, such as the Sentence Method and the Kinaesthetic Method (Hughes, 1972).

These methods are not necessarily used exclusively, and most are best used in a mixed-method approach. According to Hughes (1972), the two most common methods are the Phonic Method and the Look and Say method (otherwise known as the whole-word correspondence method (Harris & Coltheart, 1986). The Phonic method is being more recognised, especially when the phonic analysis is meaningful and applied to a whole word (as opposed to meaningless sounds) and preferably a word the child recognises by sight. However, Harris and Coltheart (1986) point out that instruction using either method in isolation is bound to be insufficient. Either the child will be lacking when attempting to read unknown words or the child will make numerous mistakes with words that do not follow complete phoneme-grapheme conversion rules. A combination is always required.

But the learning process is also buffered by the desire to read. The child beginning to learn to reading still needs to learn the purpose for reading and writing. This becomes more evident when children engage with the meaning of a text rather than only the form (letters and words). This motivation to read is not only important once children have learnt to read, but according to Paris & Okra (1986, cited in Watkins & Coffey, 2004); it is a prerequisite for becoming an effective reader. The Motivations for Reading Questionnaire (MRQ) developed by Wigfield & Guthrie (1995, cited in Watkins & Coffey, 2004) includes eleven theoretical scales: efficacy, challenge, work avoidance, curiosity, involvement, importance, recognition, grades, competition, social and compliance. After doing research with two samples of children in grades 3 – 5, Watkins and Coffey (2004) found the questionnaire inadequate and call for a

revision before it is used again. However, what is important to take out from this, is that there are a wide range of factors relevant to the motivation to read experienced by young children who are just learning to do so, and this motivation is important for how that skill ultimately develops; for engaging the child to create a context where they can learn.

This conclusion is further supported by a longitudinal study conducted by Poskiparta et al (2003) that assessed and observed children in preschool, and again in grades 1 and 2 and showed that although the sample were homogenous at preschool level, in grades 1 and 2, poor readers were rated as less task-oriented and more ego-defensive and socially dependent than were matched good readers. They concluded that this was the result of effects of the learning environment on some children and impacted on their progress learning to read and spell.

Research done with grade 10 students found that the purpose of the reading determined their processing of the text (Bråten & Samuelstuen, 2004). Students differentiate between reading for school and reading from their own choice. This personal reading is considered more pleasurable and less mentally challenging (Bråten & Samuelstuen, 2004). It is possible to suggest that since children who are learning to read, may only read for school purposes, that this difference in perception of how enjoyable and how difficult the reading task will be might influence the learning process. This is relevant because the act of reading is important for the process of learning to read. Efficient reading requires a large lexicon of known words, as well as ease with the decoding process. This develops from practicing reading.

Stage models for learning to read and write

Learning to read is different from learning to speak in a very significant way – learning to speak a native language is a gradual, organic process between a child and their immediate social environment whereas learning to read is a structured, systematic process that is explicitly taught to the child (Harris & Coltheart, 1986). An overview of the methods used for this purpose has been covered. What is now required is an understanding of the cognitive processing involved in learning to read.

The first model to be considered is the Frith's stage model (1985). According to this model, a child acquires reading and writing abilities by moving through three phases: logographic, alphabetic and orthographic.

In the logographic stage reading is based on crude visual features and so visually similar words may be confused. There is no value given to letter order within words. Spelling at this stage is negligible.

During the alphabetic stage these skills are developed first for spelling and later are absorbed into reading. Children do not have clear images of printed words and so spell words as they sound. The child must have 'phonemic awareness' to be able to understand the relationship between letters and sounds and so employ this method of spelling. Achieving this understanding is often a barrier for children (Snowling, 1984). When this ability is incorporated into reading, children are able to attempt to read words they have not previously encountered. Phonemic awareness is not the only requirement for the child to master the alphabetic stage. The child must be able to segment sounds, memorize the segments and sequence them. Therefore, there is a reliance on auditory and phonological processing. Children who have suffered from speech and language problems often find it difficult to advance to this stage.

The orthographic stage is the end point to literacy. The child at this stage will gain access to abstract representations of written language and this allows for accurate reading and automatic spelling. Both reading and writing are now independent of sound.

Another developmental stage model is that presented by Chall (cited in Resnick & Weaver, 1972). Chall also outlines three stages of reading development. The first is the prereading stage. This is followed by the decoding stage during which the child learns the components of the code. Finally there is the confirmation and fluency stage and during this stage, the child masters reading (the code) through practice. Following the acquisition of reading ability, the readers focus shifts to the meaning of what they read. This is a psycholinguistic model of reading.

The Dual Route processing model has great explanatory power when describing how skilled readers read (Harris & Coltheart, 1986). There are two possible cognitive processes a reader has at their disposable to read a word, the lexical and the non-lexical route (Harris & Coltheart, 1986). If a word is known, then the reader will use the lexical route to read the word, drawing from the mental lexicon of known words. If a word is unfamiliar, the reader will use the non-lexical – or phonological – route, using phonic conversion to read the word (Harris & Coltheart, 1986). This model is most congruent with the congenital definitions of dyslexia.

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 non-words preceded by real words. It was found that how the non-words 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 (1994, cited in Lennox & Siegel, 1998) 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.

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:

1. 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.

2. 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.

3. 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 non-words. There is a vast increase in the number of words the child can read aloud. Children are now using the phonological (non-lexical) 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 (Firth, 1972, cited in Harris & Coltheart, 1986).

4. 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.

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: 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 and Desberg (1981), Brown, (1990), Henderson and Templeton (1986). Although

these models all have their own specifics, they do share some common qualities (Ellis, 1993).

The first of these can be called 'words as pictures'. Most models propose that in the earliest stages of learning to read, words are identified exclusively on their visual appearance, much as one might recognise a picture. What this means is that children are making no use of letter-sound correspondence, and cannot read unfamiliar words. They are not able to 'sound-out' new words. Children will often make semantic errors, because they have recognised and understood the word. They may also use visual indicators as to what the word may be, for example, 'yellow' is a known word and has a /ll/ in the middle and therefore 'sma**ll**er' (an unknown word) is read as 'yellow'. Finally, they may make use of the context of the sentence to *guess* the right word without making any reference to the unknown word.

Once children are taught the relationship of spelling-sound of words, they are learning about phonics. Now children are able to sound out unfamiliar words. As has been discussed already, regular words can be read correctly via this method; irregular words cannot. As this understanding of spelling-sound relationship becomes more complex, the child becomes a more skilled reader. New words are stored in the visual input lexicon and the speech output lexicon, and the semantic system becomes more comprehensive. With all these processes, reading becomes quicker and more accurate.

Criticisms of stage models

Stage models follow a universal development theory much like Piaget's cognitive development theories. However, 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, cited in Ellis, 1993) 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, 1993, cited in 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.

Predictors for reading development

Using a functional definition of dyslexia, stage models – given the criticisms above – are not sufficient for understanding how children learn to read, especially when children deviate from the norm. The stages are too rigid and not universal. Another approach is looking at specific abilities and their predictive value in the ease with which children learn to read.

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

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

To note 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.

However, of these abilities, phonological awareness has by far proven to be the strongest and most stable predictor. Strong correlations have been 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, cited in Chard & Dickson, 1999).

Furthermore, a study using a sample of 435 children from nine schools in the UK screened children at school entry (aged 4 or 5) as predictors for their curriculum performance at age 7. 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 & Kolinksy, 1998).

But why is this so important for reading? If a child understands that phonemes are sounds used to make words, and how their presence and order creates meaning, and also how these sounds are represented by combinations of the letters of the alphabet, then a conscious awareness of the rules of manipulating these sounds can be used by a child to read and construct words (Chard & Dickson, 1999).

Approaching from another angle, research has found that direct instruction of phoneme awareness is more beneficial to children who are not performing academically in grades 1 and 2 than are other approaches that are indirect or focus on comprehension (Moats & Farrell, 1999). In summary, research has shown that the 'phonologic deficit hypothesis' is a sufficient cause of dyslexia (Ramus et al, 2003, cited in Voeller, 2004). In this study, a sample of 16 university students with dyslexia, and the same number of controls, was assessed on a large battery of tests, including language, phonological awareness, auditory and visual perception and motor control. Only phonological awareness deficit was present in all the students with dyslexia. While the sample is relatively small, the results are still compelling. This study also provides evidence that phonological awareness is not just important when children are learning to read, but remains an important deficit in adults with dyslexia.

Although it is understood that reading and spelling ability are related (Sunseth & Bowers, 2002) it cannot be taken for granted that the predictors for performance on both activities will be the same. However, Sunseth and Bowers (2002) found that phonological awareness was the best predictor of spelling dictation ability. And although other factors (such as naming speed) may compound any deficits, phonological awareness was concluded to be the most important skill underlying spelling ability.

Phonological awareness

Phonological awareness can be defined as "conscious access to the phonemic level of the speech stream and some ability to cognitively manipulate representations at this level" (Stanovich, 1986: 362, cited in Uhry, 1999). The two main elements involved in this definition are the access to the phonemes that make up speech, on the level that they can be manipulated and the fact that this ability is conscious. Having this awareness then means two things. Firstly, it means the ability to focus on pieces of sounds of speech. Secondly, it means that there is an understanding of how these units of sound make up the meaning of a word, and how differences in these signify differences in the meaning of a word (Uhry, 1999).

The development of phonological awareness is progressive and hierarchical (Gombert, 1992). That is, it is possible – and even necessary – to differentiate between the ability to discriminate between units of sound and phonemic awareness. From this, there can be classified two types of phonological awareness: epiphonological awareness (discrimination between two sounds) and metaphonological awareness (conscious discrimination of sounds based on the identification of their phonological difference) (Gombert, 1992).

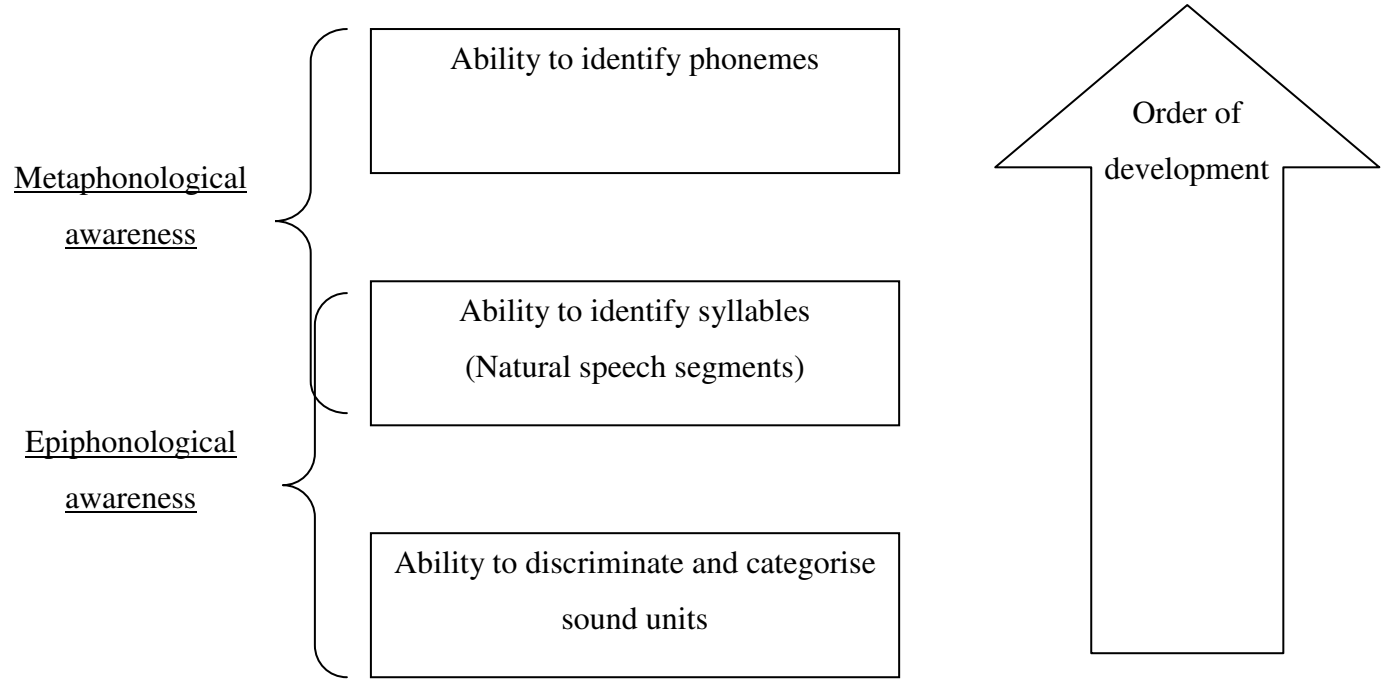


Figure 1: Hierarchical development of phonological awareness (based on Gombert, 1992)

As shown in figure 1, epiphonological awareness is the first to manifest in a child. The ability to discriminate between sounds is evident in child as young as three years of age (Gombert, 1992). This ability is a prerequisite for the more complex tasks involved in metaphonological awareness (Gombert, 1992).

The ability to identify syllables seems to straddle between epiphonological and metaphonological stages. That is, a child, from as early as four, may be able to identify rhyme. However, this is most likely a result of matching similarities in the words, and so is not true syllable segmentation. This ability is still at an epiphonological level. However, when the child (from as early as age five) is able to

correctly identify and count the syllables in a word independent of rhyme, this reflects a more conscious reflection on the segments that make up the word, and would be a metaphonological ability (Gombert, 1992).

Finally, the ability to identify phonemes in a word or syllable develops relatively late (from age seven or eight) (Gombert, 1992). This is the most complex level of ability, but as Treiman (1985, cited in Gombert, 1992) has noted, even though young children are able to make this distinction, it is different to that made by adults, in that at its early stage, it is to some extent independent of the alphabet, and this is evident when these children spell (for example, /chill/ with a /t/).

Phonological awareness is thus about understanding that language is made up of small parts that can be separated and manipulated. That is, language can be split up into sentences, sentences can be split up into words, and words may be split up into syllables, onset and rime or even individual phonemes. This understanding allows for manipulations such as deleting, adding or substituting sounds (Chard & Dickson, 1999).

According to this definition, phonological awareness lies on a continuum (Chard & Dickson, 1999). On one end of the continuum, it begins with the ability to negotiate rhymes, as well as splitting up sentences. This first level of awareness (one end of the continuum) is that spoken language is made up of discrete words. In the middle of the continuum is the awareness of syllables of words, and how these syllables are merged to form words. Further along the continuum develops the ability to segment words into their onsets and rimes, as well as the ability to merge these onsets and rimes into words. At the other end of the continuum lies phonemic awareness. Phonemic awareness is the highest level of phonological awareness, for at this stage, there exists the ability to segment words into phonemes, manipulate, rearrange and substitute them to make new words; what has been called metaphonological awareness. The above distinction was more theoretical. At a more detailed level, phonemic awareness can be understood to develop through five levels, according to Adams (1990, cited in Uhry, 1999).

1. *An ear for rhymes.* The first level is around the ability to hear rhymes in words. By hearing the rhyme, a child becomes aware that one part of the word has been exchanged for another.
2. *Matching words by rhyme and alliteration*. The second level concerns the ability to match – or group - spoken words by alliteration or by rhyme.
3. *Segmenting onsets*. The third level involves segmenting words by syllables. This begins with segmenting off the first phoneme. Segmenting is an especially difficult task because of the co-articulation of vowel sounds. Children may leave out the vowel sound when segmenting, or attach it to the end consonant.
4. *Full segmentation of all phonemes in words*. The fourth level is usually only reached once a child begins formal instruction in reading. The child is now able to segment all phonemes in a word, and, by using the alphabetic principle, read unfamiliar words.
5. *Manipulation of phonemes*. By the fifth and final level, children are able to manipulate the phonemes in a word, such that they can delete or exchange phonemes to make new words.

However, awareness of another principle is necessary for this to be able to occur, and that is the alphabetic principle. This refers to "an understanding of the relationship between letters ordered left to right in a written word and phonemes ordered in a specific temporal sequence in spoken language" (Uhry, 1999: 64).

Alphabetic awareness refers to the understanding that the letters of the alphabet represent the sounds used in spoken language (Allen & Beckwith, 1999). This understanding means that the alphabet is the bridge between speech and literacy (Allen & Beckwith, 1999).

This is a process that begins with learning the symbols of the alphabet. Recognition of individual letters develops into recognition of letter sequences and this allows for faster reading – or decoding – of written words (Allen & Beckwith, 1999). At this point, two competencies for reading overlap, that of phonemic awareness and that of alphabetic awareness. Children must be able to recognise a letter sequence and then map the correct phoneme onto it (Allen & Beckwith, 1999).

According to Adams (1990a, cited in Allen & Beckwith, 1999), children often learn letter names before they can recognise letter shapes, and this is often true before school. They learn the association between letter names and shapes through various means, including school, writing practice, television programmes such as Sesame Street, games and so on. It is necessary that children learn the associations between letter names and symbols and upper and lowercase versions of letters as well as print and cursive handwriting (Allen & Beckwith, 1999).

There is evidence that the relationship of the development of phonemic awareness and alphabetic awareness is a reciprocal one (Morais, Mousty & Kolinsky, 1998).

Learning to spell

Children may start attempting to write long before they have any knowledge of how to spell, and so make it up as they go (Ellis, 1993). Their attempts at spelling are sound-based and often read correctly, even though they may look strange. This is evidence that a phonic approach to spelling is natural for children; especially as this is true when their reading is still visual (Bryant & Bradley, 980, cited in Ellis, 1993). Furthermore, Bryant and Bradley (cited in Ellis, 1993) found children may be able to read words they could not spell, and spell words they could not read. Reading and writing (spelling) in the early stages seems to be based on partially different processes, with reading relying on whole-word recognition with poor letter-sound conversion and spelling relying on letter-sound conversion with poor whole-word storage of spellings. This suggests some independence between these faculties (Ellis, 1993).

Research conducted by Treiman (1998) and her colleagues examined how young children spell, seeking to uncover the reasons for the errors they make. The results suggest that children bring their knowledge of the sound structure of the language and their knowledge of the names of letters to the spelling task. Certain common spelling errors that might otherwise be difficult to explain make sense when this knowledge is taken into account.

Traditionally, the understanding that the English language is complex, irregular and illogical led to the conclusion that children learn to spell by memorising the letters in words (Treiman, 1998). There is no doubt that visual memory does play a role in spelling. However, Radaker (1963, cited in Treiman, 1998) found that even in as short a time as two weeks, training children in visual imagery improved children's spelling. Further research seemed to point to spelling as a type of serial learning exercise, because of the trend that the letters at the beginning and ending of words are spelled more accurately than those in the middle of words (Jensen, 1962, cited in Treiman, 1998).

However, changes in views of the English language brought about a reconsideration of how children learn to spell (Treiman, 1998). The work of Chomsky and Halle (1968, cited in Treiman, 1998) showed a system that was still complex but meaningful and rule-bound. Now, consistent errors made by children could be explained by understanding that children had internalised certain rules and were extending them into situations where they did not apply (for example, the rule for past tense is to add the suffix /–ed/. Children may then use go**ed** instead of went) (Treiman, 1998).

Read (1975, cited in Treiman, 1998), studying children who were just learning to write, collected unprompted creative writing from the children and determined that learning to spell is a creative process. Children attempted to spell by "trying to symbolize the sounds they heard in words rather than by trying to reproduce memorized strings of letters" (Treiman, 1998: 374). Errors, while not exactly phonetic, did show that the children were attempting to create phonological representations of the words.

Treiman (1998) continued the method of analysing the natural writing of children learning to read, i.e. meaningful writing. This was combined with experimental data to control for the fact that children do not necessarily write using a wide range of words from different spelling rules. Given this research, Treiman (1998) 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: 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.

The cognitive processes involved with reading have been covered in detail. But what are the cognitive processes involved in spelling? The following figure outlines the flow of information when a single word is spelled. This is the corollary of the simple model for single word recognition already discussed.

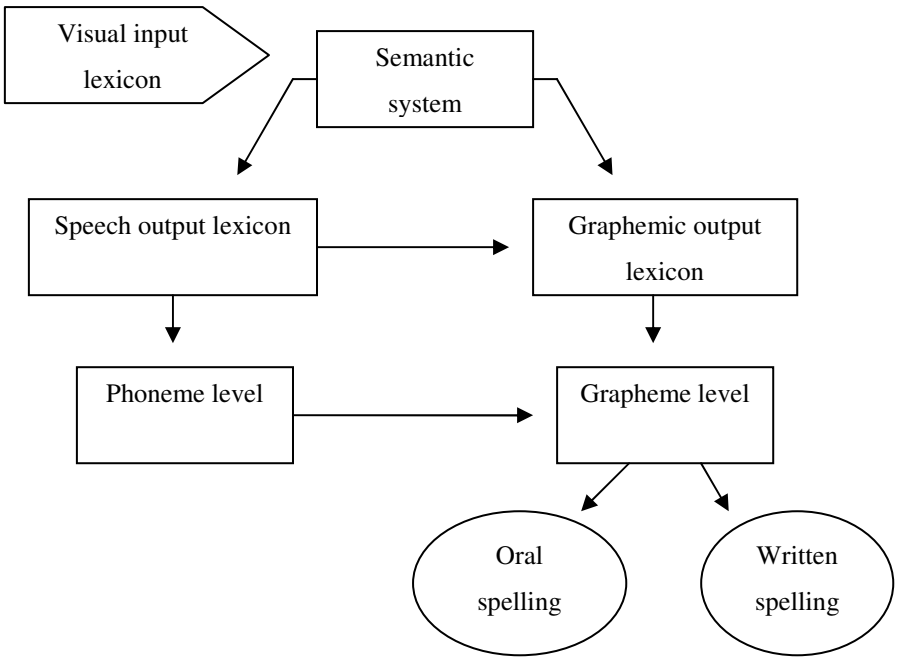


Figure 2: A simple functional model of some of the cognitive processes involved in spelling single words (adapted from Ellis, 1993: 63)

Apparent in the above figure 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 non-lexical 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 non-lexical) 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 *as well as spelling* ability.

It is valuable to outline the 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 where 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.

A survey of 500 children (aged 10-12) in the UK found interesting results of children's spelling abilities, such as most children are better at spelling the name of their favourite band than the word favourite, as well as a massive 85% who could spell "Hogwarts", 80% who could spell 'David Beckham' and only 15% who could spell 'Jane Austen' (Education (UK), 2002). This survey highlights dramatically the influence of a child's context, their interests and motivation to spell and read.

Dyslexia and spelling

Individuals with dyslexia typically have significant difficulties with spelling as well as with reading (Boder, 1973; Crichley, 1975, cited in Bourassa & 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 where 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: 329).

Methods for 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" (U.S. Office of Education, 1997, cited in 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: 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 (National Centre for Learning Disabilities, 2002, cited in 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):

1. 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.
2. 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.
3. 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.
4. 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 data sets, 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, 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):

1. General screening for dyslexia of all learners in the beginning school years
2. Implementing early intervention programmes
3. 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.

Focus of this research

From the introduction and the literature review, the following argument can be constructed.

Firstly, South Africa has an education system that is overextended on current funds, which while extensive are not sufficient, even without taking 'learners with special needs' as a priority for resources. This does not discount the importance or the severity of the needs of these learners in South Africa today.

Secondly, phonological awareness, as it has been defined in this chapter, has been shown over time to be a strong predictor of learning to read and of learning to spell. Given this, by assessing a child's level of phonological awareness in the classroom, it may be possible to identify children susceptible to learning difficulties.

This study focuses on the use of the Phonic Inventories as classroom-based instruments and attempts to establish whether particular patterns of errors on the Phonic Inventories are associated with dyslexia. This is done through administering the instruments to children who have been previously diagnosed as dyslexic and to children in normal mainstream schooling.

The aim of this study is to compare the performance of children identified to have learning difficulties with children in mainstream education. The Phonic Inventories will be used for this purpose. The study will involve comparing the errors the two groups of children make with the aim of establishing whether errors made on these classroom-based instruments can discriminate children identified as having learning difficulties from children in mainstream education.

The Phonic Inventories

Overview

This chapter serves to provide a comprehensive introduction to the Phonic Inventories. It explains the nature of the instrument as well as the reason that it was chosen as a potential measure to fulfil the requirements of a screening instrument for dyslexia.

All the instruments utilised in this study are written spelling tests and so this study made use of written spelling tests as measures of performance. The reasons for this were as follows: it is simple to administer to groups of children at one time. Also, according the definition for dyslexia used in this study, spelling is the most persistent indicator of dyslexia (Lundberg, 1999). And finally, it has been found that for younger children, there is no difference in performance between written and oral spelling, but that older children perform better on written spelling tests (Treiman & Bourassa, 2000a, cited in Bourassa & Treiman, 2003).

Measuring phonological awareness in a group situation

The Phonic Inventories consist of three classroom-based tests which can be administered and scored by teachers. They can be administered to large groups of children at one time, and take a modest amount of time to administer and to score.

The Phonic Inventories have been chosen for use in this study as they can be administered in groups and are designed to allow for error analysis. They thus have the potential to be used for screening for children in the South African education system, as an avenue to begin a process of identifying children with learning difficulties.

Group administration would allow for speed of administration, while error analysis would allow for individual profiles of errors to be drawn up. If patterns of errors were found which are characteristic of children with learning disabilities, this would allow for referral of these children for more in-depth diagnosis and testing. It would also allow more accurate estimations of the proportion of children who may require special educational needs, as well as open the possibility of identifying these children early, to offset educational delays.

However, given the size and lack of resources of the education system, such a screening instrument would need to be easily accessible. The scoring system would also need to be simple, accurate and reliable, if the instrument is to be one that teachers could administer and score, which could be administered to large groups and in a reasonable amount of time. Finally, it would need to accurately identify children who may be at risk for learning difficulties and should be investigated further. What is required is an instrument that fits all the demanding criteria of the unique situation of the South African education system as well as an instrument that is culturally appropriate for South Africa.

Finally and most importantly, the instrument would need to be one that has discriminative value, in being able to accurately and consistently act as a persistent indicator finally, what is required is an instrument that accurately and consistently taps into a persistent indicator of dyslexia. The literature chapter provided a strong argument for the use of phonological awareness as this indicator, being phonemic awareness and alphabetic awareness.

The Phonic Inventories (see Appendix C)

The Phonic Inventories were developed 20 years ago by Prof. C.S. Potter and were largely based on Jean Chall's research. They have been utilized to establish an initial starting point for remediation as well as ongoing monitoring of progress within the Targeted Revisualization Programme (see Appendix F).

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, 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.

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 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 to know which graphemes are appropriate in which instances.

Phonic Inventory Level Three: for this test the focus is on polysyllabic words. The words are presented in groups, 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, 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.

Skills measured by the Phonic Inventories

The Phonic Inventories are criterion-referenced tests (i.e. they are target specific and relate to particular developmental stages in the teaching of spelling, as opposed to being norm or group-referenced). The instrument's purpose is to ascertain how children make words and which phonic and alphabetic rules children have established and have not yet established.

Put another way, the Phonic Inventories are knowledge and content-based tests. Specifically, the scoring system of the Phonic Inventories is designed to identify the type of spelling errors made by a child. Administered either individually or in groups, the instrument allows for the establishment of a baseline of the individual patterns of spelling errors made by each child. Using this kind of information, an individual record and profile can be made for each child.

The Phonic Inventories have been used for this purpose with children identified as having learning difficulties as a way of establishing the types of errors made by children, to establish appropriate level of instruction on a remedial programme called the Targeted Revisualisation Programme. The error patterns are then used to inform instruction. Previous research (see Abelheim, 2002; George, 2002; Wilson, 2001) indicates that the instruments can be successfully used to assess the exact areas on which each individual child needs to focus, as well as to monitor progress made by each child (please see appendix E for an outline of the Targeted Revisualization Programme).

Given evidence of specific types of errors requiring remediation, the evidence from this previous research strongly suggests that the Phonic Inventories should be investigated as such an instrument, to identify children with potential learning difficulties, within the school system. The rationale would be to identify whether there are 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.

How the Phonic Inventories measure phonological awareness

The three tests making up the Phonic Inventories are split on complexity of task and type of task, measuring phonological awareness as follows:

When completing the Phonic Inventories, the child is required to listen to the verbal production of a word in isolation, listen to it embedded in a meaningful sentence, then listen to it again in isolation. Finally, the child is required to reproduce the word in written form on the page in front of them. But what does this actually require the child to do?

1. Listen to the target word in isolation. The child must attend to the person administering the test; speaking the target word. They must also correctly identify the individual phonemes that make up the target word as well as attend to the correct order of the phonemes.
2. Listen to the target word embedded in a sentence. This requires the child to assimilate the phonemes of the target word into one word, and aided by the context of the sentence, ascribe meaning to the word. The group of phonemes are creating a word with a fixed beginning and end, which is not as obvious to distinguish when heard as when seen in text form. The child must understand that the choice and order of phonemes are representing a meaning in the form of a spoken word, and must distinguish the target word from the other words in a sentence.
3. Listen to the target word again in isolation. The child must now pay close attention to the specific phonemes that make up the word and the order in which they occur, and hold this in short term memory. (This is likely to be a simpler task if the child has understood some meaning of the word from the sentence).
4. Reproduce the target word in written form. While holding the target word in short term memory, the child must isolate each phoneme, convert it to the relevant grapheme and produce these on the page in the correct order. This task requires firstly the ability to separate and manipulate phonemes in a word, and furthermore, convert them into written form using

phoneme-grapheme conversion, all the while understanding that the pieces are used to make meaning, and so what they sound like, what they look like and the order in which they occur are important and rule bound.

5. If the word is known, the child is likely to write the word using the lexical route. If unknown, it is likely to be assembled using a phonological or combined route, using previously assimilated phoneme-grapheme associations or knowledge of similar sounding (rhyming) words.

This process requires understanding that the written word is a representation of the spoken word and is meaningful. It also requires both phonemic awareness and alphabetic awareness to move from hearing the target word to reproducing it in written form. There are also a number of cognitive functions involved such as short term memory and fine motor skill and this relationship was discussed in the literature chapter. In terms of the sequences of skills involved in the development of phonological awareness (Gombert, 1992; Chard & Dickson, 1999; Adams, 1990, cited in Uhry, 1999), this instrument would appear to be measuring phonological awareness on a number of different levels.

It is also likely to enable children to utilise either a phonological or lexical route or a combination of the two. To be able to complete the tests, it will be necessary for a child to have developed skills in phonemic awareness as well as alphabet knowledge. The majority of the words used are phonically regular. However, irregularities as well as the use of similar long vowel sounds requiring use of different vowel digraphs imply that it is also necessary for a child to have been previously exposed to reading, and to have seen the word before.

How the Phonic Inventories relate to classroom measures of spelling

Given the knowledge and content-focus of the instruments, it would be anticipated that there would be a certain amount of overlap between the Phonic Inventories and other spelling tests currently used in South African classrooms and this was also investigated in this study.

With any new instrument or test, it is important that it measure a new set of content or skill, as opposed to merely duplicating the skills measured by existing instruments or tests. Besides the Phonic Inventories having been developed in South Africa (many other spelling tests being used are not), the biggest potential advantage of the Phonic Inventories is the relevance of the scoring system, and the potentially valuable extra information about patterns of error which the instruments afford. Whereas general classroom spelling tests deliver an estimate of a child's spelling ability – relative to some norm – based on the number of correctly spelled words, the Phonic Inventories involve a process of error analysis. This enables an estimate to be made of the level of phonemic and alphabetic awareness attained by the child.

General classroom spelling tests, in contrast, provide total scores. Error analysis is incidental, as opposed to involving a system designed to yield specific information about the patterns of error made by individual children. Because of the specialised scoring of the Phonic Inventories, it is possible to know a child's spelling level as well as specific areas of difficulty, that require attention or intervention. In this way, the Phonic Inventories move beyond traditional spelling assessment by directly accessing the level of phonological awareness and alphabetic knowledge attained by the child as well as the specific areas of difficulty.

For this reason, it is suggested that traditional spelling tests are heavily influenced by phonological awareness, whilst the Phonic Inventories specifically test for phonological awareness. In particular, the words in the Phonic Inventories have been chosen to test for phonemic awareness as the highest level of phonological awareness. The instrument taps the third, fourth and fifth levels of phonemic awareness identified by Adams (1990, cited in Uhry, 1999), namely:

- Segmenting onsets: segmenting words by syllables, involving segmenting phonemes and co-articulation of vowel sounds.
- Full segmentation of all phonemes in words: segmenting all phonemes in a word, and by using the alphabetic principle, spelling unfamiliar words.
- Manipulation of phonemes: manipulating the phonemes in a word, such that a learner can delete or exchange phonemes to make new words.

The Phonic Inventories are also based on awareness of the alphabetic principle, involving "an understanding of the relationship between letters ordered left to right in a written word and phonemes ordered in a specific temporal sequence in spoken language" (Uhry, 1999: 64). The child's written language is used to assess the understanding that the letters of the alphabet represent the sounds used in spoken language (Allen & Beckwith, 1999). The instruments are thus designed to test ability to use the alphabet in forming words as the bridge between speech and literacy (Allen & Beckwith, 1999).

Methodology

Instruments

1. Phonic Inventories (see appendix C)

The Phonic Inventories consist of three separate spelling tests.

- 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 – 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 – 7.
- Level Three consists of a list of 48 words, focusing of polysyllabic words. Level Three is appropriate for grades 3 – 7 for mainstream schools and grades 4 – 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 organization and rate of work, implying that a period of thirty minutes or longer was required for group administration of each test). Each test follows the same procedure: reading aloud the target word in isolation, reading aloud the target word in a sentence and repeating it again in isolation. The child then writes the target word on an A4 sheet of paper.

2. Daniels and Diack Graded Spelling Test (see appendix D)

The Daniels and Diack one word spelling test consists of a list of 40 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. This test is appropriate for children in grades 1 and 2.

3. Schonell Graded Spelling Test (see appendix E)

The Schonell graded spelling 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 Schonell is a very long test. As it is graded,

every ten words measure an age level, starting at age 5 and counting up to age 15. Given the time intensive nature of this test, it was only administered up to age 11 (that is, the first 60 words). This provided sufficient data for the purposes of this study and was a considered trade off to try and shorten the amount of time required to administer all the tests. This was the only place where it was possible to do so.

Both the Daniel and Diack and the Schonell tests are A Level tests as categorized by the HSRC and can therefore be administered by teachers or research assistants.

Research design

The study was a non-experimental ex-post facto design with the Independent Variables (IV) being the error types on the three levels of the Phonic Inventories. There were thirteen error types for each level, with 39 IV's in total. The Dependent Variables (DV) were the scores on the Daniel and Diack and the Schonell. The classification groups were the school type, being remedial or mainstream. There were seven levels, these being grades 1 – 7.

Sample and sampling

The sample in this study consisted of 741 primary school children. Of this, 229 children were attending Parkview Junior School (Grade 1 – 3), 329 children were attending Parkview Primary School (Grade 4 – 7) and 171 were attending Japari Remedial School (Grade 1 – 7). This means the sample was made up of primary school children from two groups; one group in mainstream education and one group in full time remedial education.

There was an even gender split with boys accounting for 52% of the sample and girls for 48% of the sample. The age range was from 6 to 15. The split across the grade was as follows (these percentages have been rounded off): Grade 1 (13%), Grade 2 (15%), Grade 3 (13%), Grade 4 (15%), Grade 5 (14%), Grade 6 (14%) and Grade 7 (17%).

All three schools are in the same geographic area (within walking distance of each other); they are serving the same community and have access to the same resources. Given these considerations, it makes the children attending them comparable on many levels. The sample was selected partly for this reason.

Given the populations of interest for this study were children in mainstream education and children in full time remedial education, the children at these three schools were the experimentally accessible population. The entire experimentally accessible population was sampled as all the children attending these three schools were included in the sample.

Procedure

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

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 – 3), it was decided that the teachers themselves should administer the tests as this would less disruptive for the young children. The researcher dropped off test packs (one per class) containing a letter to the teacher (see appendix A) as well as the tests relevant to their class, with instructions for each test, inside an A3 envelope. Grade 1 completed Phonic Inventory 1 and the Daniel and Diack; Grade 2 completed Phonic Inventories 1 and 2 as well as the Daniel and Diack. Grade 3 completed all three Phonic Inventories as well as the Schonell.
These were dropped off at the school, to be circulated from the main office. After the teachers had administered all the spelling tests, 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 3 weeks later. All the classes had completed the tests. This consisted of three Grade 1 classes, three Grade 2 classes and three Grade 3 classes. There was also one Grade 2 remedial class and one Grade 3 remedial class.

At Parkview Primary School, it was decided that an external research assistant aided by one teacher should administer the tests. The tests were administered to all the classes over the period of one week. Test packs were also put together for this school, with an A3 envelope pre-marked for each class. After all the tests had been administered, they were all placed inside the relevant envelope, and the envelope was sealed. All classes completed all three levels of the Phonic Inventories as well as the Schonell. This consisted of three Grade 4 classes, three Grade 5 classes, three Grade 6 classes and four Grade 7 classes.

2. For the remedial school

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. Only the Phonic Inventories were administered to the children at Japari.

Data organization and scoring

Once all the tests (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 weeks. For the Daniel and Diack, which is a right–wrong spelling test, the child

received a score out of 40. For the Schonell, which is also a right-wrong spelling test, the child received a score out of 60.

Scoring of errors in the three Phonic Inventories was done using a specially designed notation, enabling errors to be categorised and tallied in an error grid (see appendix G for an example of how this grid is used). 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 1 below.

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 *initial* 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.	/th/ = /t/ /sch/ = /sh/ /str/ = /st/ /scr/ = /sk/ /scr/ = /scr/

	*note distinction from wrong word *note distinction from letter reversal	/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/ /charm/ = /chem/
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 cluster	This type of error refers to mistakes made in spelling consonant blends, where 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 of the omission of a letter. Alternatively, an extra letter may be added in. *note distinction from ending consonants *note distinction from letter reversals	/hedge/ = /hej/ /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	/here/ = her/ /rule/ = /rul/ /spare/ = /spar/ /like/ = /lik/

	/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	/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/ /ive/ = /eve/ /tion/ = /shin/ 2./happily/ = /hapily/ /happily/ = /happely) /hoping/ = /hopeing/
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/.	postman/ = /post man/ /bird/ = /birad/ /hoping/ = /hopping/ /bigger/ = /biger/

	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).	
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/

Table 1: Error marking outline for the Phonic Inventories

As mentioned, different types of words are included in the different levels of the Phonic Inventories. Level One focuses on words with short vowel sounds, Level Two focuses on words with long vowel sounds and Level Three focuses on polysyllabic words. As a result, some error types are expected to occur more frequently on one or other level of the instrument. The aim of the analysis as a whole is ipsative, based on an attempt to identify the types of errors made by children. One is 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 is also to identify the position within words where the child makes errors, as this may indicate 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 is to identify the stage of phonological development a particular child has reached, as the basis for building the phonological system further.

Classification of errors

Errors are classified by considering the form of the target word against the form of the word the child has written. Thus, if a word is based on a short vowel sound which requires use of a single vowel /a/ (e.g. /cat/), and the child uses a vowel digraph /ae/ (the child writes /caet/), this is scored as a medial vowel error, affecting use of the short vowel sound. If a word requires an initial blend /th/ (e.g. 'this') and the child spells the word with one consonant /t/ (writing /tis/), this is scored as an initial blend error.

The logic of the analysis is as follows: all errors would be scored and classified. In a particular level of the phonic inventory, it might be found that the child makes a large number of ending blend errors as well as medial vowel errors affecting short vowels. However, the child the child makes few errors with either initial consonants or initial consonant blends. If this pattern is found, the deduction would be that the child has established the rule systems relevant to initial consonants and initial blends in his/ her phonological development. However, there would be errors affecting the use of short vowels in words, indicating difficulties with the rule systems relating to short vowel sound/ letter relationships. These might also be indicative of other more underlying problems affecting phonological development (e.g. difficulties relating to auditory discrimination of vowels), which would then need to be tested in more depth.

The errors made with ending blends/ clusters would also be indicative of difficulties with the rule systems relating to blending letters at the end of words (e.g. /chimps/ =

/chims/; /tusks/ = /tuss/) as well as difficulties in establishing the rules relevant to the use of the clusters of letters which work together to make single sounds at the end of words (e.g. /ll/, /ff/, /ss/, /ck/, /th/, /tch/, /ng/). If blending/ clustering rules are being established at the beginning of words but not at the end of words, this could also be indicative of other underlying problems affecting phonological development (e.g. difficulties relating to sequencing and/ or auditory sequential memory), which would then need to be tested in more depth.

Each error should be scored only once, and fitted into one category. For example, it is possible certain long and short vowel errors could potentially be scored under medial vowel digraph error. Any individual error can 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.

The classroom context

Another aspect taken into consideration when scoring the Phonic Inventories was the context of the full class of tests. If for example the whole class wrote down the wrong word, then it is possible that the administrator read out the wrong word, and this was not scored as an error. Similarly, if a whole class wrote down the wrong form of a word, then it is possible that the administrator mispronounced the word or read it in a sentence that gave it the wrong context.

Equally, if the majority of children in a particular classroom make the same error, this could be an indicator that the type of teaching in the classroom programme has influenced the error made. This context was taken into consideration when scoring the tests, as well as in the way in which scores of children were considered relative to each other in the statistical analysis, which focused on proportions of errors made by children as opposed to frequencies.

Finally, 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.

Data coding

Once all the tests were marked and coded, the scripts were handed over to another research assistant who entered all the data 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 actually 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 the list of variables in this study as outlined in Table 2 below.

Variable	Range	Scale of measure
Biographical		
School	Remedial/ mainstream	Nominal
Year of study	Grade 1-7	Ordinal
Gender	Girl/ boy	Nominal
Age	In years	Interval
Test variables		
Phonic Inventory Level One		
Phonic one total	Frequency	Interval
Initial consonant (IC)	Frequency	Interval
Initial blend (IB)	Frequency	Interval
Medial vowel (MD)	Frequency	Interval
Medial vowel digraph (MD)	Frequency	Interval
End consonant (EC)	Frequency	Interval
End blend (EB)	Frequency	Interval
Long short vowel confusion (LS)	Frequency	Interval
Consonant/ sound confusion	Frequency	Interval

Reversals/ transposals	Frequency	Interval
Prefix errors (Pref)	Frequency	Interval
Suffix errors (Suff)	Frequency	Interval
Syllabification errors (Syll)	Frequency	Interval
Other errors (other)	Frequency	Interval
Phonic Inventory Level Two		
Phonic two total	Frequency	Interval
Initial consonant (IC)	Frequency	Interval
Initial blend (IB)	Frequency	Interval
Medial vowel (MD)	Frequency	Interval
Medial vowel digraph (MD)	Frequency	Interval
End consonant (EC)	Frequency	Interval
End blend (EB)	Frequency	Interval
Long short vowel confusion (LS)	Frequency	Interval
Consonant/ sound confusion	Frequency	Interval
Reversals/ transposals	Frequency	Interval
Prefix errors (Pref)	Frequency	Interval
Suffix errors (Suff)	Frequency	Interval
Syllabification errors (Syll)	Frequency	Interval
Other errors (other)	Frequency	Interval
Phonic Inventory Level Three		
Phonic three total	Frequency	Interval
Initial consonant (IC)	Frequency	Interval
Initial blend (IB)	Frequency	Interval
Medial vowel (MD)	Frequency	Interval
Medial vowel digraph (MD)	Frequency	Interval
End consonant (EC)	Frequency	Interval
End blend (EB)	Frequency	Interval
Long short vowel confusion (LS)	Frequency	Interval
Consonant/ sound confusion	Frequency	Interval
Reversals/ transposals	Frequency	Interval
Prefix errors (Pref)	Frequency	Interval
Suffix errors (Suff)	Frequency	Interval
Syllabification errors (Syll)	Frequency	Interval
Other errors (other)	Frequency	Interval
Contrast spelling tests		
Daniel and Diack (DD)	Frequency	Interval
Schonell (Scho)	Frequency	Interval

Table 2: Variables in the study

Analyses

1. Summary statistics

Summary statistics were computed for all the biographical variables. Since these variables are either nominal or ordinal, the statistics run were frequencies, presented as percentages or ratios. This served the purpose primarily of describing the sample and the data set.

2. Converting frequencies to proportions

The error types were first entered as frequencies for each child. However, use of frequency data in statistical analysis of the results was considered to be problematic where the aim was to compare across children. To use frequencies would open the process to a number of potential errors, as the relevance of error type was likely to be mediated by the total number of errors made by each child. In a non-experimental design, to use frequencies would also have opened the results to a number of possible confounding variables (such as language, spelling ability, education of parents, quality of teaching received; cultural and ethnic factors) which could have influenced the total number of errors an individual child made. In multicultural classes, there was an even higher potential for the influence of third variables on the results.

The logic of the analysis lay on the relative importance of particular error types and so the overall pattern of errors made in groups of children (e.g. the performance of particular classrooms of children), as opposed to the frequency of errors made by one child (the ipsative performance of individual children). Group performance would thus need to be considered in such a way that groups could be compared to each other, irrespective of the number of errors made by individual children.

To correct for possible unknown contextual or biographical factors affecting the performance of particular children or classrooms, all the error type frequencies were thus converted into proportions of total errors made by each individual child. This transformation would allow these data (i.e. proportions as opposed to frequencies) to be comparable across children where matching was not possible as biographical

details and socio-economic background were unknown. Essentially, the comparison would be between proportions based on the weighting of each error type relative to the number of errors made by the child. In this way, each child would act as their own control, controlling for any confounding variables.

3. Repeated measures ANOVA

Repeated measures ANOVA was then used to establish if there were differences between the classification groups and levels. Specifically, the interest was on differences across the error types, across the grades and across the schools. Before analysis, it was necessary to run a sphericity test to check the data for type II covariance. If this is the case, then it is necessary to interpret the multivariate results as these procedures take this into account.

This is the only assumption that must be met for this test. A sphericity test was thus was run before each procedure and the results presented in each section, prior to analysis of the results of each repeated measures ANOVA.

4. Post hoc analysis

After analysing the results from the repeated measures ANOVA, it became clear that it would be valuable to consider the results in more detail, but on a practical level. For these analyses, frequencies were used. The logic was that where differences in proportions were evident, it would be more useful practically to understand the key differences and thus the patterns in terms of frequencies. Having an understanding of differences in proportions made good statistical sense, but it would not help teachers to make decisions about instruction, nor be helpful to subsequent researchers in situations where information on the biographical details and socio-economic backgrounds were available.

The focus of post hocc analysis lay on the frequencies of error types which had been demonstrated through repeated errorrs ANOVA to have high relevance. This was done with the confidence that the proportions of these errors were statistically different, but with the need to know in absolute numbers what these differences

looked like for the samples in the study. Although the issue of confounding variables was still relevant, it was felt that this would be the case in any clinical application of the instrument. As the post hoc analyses focused only on high frequency error proportions which had been demonstrated to be statistically significant, it was felt that this type of post hoc analysis was warranted.

The post hoc analyses were conducted purely on an exploratory and descriptive level, through use of frequency tables. The differences in frequency data were not tested for significance. The logic in not doing so was that, in the absence of biographical and socio-ecconomic data on each child, significance testing would not have added any further concrete evidence. It might, in addition, have produced misleading results, by opening a non-experimental design up to the potential influence of third variables.

The logic of this study as a whole has thus been to focus on the *pattern* of errors for statistical purposes, as opposed to the actual values themselves.

5. Regression analysis

A stepwise regression analysis was run to establish if, and how well, the Phonic Inventories predicted performance on contrast spelling tests. For this procedure it was decided to use the total number of errors on each level of the Phonic Inventories as predictor variables rather than the error types. This was the result of trying to establish the best form of comparison due to the differences in types of words included in each of the three levels, as well as the disparate methods of scoring the tests which resulted from these content differences.

Essentially, the logic was based on the assumption that using individual error types would have fragmented the results of the Phonic Inventories. However, using a total score of right or wrong answers was also not considered appropriate as the Phonic Inventories are never scored in this way. It was thus concluded that the overall number of errors was the most meaningful and complete way of presenting the Phonic Inventories in this analysis.

An argument must be made why it was considered inappropriate to use frequency scores for the repeated measures ANOVA, but considered appropriate to use frequencies for the regression analysis. The rationale for not using frequencies for the repeated measures ANOVA has already been presented, and was based on controlling for the individual differences between children. However, it was assumed that as both the Phonic Inventories and the contrast spelling tests test different facets of spelling ability, these individual differences would affect both the Phonic Inventories and the contrast spelling tests (the Daniel and Diack and the Schonell) in similar ways. Since it was the same group of children completing the tests and both predictor and criterion variables would be likely to be similarly affected, similar third variables would be likely to affect both predictor and criterion variables.

Essentially, this would mean that the groups of children would act as controls for themselves. Thus for the regression, it was concluded that frequency scores were relevant and appropriate.

6. Discriminant analysis

A discriminant analysis procedure was run to determine how well performance on the Phonic Inventories could predict to which classification the children belonged, that is remedial or mainstream. This was done using a complete set of all three levels of the Phonic Inventories. This was then contrasted against similar discriminant analyses based on each of the three levels of the Phonic Inventories, to establish whether the battery as a whole had better discriminative power than each of the individual levels.

Ethics

Japari Remedial School is a private institution and thus permission was required from the principal. This was attained through a personal meeting. Since the teachers administer the tests routinely, there was no need to invite them to participate. However, a letter was circulated as a follow up to the original staff meeting (see appendix A) to keep the teachers involved. Furthermore, parental consent was attained by letter (see appendix B).

Since Parkview Junior School and Parkview Primary School are government run institutions it was necessary to get permission from the Department of Education. At Parkview Junior School, it was necessary to invite the teachers to participate, and this was done by way of a letter (see appendix A). Also, at Parkview Junior and Parkview Primary School, parental consent was attained through a letter (see appendix B). Furthermore, at these schools, child assent was attained verbally, by the individual (either the teacher or the research assistant) administering the tests. However, they were clearly instructed to inform the children of their right to not participate and to discontinue at any time, without any adverse consequences to themselves.

Finally, confidentiality was ensured by numbering all the test scripts and keeping this list separate from the scripts themselves. No individual information was recorded or reported as the level of interest was on group trends.

Finally, feedback sessions have been scheduled at all the schools involved.

Results

Variables

For ease of reference table 3 below reiterates the variables in the study, along with their meaning and for which analyses they were used. Given that during analyses, new variables were created (such as for proportions), this list does not exactly match the variable list as it was entered into MS Excel.

Variable	Meaning	Analyses used
Biographical		
Group	Remedial/ mainstream	Summary statistics, repeated measures ANOVA, discriminant analysis
Grade	Grade of child (1 – 7)	Summary statistics, repeated measures ANOVA, post hoc analysis
Gender	Boy, girl	Summary statistics
Age	In years	Summary statistics
Test variables		
Phonic Inventory Level One		
Total errors 1	The total number of errors on Level One	Regression analysis
Error type 1	Proportion Initial consonant	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 2	Proportion Initial blend	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 3	Proportion Medial vowel	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 4	Proportion Medial vowel digraph	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 5	Proportion End consonant	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 6	Proportion End blend	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 7	Proportion Long short vowel confusion	Repeated measures ANOVA, discriminant analysis, post hoc analysis

Error type 8	Proportion Consonant/ sound confusion	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 9	Proportion Reversals/ transposals	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 10	Proportion Prefix errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 11	Proportion Suffix errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 12	Proportion Syllabification errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 13	Proportion Other errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Phonic Inventory Level Two		
Total errors 2	The total number of errors on Level Two	Regression analysis
Error type 1	Proportion Initial consonant	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 2	Proportion Initial blend	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 3	Proportion Medial vowel	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 4	Proportion Medial vowel digraph	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 5	Proportion End consonant	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 6	Proportion End blend	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 7	Proportion Long short vowel confusion	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 8	Proportion Consonant/ sound confusion	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 9	Proportion Reversals/ transposals	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 10	Proportion Prefix errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis

Error type 11	Proportion Suffix errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 12	Proportion Syllabification errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 13	Proportion Other errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Phonic Inventory Level Three		
Total errors 3	The total number of errors on Level Three	Regression analysis
Error type 1	Proportion Initial consonant	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 2	Proportion Initial blend	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 3	Proportion Medial vowel	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 4	Proportion Medial vowel digraph	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 5	Proportion End consonant	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 6	Proportion End blend	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 7	Proportion Long short vowel confusion	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 8	Proportion Consonant/ sound confusion	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 9	Proportion Reversals/ transposals	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 10	Proportion Prefix errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 11	Proportion Suffix errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 12	Proportion Syllabification errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis
Error type 13	Proportion Other errors	Repeated measures ANOVA, discriminant analysis, post hoc analysis

Contrast spelling tests		
Daniel and Diack	Total score on Daniel and Diack	Regression analysis
Schonell	Total score on Schonell	Regression analysis

Table 3: Variables for analysis

Table 3 works as a reference guide to the variables in the analyses to follow. To note specifically that the error types coded for all three levels of the Phonic Inventory were the same. However, they were entered under the heading of the test, being Level One, Level Two or Level Three. For this reason, although the same errors were coded for each test, the numbers of each error type made on each level were kept separate.

Cleaning the data set

All the data was entered into an Excel spreadsheet. This was then imported into SAS Enterprise Guide 3 (SAS Institute, 2004).

First of all, a check for data errors was done. There were no errors. Thereafter, a rho column was added to be able to keep track of record numbers. At this stage, 12 records were deleted from the sample. These were children from Parkview Junior School who were in remedial classes. These children did not fall in either group of the study. That is, they were neither fulltime remedial nor fulltime mainstream. Also, the sample was large enough to allow for this loss. At this point, a new variable, GROUP was added. This identified all the children in the study as either remedial or mainstream.

The data set was now ready to run checks for missing values. The guideline used stipulated that should the missing values account for less than 10 percent of the sample of values, then they would be imputed. This was done to avoid the need to use alternate analyses should there be missing values. However, the patterns of missing values were checked to ensure that they were all at least missing at random, and not the result of a systematic error.

- There were four missing values for the Gender variable.
- There were also four missing values for Age.
- For the test scores, there were seven missing values for the Daniel and Diack, 13 missing values for the Schonell, 14 missing values for the Phonic Inventory Level One, 19 for the Phonic Inventory Level Two and 8 for the Phonic Inventory Level Three.

A multiple imputation was done for the whole data set using a SAS callable package, IVEware (see: http://www.isr.umich.edu/src/smp/ive/). The requirement to qualify for this is missing at random data which was met by this data set. It uses a Sequential Regression Imputation procedure that allows for all missing data to be imputed all at one time, being able to support count and continuous data as well as binary or categorical data. Since some variables in the data had a set range, limits were set on what imputed values were allowed. These limits are shown in table 4 below. To note is that not all the children wrote all the tests, and so some missing values were valid. Although this procedure imputes all the missing values, this was accounted for by only including the relevant sample sections in the different analyses. Once all the missing values had been imputed the data set was ready for analysis.

Variable	Values
Subject	1 – 741
School	1/ 2/ 3
Grade	1 – 7
Gender	1/ 2
Age	6 – 15
DD	0 – 40
Schon	0 – 60
Total errors 1	0 – 50
Error type 1 – 13	0 – 50
Total errors 2	0 – 59
Error type 1 – 13	0 – 59
Total errors 3	0 – 48
Error types 1 – 13	0 – 48

Table 4: Limits for variable values

At this stage, the errors had been entered as frequencies. However, to make the relative importance of the errors comparable across subjects, these were converted to proportions. Each error was now represented as a proportion of the total errors made by each child. Thus, the relative importance of each error type was comparable across children irrespective of whether the children made a different number of errors overall.

Biographic variables

Table 5 below shows the split between the mainstream sample (Parkview Junior and Parkview Primary) and the remedial sample (Japari). 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.

	Frequency	**Percent**
Parkview Junior	229	31.4
Parkview Senior	329	45.1
Japari	171	23.5
Total	729	100.0

Table 5: Ratio of mainstream to remedial schools

Table 6 below shows the split of gender across the two sample groups of mainstream and remedial. Evident in this table, is the roughly equal gender split in the mainstream sample and the male skew in the remedial sample. However, gender was not a research variable in this study, and so this was not seen to be problematic.

	GROUP			
	Mainstream		Remedial	
	Gender		Gender	
	Male	Female	Male	Female
Grade 1	37	41	10	4
Grade 2	42	40	18	8
Grade 3	32	37	18	9
Grade 4	45	38	16	10
Grade 5	35	38	15	17
Grade 6	28	48	18	5
Grade 7	45	52	17	6
Total	264	294	112	59

Table 6: Sample split over school and gender

The age range for the entire sample was 6 to 15 years. This is expected for primary school level, with greater density in the middle region.

Repeated measures ANOVA

A repeated measures ANOVA procedure was used to answer research questions 1, 2 and 3. This was to establish if there were statistical differences between the patterns of errors made by the children in the two sample groups. Given that there were 13 error types, for each of the three levels of the Phonic Inventories, the number of errors for each child being compared was quite substantial. In such an instance, it is unlikely that the error variables were independent. A repeated measures ANOVA was used to correct for this.

The overall aim was to examine the impact of grade and group on the error rates for the three levels of the Phonic Inventories, thus establishing which factors influenced the pattern of errors. For all the following tests alpha was set at 0.01.

Question one: What are the patterns of spelling errors made by mainstream learners on the Phonic Inventories, i.e., children studying in mainstream classes?

Phonic Inventory Level One

For this level, Grade had 7 levels (Grade 1 – 7), with a total of 558 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (29699.526) with an associated of p < .0001, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of the repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

	Multivariate (test of Wilk's Lambda)	
Within Subjects	**Manova F**	**Pr > F**
Error type	325.97	<.0001
Between Subjects		
Grade	12.58	<.0001

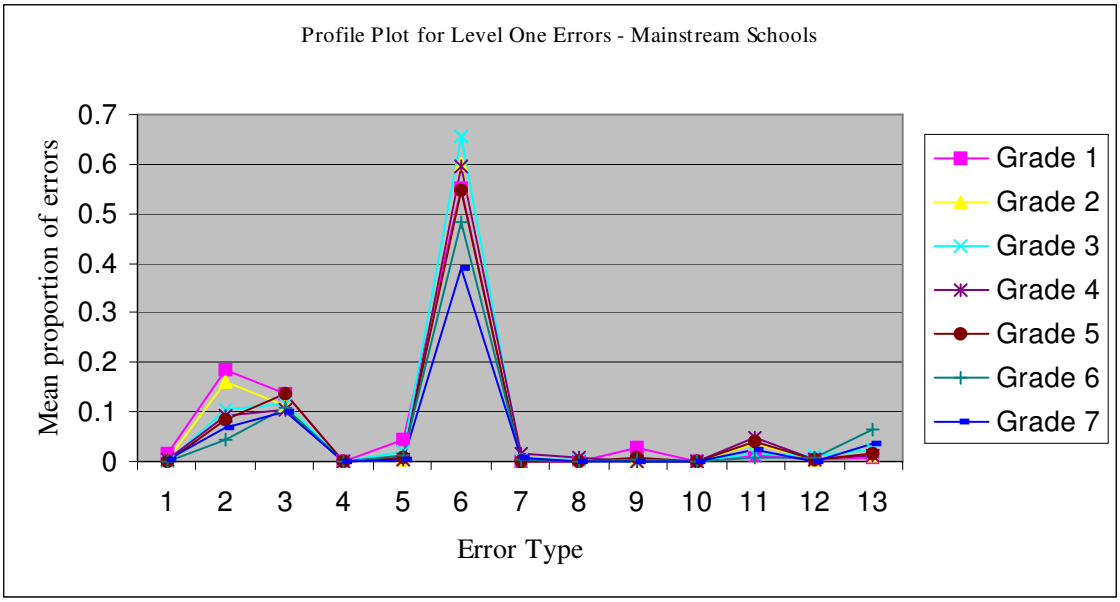
Table 7a: Repeated Measures ANOVA Results - Level One errors (mainstream)

Within subjects test

Null Hypothesis 1: this tested the hypothesis that there would be no change in the mean proportion of error types on Level One across type 1-13. The F= 325.97 with associated p <.0001, as seen in table 7a, leads to the rejection of the null hypothesis. Hence, it can be concluded that the proportion of error types changed over error type 1 - 13. That is, for the mainstream sample, for Phonic Inventory Level One, there is a significant difference in the proportions of the different error types made by the children.

Between subjects test

Null Hypothesis 2: this tested the hypothesis that the mean proportion of the different error types on Level One would be the same for learners in different grades. From this analysis, the significant between subjects main effect of grade (F =12.58 and p <.0001, as seen in table 7a), indicates that the average proportion of error types made by learners in different grades differed significantly. From this, it was concluded that, there was a significant difference between the patterns of errors children in mainstream classes made on the Phonic Inventory Level One over the different grades.



Plot 1: Mean rates for each error for Phonic Inventory Level One (mainstream schools)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 1 shows the mean proportion error rates for the different error types across the grades. There is a similar plot for each Phonic Inventory level for both mainstream and remedial groups. To note, for all the plots, as has been discussed in the methodology section, some errors will be more pronounced on one of the three levels, because there is more potential to make certain errors on certain levels. This is to be expected. But the relative patterns of these errors are the point of interest. To explain here, and the same applies to all the profile plots to follow, these values are mean proportions. That is, for error type 6 (end blends), a child in grade 2 would score 0.6.

So out of the errors that the child made, 60% of them were error type 6 (end blends). It is clear that error type 6 (end blends) was by far the most frequent error type across all the grades, accounting for between 40 and 65% percent of the errors, with error type 2 (initial blends) also standing out with up to 20% of the errors, especially for the lower grades and error type 3 (medial vowel) also being noticeable for all grades. To explain here, and the same applies to all the profile plots to follow, these values are mean proportions. That is, for error type 6, a child in grade 2 would score 0.6. So out of the errors that the child made, 60% of them were error type 6.

Given the above results, it was important to run pos hoc analysis on the frequencies of the key errors, to ensure the results were of practical value. Given the limitations of running a frequency analysis, this was limited only to those error types already noted to be key variables. Table 7b below provides the mean frequency and standard deviation as well as the sum of the errors for each of the key error types per grade for Phonic Inventory Level One. To reiterate, the purpose of this exercise was to establish patterns, and while it was necessary to see this pattern in frequencies, no significance testing was done on the frequencies given its statistical limitations.

	Error type 2 (initial blend)			**Error type 3 (medial vowel)**			**Error type 6 (end blend)**		
	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum
Grade 1	5	3	352	3	3	264	12	5	961
Grade 2	1	1	89	1	3	91	4	3	313
Grade 3	1	2	90	1	2	98	6	4	385
Grade 4	1	1	54	1	2	95	4	3	315
Grade 5	1	1	51	2	3	130	4	4	279
Grade 6	0	1	16	1	1	47	2	2	145
Grade 7	0	0	20	1	1	54	2	2	149

Table 7b: Frequency analysis of key variables for Level One (mainstream)

It is evident in table 7b that the frequencies of the key error types on Level One (initial blends, medial vowels and end blends) decrease with higher grades. The mean scores temper this effect somewhat because of the relatively low numbers or errors and the high stand deviation. However, the evidence clearly shows that the lower

grades make a substantively higher frequency of errors on the key error types. This suggests that the number of errors a mainstream learner makes on the key error types on Level One is an indicator of the grade that learner has reached.

Phonic Inventory Level Two

For this level, Grade had 6 levels (Grade 2 – 7), with a total of 480 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (6998.7044) with an associated of $p < .0001$, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

	Multivariate (test of Wilk's Lambda)	
Within Subjects	**Manova F**	**Pr > F**
Error type	349.06	<.0001
Between Subjects		
Grade	9.67	<.0001

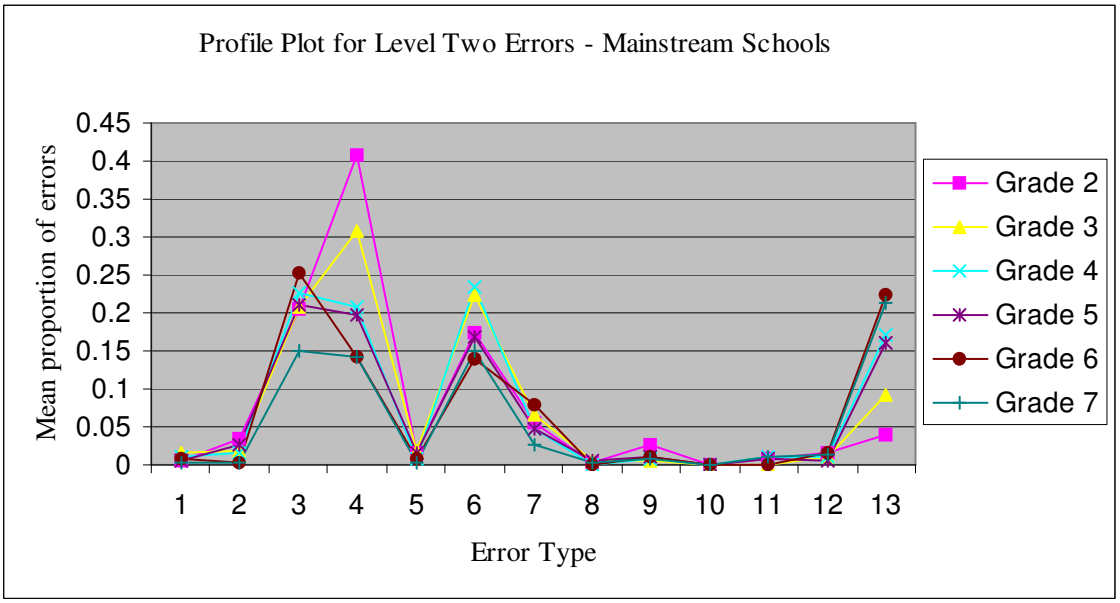
Table 8a: Repeated Measures ANOVA Results – Level Two errors (mainstream)

Within subjects test

Null Hypothesis 1: this tested the hypothesis that there would be no change in the mean proportion of error types on Level Two across type 1-13. The $F= 349.06$ with associated $p <.0001$, as seen in table 8a, leads to the rejection of the null hypothesis. Hence, it can be concluded that the proportion of error types changed over error type 1 - 13. That is, for the mainstream sample, for Phonic Inventory Level Two, there was a significant difference in the proportions of the different error types made by the children.

Between subjects test

Null Hypothesis 2: this tested the hypothesis that the mean proportion of the different error types on Level Two would be the same for learners in different grades. From this analysis, the significant between subjects main effect of grade (F =9.67 and p <.0001, as seen in table 8a), indicates that the average proportion of error types for learners in different grades differed significantly. That is, there is a significant difference between the patterns of errors children in mainstream classes made on the Phonic Inventory Level Two over the different grades.



Plot 2: Mean rates for each error for Phonic Inventory Level Two (mainstream schools)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

From Plot 2, it was evident that error type 3 (medial vowel), 4 (medial vowel digraph), 6 (end blend) and 13 (other errors) discriminated most between children in the lower and higher mainstream grades, with error type 4 (medial digraph) consisting of up to 40 % of the overall errors made on Phonic Inventory Level Two.

Again, it was of practical value to run a frequency analysis on the key error types for the Phonic Inventory Level Two, to see the pattern in frequency format. This is shown in table 8b below.

	Error type 3 (medial vowels)			**Error type 4 (medial vowel digraph)**			**Error type 6 (end blends)**			**Error type 13 (other errors)**		
	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum
Grade 2	4	3	364	8	5	645	4	3	318	1	1	70
Grade 3	3	2	182	4	3	263	3	2	183	1	1	72
Grade 4	2	2	165	2	2	164	2	2	153	1	2	110
Grade 5	2	2	119	2	2	134	1	2	104	1	2	70
Grade 6	1	1	82	1	1	66	1	1	53	1	1	63
Grade 7	1	1	71	1	1	62	1	1	65	1	1	75

Table 8b: Frequency analysis of key variables for Level Two (mainstream)

The evidence in table 8b shows a steady decline in the frequency of key errors (medial vowels, medial vowel digraphs, end blends, and other errors). The evidence suggests that the frequency of errors a leaner makes on the key errors on Level Two is an indicator of the grade that learner has reached.

Phonic Inventory Level Three

For this level, Grade had 5 levels (Grade 3 – 7), with a total of 398 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (12989.128) with an associated of $p < .0001$, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

	Multivariate (test of Wilk's lambda)	
Within Subjects	**Manova F**	**Pr > F**
Error type	265.28	<.0001
Between Subjects		
Grade	14.71	<.0001

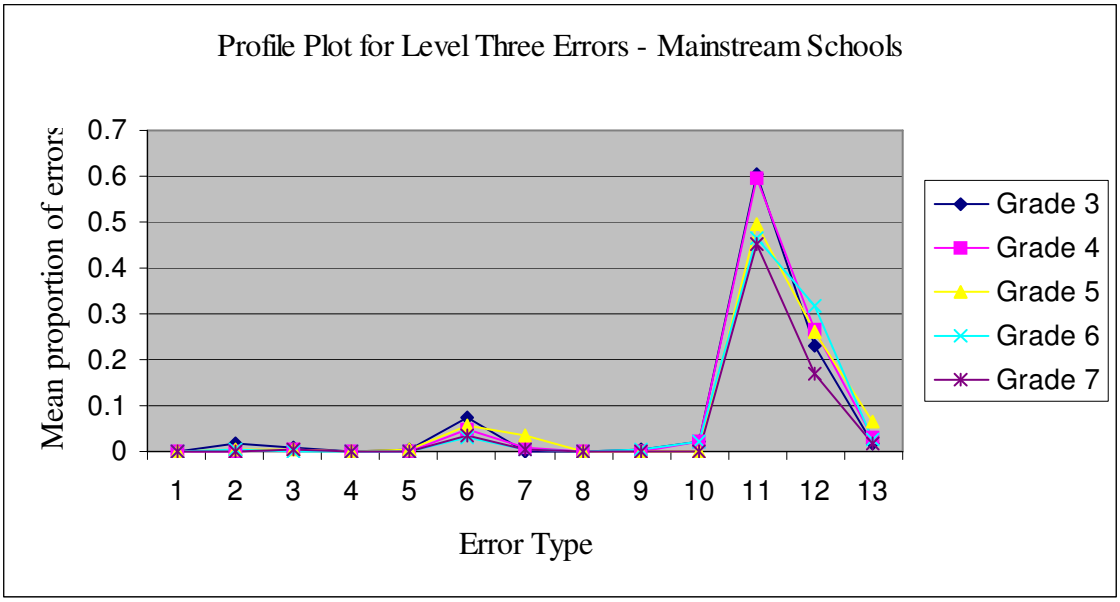
Table 9a: Repeated Measures ANOVA Results – Level Three errors (mainstream)

Within subjects test

Null Hypothesis 1: this tested the hypothesis that there was no change in the mean proportion of error types on Level Three across type 1-13. The F= 265.28 with associated p <.0001, as seen in table 9a, leads to the rejection of the null hypothesis. Hence, it is concluded that the mean proportion of error types changed over error type 1 - 13. That is, for the mainstream sample, for Phonic Inventory Level Three, there was a significant difference in the proportions of the different error types made by the children.

Between subjects test

Null Hypothesis 2: this tested the hypothesis the mean proportion of the different error types on Level Three would be the same for learners in different grades. From this analysis, the significant between subjects main effect of grade (F =14.71and p <.0001, as seen in table 9a), indicates that the average proportion of error types for learners in different grades differed significantly. That is, there is a significant difference between the patterns of errors children in mainstream classes made on the Phonic Inventory Level Three over the different grades.



Plot 3: Mean rates for each error for Phonic Inventory Level Three (mainstream schools)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 3 shows the mean error rates for the different error types across the grades. It is evident that error type 11 (suffix errors) was by far the most frequent, with 45-60% of the errors in Phonic Inventory Level three being of this type. Error 12 (prefix errors) were also common, with between 15-30% of the errors being of this type.

Finally, it was also important to run a frequency analysis on the key error types for the Phonic Inventory Level Three, to see the pattern of errors in frequencies. This is shown in table 9b below.

	Error type 6 (end blends)			Error type 11 (suffix errors)			Error type 12 (syllabification errors)		
	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum
Grade 3	1	2	89	8	5	518	3	2	190
Grade 4	1	1	52	5	4	455	2	2	184
Grade 5	1	1	50	4	4	275	2	2	128
Grade 6	0	0	15	2	2	181	1	1	106
Grade 7	0	1	18	2	2	173	1	1	71

Table 9b: Frequency analysis of key variables for Level Three (mainstream)

The evidence in table 9b shows a steady decline in the frequency of key errors (end blends, suffix errors and syllabification errors). The evidence suggests that the frequency of errors a leaner makes on the key errors on Level Three is an indicator of the grade that learner has reached.

Question 2: What are the patterns of spelling errors made by children who have been identified as having specific learning or reading difficulties on the Phonic Inventories, i.e., by children in full time remedial education?

Phonic Inventory Level One

For this level, Grade had 7 levels (Grade 1 – 7), with a total of 171 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (3531.2889) with an associated of $p < .0001$, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

	Multivariate (test of Wilk's Lambda)	
Within Subjects	**Manova F**	**Pr > F**
Error type	2119.46	<.0001
Between Subjects		
Grade	0.89	0.5042

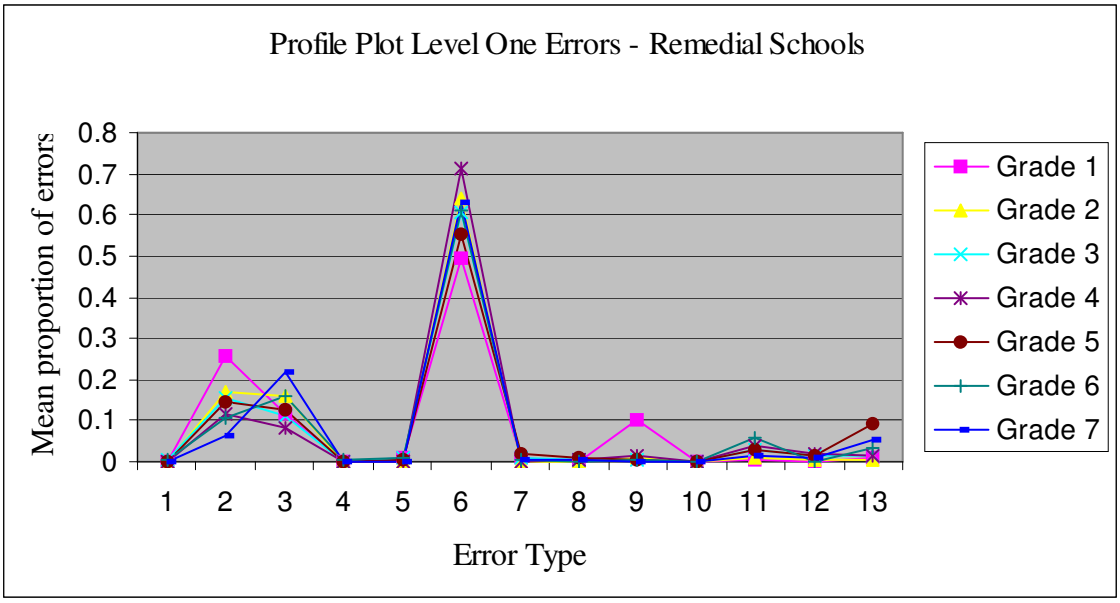
Table 10a: Repeated Measures ANOVA Results – Level One errors (remedial)

Within subjects test

Null Hypothesis 1: this tested the hypothesis that there was no change in the mean proportion of error types on Level One across type 1-13. The F= 2119.46 with associated p <.0001, as seen in table 10a, leads to the rejection of the null hypothesis. Hence, it was concluded that the proportion of error types changed over error type 1 - 13. That is, for the remedial sample, for Phonic Inventory Level One, there was a significant difference in the proportions of the different error types made by the children.

Between subjects test

Null Hypothesis 2: this tested the hypothesis that the mean proportion of the different error types on Level One would be the same for learners in different grades. From this analysis, the between subjects main effect of grade (F = 0.89, p = 0.5042, as seen in table 10a), indicates that the average proportions of the different error types on Level One for learner s in different grades *does not* differ significantly. That is, there is no significant difference between the patterns of errors children in remedial class make on the Phonic Inventory Level One over the different grades. This indicates that children in the different grades in the remedial school were not making significantly different patterns of errors on Phonic Inventory Level One.



Plot 4: Mean rates for each error for Phonic Inventory Level One (remedial school)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 4 shows the mean error rates for the different error types across the grades. It is evident that error type 6 (end blends) is the most frequent, accounting for between 50-70% of the errors made, with error type 2 (initial blends) and error type 3 (medial vowels) also showing some importance.

Similarly as for the mainstream group, a post hoc analysis was run on the key error types for the Phonic Inventory Level One, to see the pattern of errors in frequencies. This is shown in table 10b below.

	Error type 2 (initial blends)			Error type 3 (medial vowels)			Error type 6 (end blends)		
	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum
Grade 1	4	3	62	2	1	25	8	2	106
Grade 2	3	2	87	4	4	96	12	4	318
Grade 3	2	1	46	2	2	42	7	4	186
Grade 4	1	1	31	1	2	32	8	4	198
Grade 5	1	1	39	2	3	61	5	3	175
Grade 6	1	1	25	2	3	53	6	3	130
Grade 7	1	1	17	2	2	39	4	4	92

Table 10b: Frequency analysis of key variables for Level One (remedial)

The frequency analysis in table 10b clearly shows that there is not such a clear decrease in the sum frequencies of the key error types for the remedial group on Level One as was evident for the mainstream group. This is consistent with the finding that there was no significant difference in the mean proportions of the key error types over grade. At first glance, it appears that there was an overall lower frequency of errors made by the remedial group; however this is due to the fact that the remedial group had a smaller sample size. In fact, on average, the remedial group made more errors than the mainstream group. Also, unlike for the mainstream group, the frequency of key errors would not be an indicator of the grade attained by the learner.

Phonic Inventory Level Two

For this level, Grade had 6 levels (Grade 2 – 7), with a total of 157 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (2889.8802) with an associated of $p < .0001$, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

	Multivariate (test of Wilk's Lambda)	
Within Subjects	**Manova F**	**Pr > F**
Error type	1864.54	<.0001
Between Subjects		
Grade	0.95	0.4492

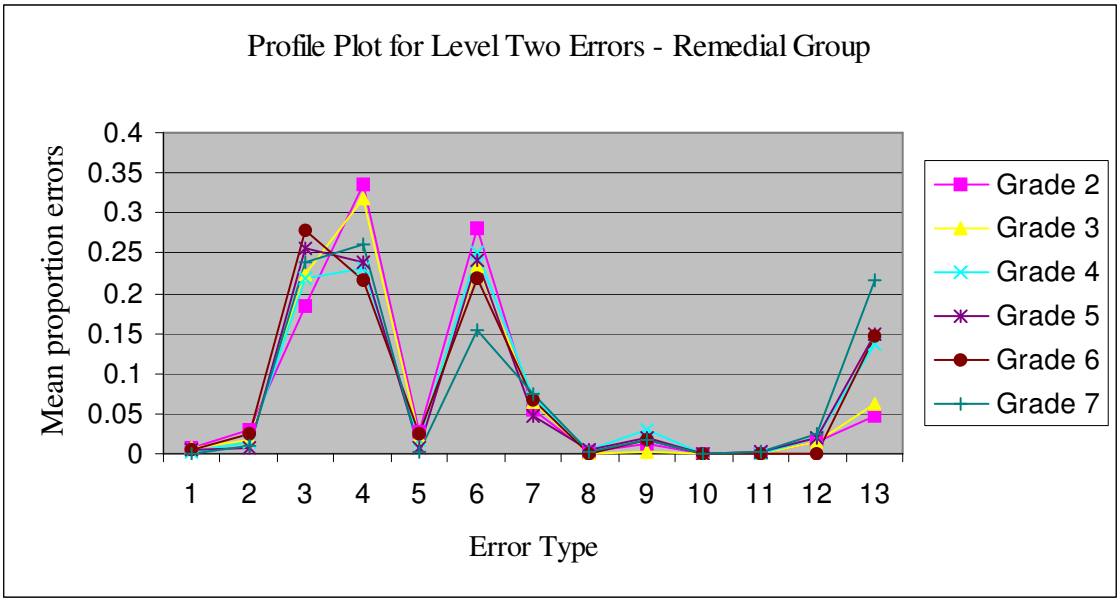
Table 11a: Repeated Measures ANOVA Results – Level Two errors (remedial)

Within subjects test

Null Hypothesis 1: this tested the hypothesis that there was no change in the mean proportion of error types on Level Two across error types 1-13. The F= 1864.54 with associated p <.0001, as seen in table 11a, leads to the rejection of the null hypothesis. Hence, it was concluded that the mean proportion of error types changed over error type 1 - 13. That is, for the remedial sample, for Phonic Inventory Level Two, there was a significant difference in the proportions of the different error types made by the children.

Between subjects test

Null Hypothesis 2: this tested the hypothesis that the mean proportion of the different error types on Level Two would be the same for learners in different grades. From this analysis, there was no significant between-subjects main effect of grade (F = 0.95, p = 0.4492, as seen in table 11a). This indicated that the average proportion of error types made by learners in different grades did not differ significantly. That is, there was no significant difference between the patterns of errors children in remedial class make on the Phonic Inventory Level Two over the different grades.



Plot 5: Mean rates for each error for Phonic Inventory Level Two (remedial school)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 5 shows the mean error rates for the different error types across the grades. Specifically, error types 3 (medial vowel), 4 (vowel digraph) and 6 (end blend) make up most of the error types, counting for 25%, up to 35% and 30% respectively.

The post hoc frequency analysis for the key error types for Level Two for the remedial group are shown in table 11b below.

	Error type 3 (medial vowels)			**Error type 4 (medial vowel digraph)**			**Error type 6 (end blends)**			**Error type 13 (other errors)**		
	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum
Grade 2	6	4	146	10	5	252	8	5	209	1	1	34
Grade 3	4	3	113	7	6	192	5	3	124	1	1	29
Grade 4	4	2	102	5	4	128	5	3	126	2	1	46
Grade 5	4	3	140	5	4	155	3	2	105	3	2	82
Grade 6	4	2	86	4	3	81	3	3	80	2	1	46
Grade 7	3	2	59	3	3	69	2	2	45	2	2	54

Table 11b: Frequency analysis of key variables for Level Two (remedial)

In table 11b above, it is clear that there is no steady decrease in the sum frequency of errors made on Level Two by the remedial group. This is consistent with the finding that there was no significant difference between the mean proportions of key errors over grade, suggesting that it would not be possible to use the frequency of key errors on Level Two as an indication of grade attained by the learner. Finally, relative to sample size, the remedial learners made, on average, a higher frequency of the key error types on Level Two than the mainstream learners.

Phonic Inventory Level Three

For this level, Grade had 4 levels (Grade 4 – 7), with a total of 90 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (2342.0641) with an associated $p < .0001$, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

	Multivariate (test of Wilk's Lambda)	
Within Subjects	**Manova F**	**Pr > F**
Error type	511.41	<.0001
Between Subjects		
Grade	0.98	0.4051

Table 12a: Repeated Measures ANOVA Results – Level Three errors (remedial)

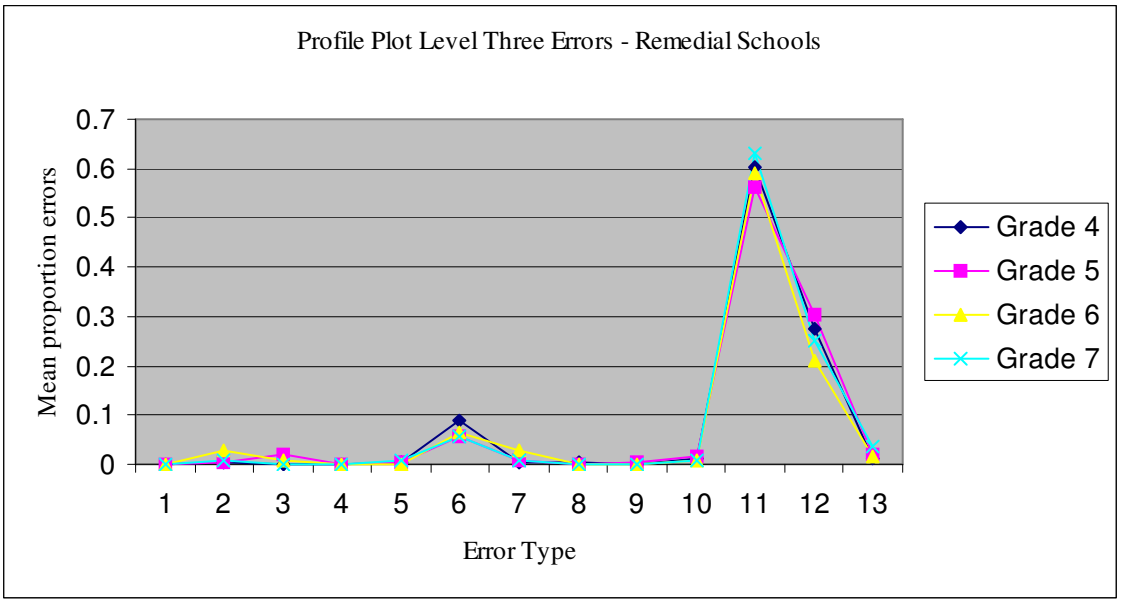
Within subjects test

Null Hypothesis 1: this tested the hypothesis that there was no change in the mean proportion of error types on Level Three over type 1 – 13. The $F= 511.41$ with associated $p <.0001$, as seen in table 12a leads to the rejection of the null hypothesis. Hence, it was concluded that the mean proportion of error types changed over error type 1 – 13. That is, for the remedial sample, for Phonic Inventory Level Three, there

was a significant difference in the proportions of the different error types made by the children.

Between subjects test

Null Hypothesis 2: this tested the hypothesis that the mean proportion of error types on Level Three was the same for learners in different grades. From this analysis, there is no significant between subjects main effect of grade ($F = 0.98$, $p = 0.4051$, as seen in table 12a), indicating that the average proportion of error types for learners in different grades did not differ significantly. That is, there is no significant difference between the patterns of errors children in remedial class make on the Phonic Inventory Level Three over the different grades.



Plot 6: Mean rates for each error for Phonic Inventory Level Three (remedial schools)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 6 shows the mean error rates for the different error types across the grades. It is evident that the most common error types made by this group were error type 11 (suffix errors) (+/- 60% of the errors made) with error type 12 (prefix errors) also

accounting for between 20-30%. Error type 6 (end blends) also features to a small amount.

Table 12b below shows the results from the post hoc frequency analysis run on the key error types for Level Three.

	Error type 6 (end blends)			**Error type 11 (suffix errors)**			**Error type 12 (syllabification errors)**		
	Mean	SD	Sum	Mean	SD	Sum	Mean	SD	Sum
Grade 4	2	1	18	9	5	108	4	2	42
Grade 5	1	1	30	8	5	265	4	2	112
Grade 6	1	2	25	6	4	143	2	2	57
Grade 7	1	1	13	6	3	129	2	2	51

Table 12b: Frequency analysis of key variables for Level Three (remedial)

The evidence in table 12b above shows that there is no steady decrease in the sum frequencies of the key error types, which is consistent with the finding that there was no significant difference between the mean proportions of the key error types on Level Three over grade. This suggests that the frequency of key error types a remedial learner makes on Level Three would not be an indicator of the grade that learner had attained. Finally, on average, and accounting for sample size, the remedial learners made a higher frequency of errors on the key error types on Level Three than did the mainstream learners.

Question 3: Are there differences in the patterns of spelling errors exhibited by mainstream learners and learners with identified learning difficulties?

This section is specifically focusing on the difference between the two groups - mainstream and remedial.

Phonic Inventory Level One

For this level, Grade had 7 levels (Grade 1 – 7) and 2 groups (remedial and mainstream), with a total of 729 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (16335.068) with an associated $p < .001$, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

	Multivariate (test of Wilk's Lambda)	
	Manova F	**Pr > F**
Between Subjects		
Group	26.15	<.0001
Grade*Group	3.58	0.0017

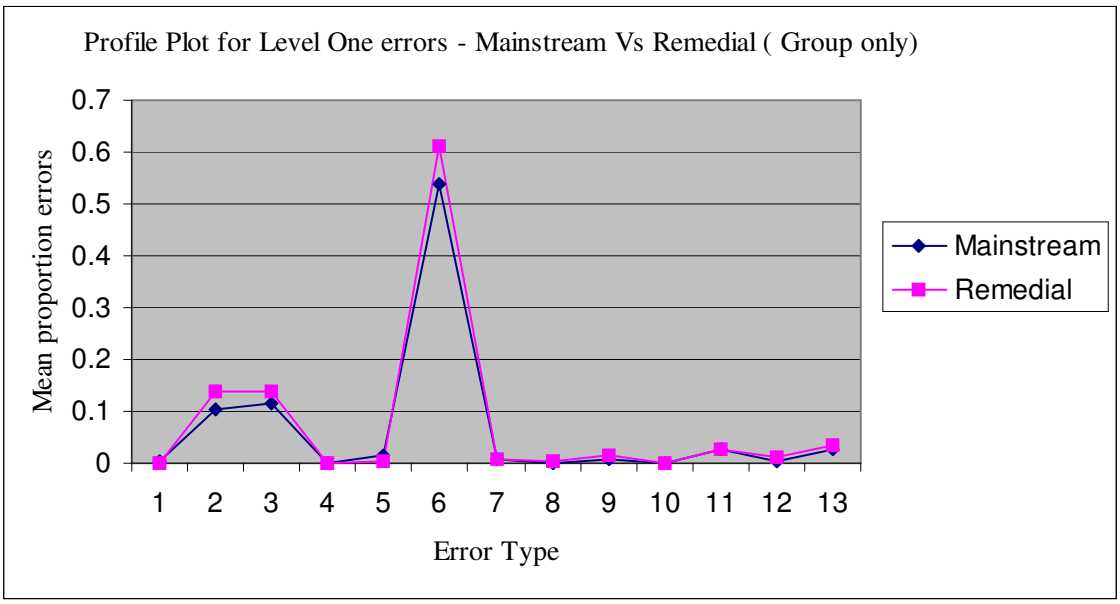
Table 13: Repeated Measures ANOVA Results – Level One errors (mainstreams versus remedial)

Between subjects test

Null Hypothesis 1: the hypothesis being tested was that group affiliation had no effect on the mean proportion of error types made on Level One. From this analysis, the significant between subject main effect of group, with $F = 26.15$ with an associated $p < .0001$, as seen in table 13, provided enough evidence to reject the null hypothesis and thus conclude that the mean proportion of error types for mainstream and remedial learners differed significantly. That is, for Phonic Inventory Level One, there were significant differences between the mean proportions of the different error types 1 – 13 made by children in mainstream and in remedial schools.

Null Hypothesis 2: the hypothesis being tested was that the grade by group interaction had no effect on the mean proportion of error types made on Level One. The analysis indicated a significant grade by group interaction effect with $F = 3.58$ and an associated $p = 0.0017$, as seen in table 13. Therefore, the null hypothesis was rejected and it was concluded that the grade in which the learner was enrolled combined with group affiliation (mainstream or remedial) influenced the mean proportion of error types made. That is, there was a significant difference between the

patterns of errors made by children in mainstream and remedial schools on Phonic Inventory Level One depending on their grade.



Plot 7: Mean rates for each error for Phonic Inventory Level One (mainstream and remedial schools)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 7 shows the mean error rates for the different error types for mainstream and remedial. To note is that although the differences are significant, in practical significance, the pattern of errors looks very similar, with remedial school children making a proportionately greater number of the key indicator error types over the mainstream learners.

Phonic Inventory Level Two

For this level, Grade had 6 levels (Grade 2 – 7) with two groups (remedial and mainstream), with a total of 637 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (9227.4304) with an associated of $p < .0001$, which is less than the alpha level of 0.01. This suggests that

the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

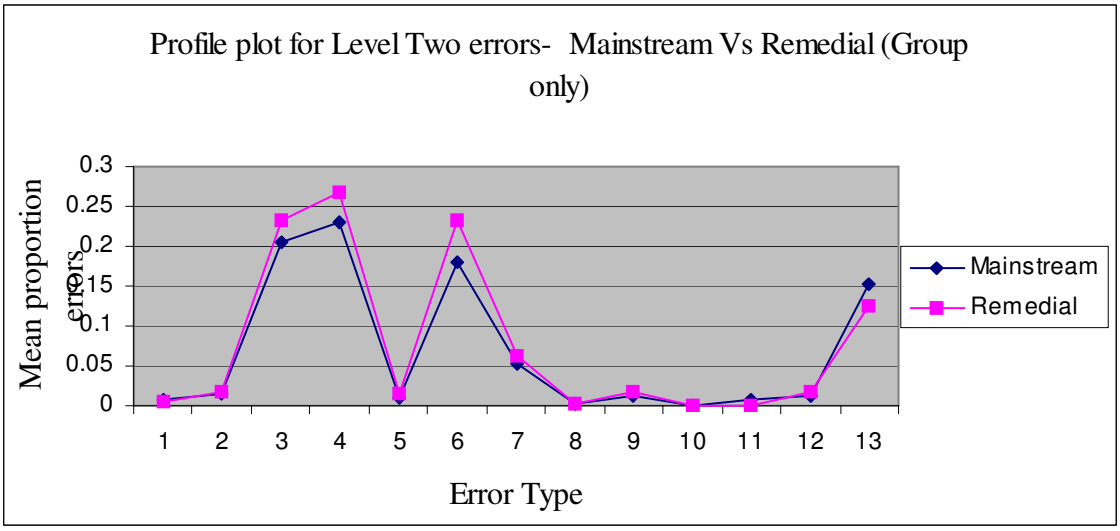
	Multivariate (test of Wilk's Lambda)	
	Manova F	**Pr > F**
Between Subjects		
Group	15.92	<.0001
Grade*Group	3.02	0.0105

Table 14: Repeated Measures ANOVA Results – Level Two errors (mainstream versus remedial)

Between subjects test

Null Hypothesis 1: the hypothesis being tested was that group affiliation had no effect on the mean proportion of error types made on Level Two. From this analysis, the significant between subject main effect of group with F = 15.92 with an associated p <.0001, as seen in table 14, was enough evidence to reject the null hypothesis, indicating that the mean proportion of error types for mainstream and remedial learners differed significantly on Level Two. That is, for Phonic Inventory Level Two, there were significant differences between the mean proportions of the error types made by children in mainstream and in remedial schools.

Null Hypothesis 2: the hypothesis being tested was that the grade by group interaction had no effect on the mean proportion of error types made on Level Two. The analysis indicated a significant grade by group interaction effect with F = 3.02 and as associated p = 0.0105, as seen in table 14. Therefore, the null hypothesis was rejected and it was concluded that the grade in which the learner was enrolled combined with the group affiliation (mainstream or remedial) influenced the overall mean proportion of error types. That is, there was a significant difference between the patterns of errors made by children in mainstream and remedial schools on Phonic Inventory Level Two, depending on the grade they were in.



Plot 8: Mean rates for each error for Phonic Inventory Level Two (mainstream and remedial schools)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 8 shows the mean error rates for the different error types for mainstream and remedial. A similar finding as for Phonic Inventory Level One, in that the pattern of errors superficially looks very similar. It is evident that the remedial learners are making a proportionately greater number of the key indicator error types over the mainstream learners.

Phonic Inventory Level Three

For this level, Grade had 5 levels (Grade 3 – 7), with a total of 488 observations included in the analysis.

The results of the Sphericity Test showed a Chi-square statistic (15300.74) with an associated of $p < .0001$, which is less than the alpha level of 0.01. This suggests that the data does not meet the sphericity assumption of repeated measures ANOVA. For this reason, the multivariate outputs of the results are used in the following interpretations.

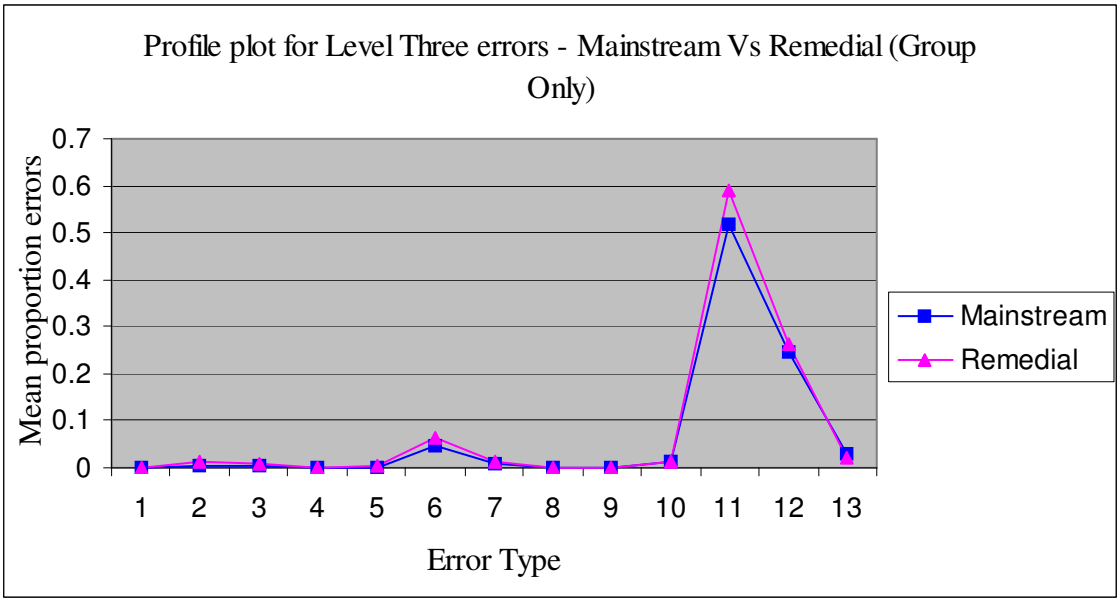
	Multivariate (test of Wilk's Lambda)	
	Manova F	**Pr > F**
Between Subjects		
Group	12.46	0.0005
Grade*Group	3.75	0.011

Table 15: Repeated Measures ANOVA Results – Level Three errors (mainstream versus remedial)

Between subjects test

Null Hypothesis 1: the hypothesis being tested was that group affiliation had no effect on the mean proportion of error types made on Level Three. From this analysis, the significant between subject main effect of group, with F = 12.46 and an associated p = 0.0005, as seen in table 15, made it possible to reject the null hypothesis, thus indicating that the mean proportion of error types for mainstream and remedial learners differed significantly on Level Three. That is, for Phonic Inventory Level Three, there were significant differences the mean proportions of the different error types 1 – 13 made by children in mainstream and in remedial schools.

Null Hypothesis 2: the hypothesis being tested was that the grade by group interaction had no effect on the mean proportion of error types made on Level Three. The analysis indicated a significant grade by group interaction effect, with F = 3.75 and an associated p = 0.011, as seen in table 15. Therefore, the null hypothesis was rejected and it was concluded that the grade in which the learner was enrolled combined with group affiliation (mainstream or remedial) influenced the mean proportion of error types. That is, there was a significant difference between the patterns of errors made by children in mainstream and remedial schools on Phonic Inventory Level Three depending on the grade they are were in.



Plot 9: Mean rates for each error for Phonic Inventory Level One (mainstream and remedial schools)

Key to error types												
1	2	3	4	5	6	7	8	9	10	11	12	13
Initial consonant	Initial blend	Medial vowel	Medial vowel digraph	End consonant	End blend	Long/short vowel confusion	Sound/ consonant confusion	Reversals/ transposals	Prefix errors	Suffix errors	Syllabification errors	Other errors

Plot 9 shows the mean error rates for the different error types for mainstream and remedial. To note is the similar pattern again between the errors of the two groups – remedial and mainstream – with the difference in the mean proportion of the key error types (which were statistically different) rather than in the type of errors being made.

Regression analysis

Question 4: Does performance on the Phonic Inventories predict performance on the Daniels and Diack spelling test (for grades 1 and 2) and the Schonell graded spelling test (for grades 3 – 7)?

This procedure was used to establish if a learner's performance on the Phonic Inventories could predict performance on a contrast spelling test. This was only relevant for the mainstream sample, as they completed the contrast tests. This analysis required special attention to ensure the results were meaningful. It was not

possible to use the frequencies of each type as predictors as, like before, in this form, the results were not comparable between learners. However, using proportions was not ideal either, as this would require rescaling the results to make them sensible and it was decided to rather not manipulate the data unless absolutely necessary. Using the total scores of right-wrong answers for the Phonic Inventories was also not desirable as this is not how these tests are scored. Therefore, it was decided to use the total number of errors for each level of the Phonic Inventories as predictor variables. This used a meaningful method of scoring the Phonic Inventories as predictor variables, without creating the need to rescale the results. It does not indicate the overall importance of each error type, but that information is available from the repeated measures ANOVA. So the variables, Total errors 1 (total errors on Level One), Total errors 2 (total errors on Level Two) and Total errors 3 (total errors on Level Three), were created as the total number of errors on each level of the Phonic Inventories and these were entered as predictor variables for the Daniel and Diack and the Schonell contrast spelling tests.

First, a stepwise regression was run using the total errors from Phonic Inventory Level One (Total errors 1) and the total errors from Phonic Inventory Level Two (Total errors 2). This was because the learners who completed the Daniel and Diack were in Grades 1 and 2 and so would only have completed either only Phonic Inventories Level One or Levels One and Two. Both predictor variables were included in the final model, which was significant ($F = 91.62$, with $p < 0.0001$). This model explained 69 percent of the variance in the Daniel and Diack scores.

As evident in table 16 below, Level Two was the more explanatory of the tests. But with an increase in errors on both levels, there was a significant decrease in the score on the Daniel and Diack. From these results, it is reasonable to suggest that the Phonic Inventories, Level One and Two predict performance on the contrast spelling test, the Daniel and Diack, with a good degree of fit. This would suggest that Phonic Inventories Level One and Level Two test substantively the same type of ability as the Daniel and Diack spelling test, but with the possible advantage of providing additional information about the types of errors made by children.

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	37.79271	0.56225	67.22	<.0001
Total errors 1	-0.18393	0.05605	-3.28	0.0015
Total errors 2	-0.24522	0.03087	-7.94	<.0001

Table 16: Parameter estimates from stepwise regression to predict Daniel and Diack performance

The inverse prediction of Daniel and Diack is sensible, in that the more errors a learner makes on the Phonic Inventories, in this case Phonic Inventory Level One and Level Two, the lower they will score on the Daniel and Diack, which is a total number correct type of test.

A similar procedure was run for the Schonell graded spelling test. This was done using all three levels of the Phonic Inventories as predictor variables (that is Total errors 1, Total errors 2 and Total errors 3), as the learners who completed the Schonell completed at least two, or all three levels of the Phonic Inventories. Again, the overall model built by the regression was significant ($F = 440.24$, with $p < 0.0001$). This model explained 77 percent of the variance in the Schonell spelling test scores.

In table 17 below, it is evident that all three levels were significant predictors, with Level Two being the strongest predictor, followed by Level Three and then Level One. Again, the relationship is a negative one, meaning the more errors a learner made on the Phonic Inventories, the lower their score on the Schonell. It is therefore possible to conclude that a learner's performance on all three levels of the Phonic Inventories predicts performance on the contrast spelling test, the Schonell, with a good degree of fit. This would suggest that the Phonic Inventories Level One, Level Two and Level Three, are testing substantively the same type of ability as the Schonell spelling test, but have the possible advantage of being able to possible additional information on the types of errors made by children.

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	58.88082	0.29416	200.16	<.0001
Total errors 1	-0.16687	0.04822	-3.46	0.0006
Total errors 2	-0.61159	0.0479	-12.77	<.0001
Total errors 3	-0.38756	0.05077	-7.63	<.0001

Table 17: Parameter estimates from stepwise regression to predict Schonell performance

Discriminant analysis

Question 5: Can the patterns of errors children make on the Phonic inventory predict whether they are in mainstream or remedial school?

This was done to establish if the patterns of errors made by the children in the sample (both mainstream and remedial) could determine to which group (either mainstream or remedial) they belonged.

A discriminant analysis based on cross-validation was run with information from 488 learners who had completed all the necessary tests. That is, only learners who had completed all three levels are the Phonic Inventories were used in this analysis to ensure it was comprehensive.

Number of Observations and Percent Classified			
	into GROUP		
From GROUP	**Mainstream**	**Remedial**	**Total**
Mainstream	265	133	398
	66.58	33.42	100
Remedial	35	55	90
	38.89	61.11	100
Total	300	188	488
	61.48	38.52	100
Priors	0.81557	0.18443	
Error Count Estimates for GROUP			
	1	**2**	**Total**
Rate	0.3342	0.3889	0.3443
Priors	0.8156	0.1844	

Table 18: Discriminant analysis results to predict group affiliation

The results, as shown in table 18 above, show that 66.58% of the learners from the mainstream group where correctly classified into mainstream schools, and 61.11% of the learners from the remedial group were correctly classified into the remedial school. The overall error rate from the discriminant classification was 34% indicating that the classification was above average. This would suggest that the Phonic Inventories when used in combination are able to discriminate between mainstream and remedial school children with a fair degree of success.

From this, it made sense to check the discriminant ability of each level of the Phonic Inventories separately. The results from these analyses follow.

Table 19 below shows the results for a discriminant analysis based on Phonic Inventory Level One, using the entire sample (of 729), as all the learners completed Level One.

Number of Observations and Percent Classified			
	into GROUP		
From GROUP	**Mainstream**	**Remedial**	**Total**
Mainstream	543	15	558
	97.31	2.69	100
Remedial	167	4	171
	97.66	2.34	100
Total	710	19	729
	97.39	2.61	100
Priors	0.76543	0.23457	
Error Count Estimates for GROUP			
	Mainstream	**Remedial**	**Total**
Rate	0.0269	0.9766	0.2497
Priors	0.7654	0.2346	

Table 19: Discriminant analysis results to predict group affiliation – Level One

The results from table 19 above show that 97% of the mainstream learners were correctly classified as mainstream, while only 2% of the remedial learners were correctly classified, with an overall error rate of 25%; although this may appear skewed because of the difference in sample sizes. This suggests that tested individually, Level One does not discriminate the remedial learners with as good a degree of fit as all three levels tested together.

The results for the discriminant analysis using only Phonic Inventory Level Two are shown below in table 20. This used all those learners who completed Level Two, which was a sample of 637.

Number of Observations and Percent Classified			
	into GROUP		
From GROUP	**Mainstream**	**Remedial**	**Total**
Mainstream	179	301	480
	37.29	62.71	100
Remedial	20	137	157
	12.74	87.26	100
Total	199	438	637
	31.24	68.76	100
Priors	0.75353	0.24647	
Error Count Estimates for GROUP			
	Mainstream	**Remedial**	**Total**
Rate	0.6271	0.1274	0.5039
Priors	0.7535	0.2465	

Table 20: Discriminant analysis results to predict group affiliation – Level Two

The results in table 20 above show that 37% of the mainstream group were correctly classified and 87% of the remedial group were correctly classified, with an overall error rate of 50%, although this is probably skewed because of the different sample sizes. These results suggest that Level Two tested individually, does not discriminate as well as the Phonic Inventories tested together. However, Level Two does appear to have a very high level of classification for the remedial learners. This is an indication that Level Two may have high discriminative potential where remedial learners are concerned.

Table 21 below shows the results from the discriminant analysis run using only Phonic Inventory Level Three.

Number of Observations and Percent classified			
	into GROUP		
From GROUP	**Mainstream**	**Remedial**	**Total**
Mainstream	244	154	398
	61.31	38.69	100
Remedial	41	49	90
	45.56	54.44	100
Total	285	203	488
	58.4	41.6	100
Priors	0.81557	0.18443	
Error Count Estimates for GROUP			
	1	**2**	**Total**
Rate	0.3869	0.4556	0.3996
Priors	0.8156	0.1844	

Table 21: Discriminant analysis results to predict group affiliation – Level Three

The results from table 21 above show that 61% of the mainstream sample was correctly classified and 54% of the remedial sample were correctly classified with an error rate of 40%, although this may be skewed by the difference in sample sizes. These findings suggest that Level Three does not discriminate with as good a degree of fit when tested individually as when the three levels are tested together.

Discussion

Revisiting the research questions

What are the patterns of spelling errors made by mainstream learners on the Phonic Inventories, i.e., children studying in mainstream classes?

The first research question focused on the patterns of spelling errors that children in mainstream schools made on the three levels of the Phonic Inventories. A repeated measure ANOVA as well as a plot showing the relative mean proportions of the 13 error types was used to answer this question. The findings were as follows: for all three levels of the Phonic Inventories, there was significant change across the proportion of error types and this pattern (proportions of error types) changed depending on the grade. Furthermore, the pattern when looking at frequencies also showed a distinct progression. This suggests that the Phonic Inventories are tapping into a core predictor of spelling ability, and as children move up in grade at school, this ability develops and they make fewer errors on the Phonic Inventories.

For Phonic Inventory Level One, the most proportionally common error type was 6 (end blend errors) followed by 2 (initial blend errors). Error type 3 (medial vowels) was also prominent. This evidence would suggest that initial blend, end blend and medial vowel errors are common in children learning to spell; with the frequency analysis showing a steady decrease in the number of key error types mainstream children make on Level One as they move up in grade, and that the frequency of errors they make on the key error types can act as an indicator of their grade and that Phonic Inventory Level One can yield this type of diagnostic information on individual children when administered in groups.

It would be logical to use Phonic Inventory Level One for diagnostic purposes, to yield information which can be used to plan teaching as well as to monitor the progress made by children. That is, it would be possible to use the key error types identified for Level One to establish profiles for the children in the class. This would

inform the focus of teaching for the class, as well as individual needs within the class. It would be possible to administer the test at the beginning and at the end of the year to establish improvements within the class as a whole as well as individually for each child. Also, the profiles for each child could be passed on at the end of the year to the next grades teachers to aid their lesson planning given the specifically identified needs of their class.

For Phonic Inventory Level Two, the most proportionally common error type was 4 (medial vowel digraph errors). The evidence further suggested that this type of error is most obvious in the earlier grades in primary school. Error type 6 (end blends) was also common. There was also a high proportion of error type 3 (medial vowels) and error type 13 (other errors). The evidence would suggest that end blends, medial vowel and medial vowel digraph errors are common across all grades in primary school. The frequency analysis showed a steady decrease in the number of errors mainstream learners made on the key error types on Level Two as they move up in grade. This would suggest that this frequency of key error types made by a mainstream learner on Level Two could act as an indicator of grade, and so the Phonic Inventories Level Two can yield this type of diagnostic information on individual children when administered in groups.

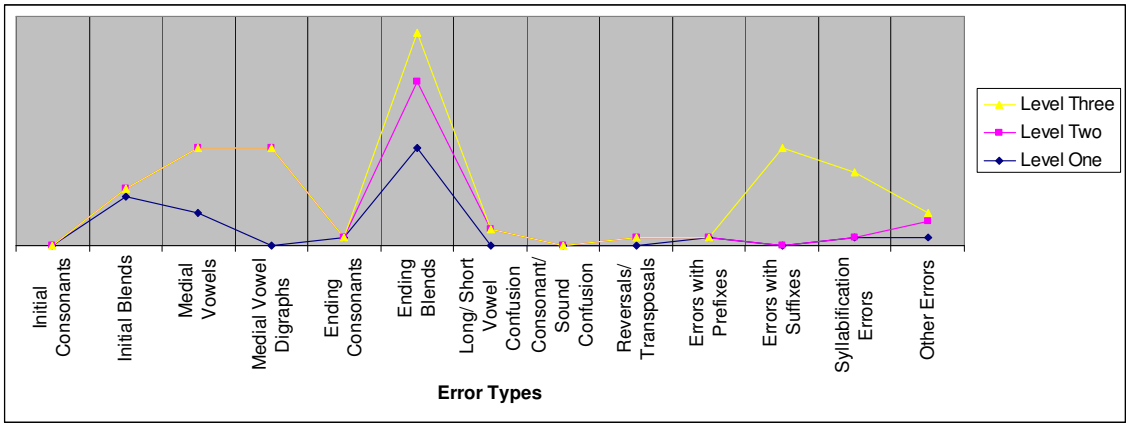
It would be logical to use Phonic Inventory Level Two for diagnostic purposes in the same way as Level One.

For Level Three, the proportionally most common errors were error type 11 (suffix errors) and 12 (syllabification errors). The evidence would thus suggest that many children in the mainstream group have difficulty with this type of error, and with the use of compound words. The frequency analysis showed a steady decrease in the number of key errors made by the mainstream sample on Level Three, suggesting the this information could be used as an indicator of grade attained.

It would be logical to use Phonic Inventory Level Three for diagnostic purposes in the same way as for Level One and Level Two. In fact, as children advance, completing first Level One, then Level One and Two and finally Level One, Two and Three, the amount of information available increases, providing more comprehensive profiles.

Of interest is the relative prominence of error type 13 (other errors) on all three levels. This error category was used to record a number of error types, such as, writing a word other than the target word, an illegible word and overgeneralization of the /e/ at the end of a word. This would suggest that the Phonic Inventories can yield information concerning non-specific errors, which can then also be used for planning individual instruction.

In summary, the above evidence would suggest that the three levels of the Phonic Inventories can be used to provide a profile of the errors made by mainstream learners in the process of learning to spell. It also shows that the specific patterns of errors that mainstream learners make on the three levels of the instrument change significantly depending on the grade (and so the spelling expertise) of the child. The *pattern of errors* to be expected for a child in mainstream school is represented in Plot 10 below.



Plot 10: Relative pattern of errors to be expected in a mainstream school

Plot 10 shows the overall pattern of errors that can be expected from a child in a mainstream school when completing all three levels of the Phonic Inventories. This pattern has been simplified; however, there are statistically significant differences in performance over grade. This plot shows the relative proportions of errors, rather than exact numbers, and what is significant is the evidence that the *frequency* of errors changes and that the *pattern* of errors also changes across primary school.

What are the patterns of spelling errors made by children who have been identified as having specific learning or reading difficulties on the Phonic Inventories, i.e., by children in full time remedial education?

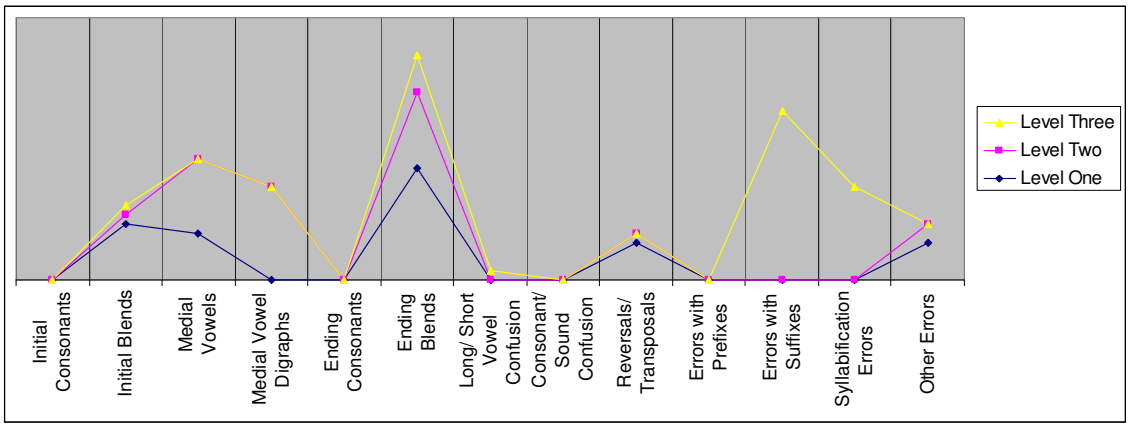
In answering this question, the focus was placed on establishing profiles of errors for remedial learners. The same process of error analysis was followed as for mainstream learners. The findings were as follows: a) it was evident that were significant differences in the mean proportion of the different errors for each level of the Phonic Inventories for the remedial group; b) it was also evident that the error patterns *did not change* significantly over grade for all three levels as was the case for mainstream learners. This is strong evidence of the Phonic Inventories tapping into important and persistent indicators of learning difficulties as there is a persistent thread of difficulties maintained throughout the remedial group, which is supported by the evidence that the patterns of errors made by this group did not change significantly over grade. This finding was consistent across all three levels of the Phonic Inventories. Furthermore, there was no steady decrease in frequency of the key error types as grade increased, as was evident for the mainstream sample. This was true for all three levels of the Phonic Inventories, suggesting that the learners in the remedial group were not performing better as they moved up in grade. This further suggests that the Phonic Inventories are tapping abilities associated with learning difficulties that are evident irrespective of the grade which the child has attained.

Of particular interest was the evidence that patterns of errors for each level were similar to the mainstream profile. For Level One, error type 6 (end blends) was by far the most frequent error, as for mainstream children. Error type 2 was also found to be common. Error type 3 (medial vowel) was also noticeable for this sample group. What was also evident however was that remedial learners made consistently *more errors* on each category. This would suggest that the Phonic Inventory Level One could be used for screening purposes in mainstream classes, with frequency of errors of the key error types for each level of the Phonic Inventories being used to identify at risk children. These children could then be assessed more fully.

For Level Two, error type 4 (medial vowel digraph) was the most common error type, with error type 6 (end blends) also common. Error type 3 (medial vowel) and 13

(other errors) also stood out, as was the case for the mainstream group. What was evident was that remedial learners made consistently *more errors* on each category. This would suggest that the Phonic Inventories Level Two could be used for screening purposes in mainstream classes, with frequency of errors of the key error types for each level of the Phonic Inventories being used to identify at risk children. These children could then be assessed more fully.

For Level Three, error type 11 (suffix errors) was by far the most common, with error type 12 (syllabification errors) also important. These two error types were of similar relative importance for mainstream children. Also of note was the evidence in Phonic Inventory Level Three that error type 6 (end blend) was prominent in the remedial group, suggesting that high frequency of errors on end blends may be an indicator of learning difficulties, which can be used for diagnostic purposes. It is also noteworthy that the actual patterns of errors made by remedial children looks very similar to that found for children in mainstream schools.



Plot 11: Relative pattern of errors to be expected in a remedial school

Plot 11 shows the overall pattern of errors that can be expected from a child in a remedial school when completing all three levels of the Phonic Inventories. It should be noted that this pattern has been simplified, but unlike with the mainstream sample, there are no statistically significance differences in performance over grade. The same rationale applies; this plot shows the relative proportions of the error types, without actual values.

Finally, it is an important finding that the key error types for each level of the Phonic Inventories, which are the same for both the mainstream and remedial groups, seemed to remain unremediated for the remedial group as proceed up remedial school. These may then be indicators of learning difficulties. This evidence suggests the frequency of the key error types for each level could be used diagnostically as indicators of potential learning difficulties.

Are there differences in the patterns of spelling errors exhibited by mainstream learners and learners with identified learning difficulties?

This question was answered by following the same procedure as for questions one and two. The findings were as follows: for all three levels of the Phonic Inventories, there were group effects, meaning that the mean error rates for the error types were significantly different for children in the mainstream and remedial groups. Furthermore, there was a significant interaction effect for group and grade, meaning that significant differences were found between the mean error rates for the different error types for the different groups (mainstream and remedial) by the different grades (1-7). In particular, the evidence suggests that the rates of the mean proportion of errors were different for each grade for remedial and mainstream children. From this, it can be concluded that remedial and mainstream children perform differently on all three levels of the Phonic Inventories.

From the error pattern plots, it is possible to compare the actual pattern of the errors made. As with analysis conducted to answer questions one and two, it was found that the actual pattern of the errors between mainstream and remedial learners was very similar. The difference lay in the frequency of the errors. Remedial children made relatively more of the same error types. In summary, there was no difference in the patterns of errors made by children in remedial and mainstream schools; however, there were statistical differences in the mean proportions of errors made.

These findings support previous research conducted by Bourassa and Treiman (2003) who claimed that learners with dyslexia do not spell using different processes to normal learners. They claimed that the difference was not a qualitative one, with performance merely being delayed. The results of this study indicate that the

difference between the patterns of errors made on the Phonic Inventories is a quantitative rather than qualitative difference. However, it is still possible that the cognitive deficit underlying this statistical difference is one of difference in processing.

On a practical level then, this means the following: the purpose of this exercise was to establish if and how the Phonic Inventories could be used a screening instrument to identify learners who should be fully assessed for potential learning difficulties. From the findings above it is possible to suggest that the Phonic Inventories would perform well as such an instrument. The focus has been on patterns, as error frequencies are a continuous scale and any cut off point would by necessity be arbitrary. Therefore, not using the frequency values, while necessary, was not any loss, as these values would change from school to school and classroom to classroom. It is the pattern of errors that is consistent. This study has firmly identified the important indicator error types on each of the three levels of the Phonic Inventories. It has also firmly established the expected pattern of these errors. From here, it is suggested that by administering this instrument to a classroom of children, it would be possible to easily identify those children in the class who make notably more errors on the key error types or deviate notably from the expected pattern.

The scholastic performance of these children could then be considered in more detail. This would be done with a view to establishing whether there were other indicators of potential learning difficulties (for example, attention deficits; language or perceptual difficulties; poor reading fluency; poor reading comprehension; poor written expressive abilities; high frequency of spelling errors) warranting referral for more in-depth assessment.

Does performance on the Phonic Inventories predict performance on the Daniels and Diack spelling test (for grades 1 and 2) and the Schonell graded spelling test (for grades 3 – 7)?

The results provide firm evidence that performance on Level One and Level Two of the Phonic Inventories, predict performance on the Daniel and Diack spelling test, explaining 69 percent of the criterion variance. It was found that Level Two was the

stronger predictor, with fit between performance on this test performance on the Daniel and Diack being greater. From this, it can be concluded that the Phonic Inventories test substantively the same abilities as those tapped by the Daniel and Diack, with the Phonic Inventories able to provide additional information on the types of errors made by children.

For the Schonell spelling tests, the results also provide firm evidence that all three levels of the Phonic Inventories predict performance on this test, explaining 77 percent of the variance in the Schonell scores. Again, Level Two was the most predictive test.

Overall, the predictive relationship between the Phonic Inventories and the Schonell was stronger than for the Daniel and Diack. It was also clear that Phonic Inventory Level Two was the most predictive test for explaining the variance in both the contrast spelling tests. It also better explained performance on the Schonell spelling test.

In conclusion, it has been established that to a fair degree, the Phonic Inventories have a fair degree of concurrent validity with other comparable spelling tests, with the advantage of providing additional information which, it has been established, is potentially indicative of children with learning difficulties.

Can the patterns of errors children make on the Phonic inventory predict whether they are in mainstream or remedial school?

This final analysis was initially limited to those children who completed all three levels of the Phonic Inventories, to test the discriminant ability of the instrument as a whole. The results showed the Phonic Inventories as a complete instrument to have good discriminatory power between the remedial and mainstream learners. This suggests the instrument is appropriate for distinguishing remedial learners from a pool of mainstream learners. This would allow it to be used as a screening instrument. Tested individually, the three levels did not manage to determine group affiliation as successfully as all three levels together. This suggests the instrument is best used in its complete form; at least for the higher grades.

Back to the literature

This report has used a functional definition of dyslexia, meaning the focus was on the difficulties and the manifestations of these difficulties experienced by the child with dyslexia. The definition used was one by Høien and Lundberg (1991, cited in Lundberg, 1999), that described specifically the disturbances in reading and spelling, and the persistence of the difficulties with spelling.

The decision to use spelling as an indicator of learning disabilities was clearly explained in the methodology section of this report. The central issue investigated in this study concerns the suitability of the Phonic Inventories to pick up on the functional disturbances a child with dyslexia will have with spelling. It has been found that children in mainstream and remedial schools make a similar pattern of errors on all three levels of the Phonic Inventories, but with statistically significant differences. Also, there were significant changes in performance by the children in the mainstream group. These changes were not evident in the remedial group. So it is possible that the instrument is tapping into underlying abilities for spelling, such as phonological awareness, which is why it picks up the improvements in normal learners, and shows no improvements in remedial learners.

Furthermore, it was found that the Phonic Inventories did predict performance on both the Daniel and Diack and the Schonell spelling tests. So there is good evidence that the Phonic Inventories are tapping into general spelling ability.

The focus of the study was on the assessment of the Phonic Inventories as potential screening instrument for dyslexia. The literature review argued that any useful screening instrument needed to allow for early identification (Voeller, 2004) to ensure the best prognosis. It also needed to be as unobtrusive as possible. The Phonic Inventories meet these criteria, in that they can be administered from grade 1. However, they are not suitable for children before they have entered school. Also, the task involved in completing the Phonic Inventories is one that occurs naturally in the classroom setting for young children, as spelling tests are commonplace. So

completing the Phonic Inventories should not be foreign or unsettling to any school going children.

After a strong argument for the abandonment of the traditional achievement discrepancy model (Stanovich, 2005; Fletcher et al, 2004; Francis et al, 2005) the literature concluded that any potential instrument for screening needed to meet the following criteria: it needed to allow for early identification and be unobtrusive. These have been dealt with already. It would need to be sensitive to change. From the findings from the repeated measures ANOVA, it is clear that the Phonic Inventories are sensitive to change over grade for the mainstream. Also, it has been used extensively to monitor progress within a remediation programme. Thus, once a child has been identified, the instrument is suitable to monitor individual change on documented areas. For sensitivity to ongoing change, the Phonic Inventories meet the requirement well.

Another important requirement is that is it highly predictive (Simpson and Everatt, 2005). That is, any such instrument would need to be able to accurately distinguish a child with no learning difficulties and a child with potential or actual learning difficulties. Given the results from the discriminant analysis, it is possible at this point to put the Phonic Inventories forward as predictive with a fair degree of fit. Also, it is predictive in accurately identifying *areas* of difficulty which is also important.

The possibility was noted 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, it is worth suggesting that this portion of the study be repeated with pre-screened samples. This may show the Phonic Inventories to have an even stronger predictive quality.

Also argued was the case for an instrument that could be incorporated into the classroom in ongoing assessment to note changes, improvements and areas of difficulty. There is good potential for the Phonic Inventories to work in this way, given it is relative quick and easy to administer. Teachers can competently administer and score the instrument with little training, it 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 of the learners and as has just been mentioned, is sensitive to change and gives simple direction to areas of difficulty.

Implications for the use of the Phonic Inventories as a screening instrument for dyslexia

Given the findings of this study, it is clear that the Phonic Inventories have considerable potential to be used within classrooms for ongoing assessment and monitoring of learners.

The focus of the instrument is pattern of error types, not the actual frequencies. This study has established that the Phonic Inventories is a valid spelling test for South African learners. It has also clearly identified the important error types to be scored for each level when administering the instrument for screening purposes.

It is suggested that the Phonic Inventories could easily be administered to a classroom of learners by a teacher. The teacher could score that class for the identified error types and easily identify children who deviated from the expected pattern or made notably more errors on the key error types than the rest of the class. Again, it is the pattern and then relative performance that is important rather than the actual number of errors. In this study it was necessary to study the proportions of the 13 error types to identify the error types that were most predictive for each level of the Phonic Inventory. Given that the pattern has been established, it is now necessary to only score those error types. Also, the frequency of these key error types is only important in relative terms, and not in absolute terms. As mentioned, because the frequencies are a continuous scale, there is no value in creating an arbitrary cut off point. However, since the instrument will always be administered in groups, it is possible to identify those children that stand out from their class. That is, to identify children who are making notably more errors on the key error types than their class mates, who are in the same grade, in the same school and have shared similar learning experiences. This is not a standardised instrument and has no table of norms. This is not a useful

application of the instrument at this stage, as the frequencies are potentially too variable. But it can be used to compare scores within a specific group, such as within one classroom.

This does not provide conclusive evidence of learning difficulties. The purpose was to establish a screening instrument. The Phonic Inventories, used in the way just described, would identify children who would need to be fully assessed. This would allow for easy and ongoing identification of children potentially at risk for learning difficulties with minimal resources and expense.

Furthermore, children, once identified as needing further assessment, could also then be fully scored on all error types, to provide a profile of where that child specifically is experiencing the most difficulty. This means that remediation could begin immediately, before further assessment. In fact, given the argument that resources do not always allow for further assessment, and that any children identified as 'at risk' should be 'treated then tested' (Fletcher et al, 2004), it is possible to suggest that the Phonic Inventories could be used to identify children who may be at risk. It could then provide a profile for each child that would provide the basis for in class remediation. And by constantly monitoring the child on the Phonic Inventories, it would be possible to note if there were any change. If there were change, this would be positive and have saved the expense and unpleasantness of comprehensive testing and remediation. If there were no change, it would suggest that the child most definitely required full assessment.

It is clear that there is vast potential for the Phonic Inventories to be used as an instrument for screening for dyslexia in the South African education system.

Strengths and limitations

However, there were a number of limitations to this study. First, and most importantly, it is possible that there were children with learning difficulties in the mainstream sample. These may be children who have learning difficulties and have remained in a mainstream school, or children who have never been identified. 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 will not have learning difficulties. This was a necessary assumption, but may have impacted on the results of the study in unknown ways.

Second, there was no guarantee of a standard administration of the Phonic Inventories. There is a basic standard administration that can be declared. That is, the lists of target words are in a specific order, and are read out to a group of children, both in isolation and within a sentence. However, the different groups in the study all had a different procedure. For Parkview Junior, the teachers were given instructions for how to administer the Phonic Inventories and in what order as well as the sentences to use, all in a test pack. However, there is no guarantee that the teachers did follow the instructions completely. There were instances where a whole class were missing one word, and so it is likely the teacher left that word out. This suggests that other mistakes were also made, such as mispronouncing a word. There is not way to accurately document these mistakes, nor to know the effect of them. For Parkview Senior, a researcher's assistant as well as one teacher administered the test. Both parties were acquainted with the instrument, but could also have not followed the instructions of administration wholly on every occasion. At Japari the teachers administered the tests independently, which means that they would have used different sentences and may have followed a different process. Overall, the testing procedure is more alike than different. But they were peculiarities in administration that are not ideal for standardising a test. Future research could account for these differences by ensuring that a set group of people were more formally trained in administering the instrument in a standard way. This would strengthen the findings of this research, giving it greater tester reliability.

However, the tests were all administered in one geographical area, and all within one month, so all at the same period of the school year. Also, the entire experimentally accessible population were included in the sampling. Furthermore, the Phonic Inventories are spelling tests, and although scoring the tests is special, they are administered in the same way. Thus, they would have been familiar to the teachers to that extent, as well as having good content validity, so there can be a level of confidence that they did not deviate too much from the instructions due to a factor

such as task confusion. Finally, the testing was done within in classroom setting, giving it a certain amount of ecological validity. Overall then, this study had solid external validity.

Another strong point of this study was that previously there has been no standard scoring procedure for the Phonic Inventories. Although there were guidelines, the instrument has previously been used in a more flexible way, which was not appropriate for the given study. Since only the researcher scored the tests, the scoring within this study was standard, and conducted against a structured scoring protocol. This provides a standard scoring the instrument, both in future research and in a clinical environment.

From the findings of 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, ensuring that there are no children with learning difficulties in the mainstream sample, diluting or confounding the results.

Also valuable for future research is to gather more detailed biographical and socio-economic data on children and their families. This would enable the pattern for frequency data to be much more meaningful. 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 that may prove to 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.

Finally, with the standard scoring that has been established, it would be useful to cross-validate the findings in this study against a wider sample and from 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 wide cross section of areas.

Conclusion

In conclusion, this research provides a strong basis for recommending the Phonic Inventories as an instrument to be used for group screening and monitoring of learners on an ongoing basis within the classroom. This is the next wave of assessment and remediation of learning difficulties as the literature shows, which is focused on earlier identification and intervention with less expense of resources. This research has established a standard approach to scoring the three levels of the Phonic Inventories and has highlighted the areas of importance. This should provide a strong foundation for further research to answer the outstanding questions, and in so doing, continue to develop the Phonic Inventories as an instrument to screen for potential learning difficulties.

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Appendices

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Appendix A: Teacher's letter

1) For mainstream schools

Dear Teacher (personalised),

My name is Dina Grasko. I am studying towards a Master in Psychology at Wits. In partial completion of this, we are required to do a research report. I have chosen to work with Prof. Charles Potter on an ongoing project which aims to help children with learning difficulties who do not respond to traditional remedial teaching methods.

Part of this project requires an assessment measure to identify these children and monitor their progress. The instrument used for this purpose is The Phonic Inventories, which is a set of 3 spelling tests. For my research I am looking at developing this instrument and so need to know how normal learners perform on the tests. It is for this reason that it would help me to have access to your classes test results.

I would like to extend an invitation for you and your class to participate in this study. This would require you to administer the tests contained in your test pack (specified for class). You will find instructions attached to each test.

Please note that participation in this study is completely voluntary and only those children with parental consent are to be included. Also, please ensure that all the children in your class are aware that they are under no obligation to participate and may stop at any time, even during a test, without adverse consequences to themselves.

Should you choose to participate, please return all completed scripts sealed in the envelope provided to the main office for collection.

I would like to thank for your consideration and hope you do choose to take part. This is an exciting study that has a lot to add to current needs for identifying children with learning difficulties in an already over extended education system. The results can be made available to you after the completion of the report.

I would like to thank you for your help. Should you have any questions, please do not hesitate to contact me on 084 588 5544.

Thank you,

Dina Grasko

2) For remedial schools

Dear Teacher,

My name is Dina Grasko. I am studying towards a Master in Psychology at Wits. In partial completion of this, we are required to do a research report. I have chosen to work with Prof. Charles Potter on an ongoing project which aims to help children with learning difficulties who do not respond to traditional remedial teaching methods.

Part of this project requires an assessment instrument to identify these children and monitor their progress. The instrument used for this purpose is The Phonic Inventories, with which you will be familiar. For my research I have decided develop this instrument further and so need to look at how children in remedial school perform on the tests. It is for this reason that it would help me to have access to your classes test results.

Since The Phonic Inventories are administered in your class systematically, I would be grateful to make use of these test scores. With permission from the principal and parents, these tests will be used as data in this study.

I would like to thank for your input. This is an exciting study that has a lot to add to current needs for identifying children with learning difficulties in an already over extended education system. The results can be made available to you after the completion of the report.

Should you have any questions, please do not hesitate to contact me on 084 588 5544.

Thank you,

Dina Grasko

Appendix B: Parental consent letter

1) For mainstream schools

Dear Parent

My name is Dina Grasko and I am studying towards a Master in Psychology at Wits. As part of the course, we do research and I have chosen to work with Prof Charles Potter in the field of learning. Prof Potter has many years experience working with and helping children with learning difficulties.

My project will focus specifically on developing a test that can help identify children with learning difficulties. However, to do this, it is essential to know how normal children, like yours, perform on the test. The test I am looking at is called the Phonic Inventories, and consists of 3 short spelling tests.

I have met with the school principal and have her permission, and would now like to ask for your permission to administer these tests to your child. This would be done by the class teacher during class time. However, the tests do not take long to complete. Also, spelling tests are part of class activities, and are done every week, so the activity would not be abnormal or stressful for your child.

The results will all be put together as the interest is on overall trends, and not individual performance. The tests will be kept anonymous, and full confidentiality is assured.

We have received permission from the school principal. If you will allow your child to participate, please complete the tear off slip and return it to the school. It is believed that this research will be beneficial to work on learning difficulties, and your permission would be greatly appreciated.

I will arrange for feedback to be made available to you after the completion of the study.
Should you have any questions, please do not hesitate to contact me on 084 588 5544.

Thank you,

Dina Grasko

The Phonic Inventories
Please complete this slip and return to the school

I _____ (parent/ legal guardian) give permission for
_____ to participate in the above mentioned study.

Signed: _____ Date: _____

2) For remedial schools

Dear Parent

My name is Dina Grasko and I am studying towards a Master in Psychology at Wits. As part of the course, we do research and I have chosen to work with Prof Charles Potter in the field of learning. Prof Potter has many years experience working with and helping children with learning difficulties.

My project will focus specifically on developing a test that can help identify children with learning difficulties. However, to do this, it is essential to know how remedial children perform on the test.

The test I am looking at is called the Phonic Inventories, and consists of 3 short spelling tests. These are routinely administered at the school to monitor your child's progress. This is common practice at any primary school, and is not abnormal or stressful for the children.

I would like to ask your permission to make use of your child's test scores in my study. This would entail my fetching previous spelling tests from the school. The interest is in overall trends, and not in individual performance. The tests will be kept anonymous, and full confidentiality is assured.

As mentioned, we have received permission from the school principal. If you will allow your child to be included, please complete the tear off slip and return it to the school. It is believed that this research will be beneficial to work on learning difficulties, and your permission would be greatly appreciated.

I will arrange for feedback to be made available to you after the completion of the study.
Should you have any questions, please do not hesitate to contact me on 084 588 5544.

Thank you,

Dina Grasko

<u>The Phonic Inventories</u>
Please complete this slip and return to the school

I _____ (parent/ legal guardian) give permission for _____ to be included in the above mentioned study.

Signed: _____ Date: _____

Appendix C: Phonic Inventories

Phonic Inventory Level One

Time taken: approx 20 minutes

Instructions:

- Ask each child to take a clean A4 sheet of paper, fold it down the middle length ways and write their name on the top.
- Read out the first word on the list. Read a sentence containing the word. Read the word again. [Sentences containing each word are listed on the following page. You may read out the prepared sentence or use any of your own. It is important that you use the word in its exact form and tense].
- Each child writes the word down on their piece of paper, each new word underneath the last. Using the fold as a column divider, they write the words down the first column until the end of the page, and then down the next column. This is important for scoring. Also for scoring, it is important that the words are read out in order.

Words

On	Shall
Us	Cling
Pat	Chill
Bed	Cross
Got	Smell
Yes	Frost
Bun	Blunt
Stop	Spend
Pram	Smash
Ship	Stink
Glad	Chest
Chop	Thank
Skid	Quick

That	Flush
Slit	Hedge
When	Swift
Scrap	Tusks
Off	Stretch
Hens	Strong
Miss	Chimps
Match	Length
Shift	Switch
Swell	Strength
Cliff	
Block	
Grunt	
Thick	

Phonic Inventory Level Two

Time taken: approx 25 minutes

Instructions:

- Ask each child to take *another* clean A4 sheet of paper, fold it down the middle length ways and write their name on the top.
- Read out the first word on the list. Read a sentence containing the word. Read the word again. [Sentences containing each word are listed on the following page. You may read out the prepared sentence or use any of your own. It is important that you use the word in its exact form and tense].
- Each child writes the word down on their piece of paper, each new word underneath the last. Using the fold as a column divider, they write the words down the first column until the end of the page, and then down the next column. This is important for scoring. Also for scoring, it is important that the words are read out in order.

Words

Cake	Oil
Day	Coin
Go	Storm
Hole	Lawn
Sky	Talk
Smile	Fern
Sea	Third
Tree	Hurt
Pain	bowl
Table	Stroll
Like	Though
Find	Turn
Boat	Dirt
Toe	Earth
We	Straw
Need	Door
Please	Roar

Die	Bird
Price	Heard
Night	Word
School	Ear
Rule	Deer
Book	Hear
Cow	Our
Loud	Flower
Crowd	Hair
Head	Spare
Far	There
Hard	
Calm	
Boy	

Phonic Inventory Level Three

Time taken: approx 25 minutes

Instructions:

- Ask each child to take *another* clean A4 sheet of paper, fold it down the middle length ways and write their name on the top.
- Read out the first word on the list. Read a sentence containing the word. Read the word again. [Sentences containing each word are listed on the following page. You may read out the prepared sentence or use any of your own. It is important that you use the word in its exact form and tense].
- Each child writes the word down on their piece of paper, each new word underneath the last. Using the fold as a column divider, they write the words down the first column until the end of the page, and then down the next column. This is important for scoring. Also for scoring, it is important that the words are read out in order.

Big	Match
Bigger	Matching
Biggest	Matched
	Matchbox
Chop	
Chopping	Quick
Chopper	Quicker
Chopped	Quickest
	Quickly
Strong	Quicksand
Strongly	
Stronger	Mark
Strongest	Market
	Supermarket
Hope	Remark
Hoping	Remarkable
Hoped	
Hopeful	Act

	Action
Play	Active
Player	Activity
Playing	React
Played	Reaction
Playful	Reactionary
Happy	
Happily	
Happiness	
Post	
Poster	
Postman	
Postbox	

Appendix D: Daniels and Diack Spelling Test

Daniels and Diack Graded Spelling Test (Daniels and Diack, 1974)

Time taken: approx 20 minutes

Instructions

- Each child should take a clean A4 page and write their name on the top and write the numbers 1 – 40.
- Read out the first word on the list. Read a sentence containing the word. Read the word again. [Sentences containing each word are listed on the following page. You may read out the prepared sentence or use any of your own. It is important that you use the word in its exact form and tense].
- Each child writes the word down.
- Continue for the whole list.

Words

List A	**List B**	**List C**	**List D**
1. on	11. the	21. ship	31. eye
2. hot	12. go	22. food	32. fight
3. cup	13. for	23. fire	33. friend
4. van	14. so	24. thin	34. done
5. jam	15. me	25. date	35. any
6. lost	16. are	26. chop	36. great
7. sit	17. of	27. seem	37. sure
8. plan	18. do	28. dart	38. women
9. mud	19. who	29. loud	39. answer
10. beg	20. here	30. form	40. beautiful

Appendix E: Schonell Graded Spelling Test

Schonell Graded Word Spelling Test (Schonell, 1952)

Time taken: approx 20 minutes

Instructions

- Each child should take a clean A4 page and write their name on the top.
- Read out the first word on the list. Read a sentence containing the word. Read the word again. [Sentences containing each word are provided. You may read out the prepared sentence or use any of your own. It is important that you use the word in its exact form and tense].
- Each child writes the word down.
- Continue down the entire list of words.

Words

Net	talk	method
Sat	loud	type
Can	ground	freeze
Hit	noise	instance
Fun	lowest	
Lid	remain	
Top	brain	
Cap	hoped	
Rag	write	
Had	worry	
Let	amount	
May	dancing	
Doll	damage	
Tree	fitted	
Bell	else	
By	spare	

Yes	through	
Ill	daughter	
Then	entered	
Egg	edge	
Land	cough	
Flower	search	
How	concert	
Son	avoid	
Your	domestic	
Seem	duties	
Cold	topic	
Four	recent	

Appendix F: Outline of the Targeted Revisualization Programme

Level of Programme	**Focuses of Mediation**	**Imagery and Revisualisation**
Level One	Introduce concept that vowels are the core of all words Identify and mediate short vowel sounds a, e, i, o, and u	Construct, deconstruct, image and revisualise words and short sentences containing short vowel sounds
Level Two	Identify and mediate long vowel sounds. Introduce y and w as vowels in positions at or near the end of words	Construct, deconstruct, image and revisualise words in the context of longer sentences containing short and long vowel sounds
Level Three	Identify and structurally analyse words with more than one vowel as these occur in the context of paragraphs and passages	Identify, list, deconstruct, image and revisualise single syllable and polysyllabic words in the context of paragraphs and passages
Level Four	Identify and mediate main ideas from images and paragraphs. Develop sequential writing skills working from picture sequences and texts Develop paragraphing skills	Draft and type up stories, descriptive and expository writing Correct spelling on computer. Identify, list, deconstruct, image and revisualise correct form of written language.
Level Five	Use reading and writing skills in the context of class work and projects	List and mediate errors. Identify, list, deconstruct, image and revisualise different forms and registers of written language.

Notes:

1. Focus on errors provides understanding of the way in which the child's rule systems for creating and analysing written language differ from those used in standard English orthography.
2. Focus on errors also provides understanding of the way in which the child's memory and sequentialisation systems work in practice.
3. As Piaget suggests, the link between perception and imagery is fostered through activities involving copying and representation of activities, pictures and words.
4. As Sternberg suggests, imagery is intimately connected with the memory systems in cognition. Use of imagery in visualisation and revisualisation is used to develop processes of short and longer-term memory storage and retrieval as these apply to memory for words, sentences and paragraphs.
5. Revisualisation is defined in the context of analysing, memorising and retrieving words from memory, as "The process of analysis of an image formed in response to a stimulus, the process of comparison of the image with the form of the original stimulus, and the process of coding output of the image into written or graphic form".
6. Laddering between different levels of mediation and revisualisation introduces variety into the programme. Following Piaget, the child's errors form the targets for remediation, reflecting the rule systems used by the child in reading, memorising and creating written language.
7. Mediating the way in which English orthography is used in context is the central task of the programme, and maximal time on task is spent on activities in which the child constructs, deconstructs, images and revisualizes written language.
8. As with the Montessori approach, the child works on structured activities involving the construction, deconstruction, imaging and revisualisation of written language. The child acts, while the tutor observes, intervening as appropriate to mediate the rules involved in the way in which English orthography is used to represent the spoken word, and the way in which written language is used to represent oral language.
9. Reading proceeds hand in hand with writing. The more the child reads, the more likely it is that the neurological processes of memory storage and

retrieval developed through targeted revisualisation will become fluent and automatic, and in Luria's sense, assist in developing the kinetic melodies through which written language is processed, encoded and automaticised in sequential representation.

10. The development of independence is an important aim underpinning the use of simple equipment and child-focused activities in the programme. The role of the tutor is to guide the process of learning, so as to enable the child to drive the bus (i.e. be skilled in techniques which can then be applied independently during and outside the remedial session in overcoming one's own problem).

Appendix G: Error grid sample

The grid below shows an example of the scoring and tallying of errors made by a remedial learner on Phonic Inventory Level One.

ANALYSIS OF PHONIC ERRORS

LEVELS ADMINISTERED (1) 2 3

TYPE OF ERROR	FREQUENCY	DETAILS
Initial Consonants	1	92 1
Initial Blends/Clusters	10	ch th sh qu cr wh. III III I I I I
Medial Vowels	9	a/i i/o e/i a/o u III III I I I
Medial Vowel Digraphs		
Ending Consonants		
Ending Blends/Clusters	21	ll ck ss sk nt nk sh ng ngth mp nh ~~IIII~~ II III I I II II I I I II
Long and Short Vowel Confusion		
Consonant/Sound Confusion		
Reversals/Transposals		
Errors with Prefixes		
Errors with Suffixes		
Syllabification Errors		
Other Errors		

REMARKS: Has established three letter blending but has difficulties with medial vowels, exacerbated by first/second language [English/Afrikaans] interference. On the writing level, the previously noted reversals are less evident. Emotionality concerning written language tasks is still present.

RECOMMENDED PROGRAMME: Needs a structured phonics programme, focussing on establishing the alphabetical principle in English. This needs to focus on short vowels and initial blends and clusters, then to include ending blends and clusters. Target the specific letter/consonant combinations above. Combine this with workbook activities, directed at establishing recognition of sound/letter relationships. Once the consonant combinations have been established, phonogram cards and reading activities based on a transparent orthography should be included in the programme.

Appendix H: Ethical permission

University of the Witwatersrand

Human Research Ethics Committee (Non-medical):

Reference number: R14/49 Grasko

Protocol number: 50801

Gauteng Education Department

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Date:	15 December 2005
Name of Researcher:	Grasko Dina
Address of Researcher:	235 Ville franche
	Fourways
	2146
Telephone Number:	(011) 7227223
Fax Number:	(011) 7227351
Research Topic:	The Phonic Inventories: A Comparison of Spelling Error Patterns Made by Children in Fulltime Remedial Education and Children in Mainstream Classes
Number and type of schools:	2 Primary Schools
District/s/HO	Johannesburg North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. ***The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.***
2. ***The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.***
3. ***A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.***

Office of the Senior Manager – Strategic Policy Research & Development
Room 525, 111 Commissioner Street, Johannesburg, 2001 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0488 Fax: (011) 355-0286

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Senior Manager (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher must supply the Senior Manager: Strategic Policy Development, Management & Research Coordination with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Senior Manager concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

ALBERT CHANEE
ACTING DIVISIONAL MANAGER: OFSTED

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	15 12 2005