Learning to spell for children 5-8 years of age: the importance of an integrated approach to ensure the development of phonic, orthographic and morphemic knowledge at compatible levels

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Learning to spell for children 5-8 years of age: the importance of an integrated approach to ensure the development of phonic, orthographic and morphemic knowledge at compatible levels

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Abstract:	This paper considers samples of independent writing highlighting the integral role of phonology, orthography and morphology in spelling development for children from 5-6 years to 7-8 years (3 years of formal schooling) and introduces an approach to monitoring spelling development by considering the sources of knowledge that are evident in children's attempts to spell when writing independently. Synthetic phonics can be a powerful and effective strategy for both reading and spelling but when the development of a synthetic phonics strategy fails to take account of the importance of compatibility with orthographic and morphemic knowledge its predominant use can lead to long term spelling difficulties for children who cannot acquire this knowledge from implicit learning when reading. Furthermore, this paper proposes that there is a critical period for ensuring the interaction between phonemic, orthographic and morphemic knowledge (5-6 years to 7-8 years; 3 years of formal schooling) during which time significant gains can be made for all children. This is particularly important for children who are at risk of long-term spelling difficulties because they spell by sounds alone due to insensitivity to orthographic and ortho-morphemic patterns.

Abstract

This paper considers samples of independent writing highlighting the integral role of phonology, orthography and morphology in spelling development for children from 5-6 years to 7-8 years (3 years of formal schooling) and introduces an approach to monitoring spelling development by considering the sources of knowledge that are evident in children's attempts to spell when writing independently. Synthetic phonics can be a powerful and effective strategy for both reading and spelling but when the development of a synthetic phonics strategy fails to take account of the importance of compatibility with orthographic and morphemic knowledge its predominant use can lead to long term spelling difficulties for children who cannot acquire this knowledge from implicit learning when reading. Furthermore, this paper proposes that there is a critical period for ensuring the interaction between phonemic, orthographic and morphemic knowledge (5-6 years to 7-8 years; 3 years of formal schooling) during which time significant gains can be made for all children. This is particularly important for children who are at risk of long-term spelling difficulties because they spell by sounds alone due to insensitivity to orthographic and ortho-morphemic patterns.

Fast and efficient retrieval of spellings from memory is a critical skill in the translation of ideas into rich and meaningful texts. Yet despite a shift from the traditional approach of rote visual memorization that predominated until the 1990s the more recent move to an alphabetic strategy has not brought about improvements in the spelling performance of children who struggle. According to XXXXXXX(2006) and Daffern (2017) there are three overarching components that underpin learning to spell effectively; phonology, orthography and morphology referred to by Wolter and Dilworth (2013:77) as the 'linguistic trilogy'. Stage theorists (Marsh, Freidman, Welsh, Desberg, and Welsh,1980; Gentry 1982; Frith, 1985;) proposed that learning to spell is a linear process which proceeds from phonology to orthography to morphology. According to this position, children begin as sound-based spellers, while the roles of orthography and morphology do not become prominent until later in development following qualitative shifts in strategy use (Larkin and Snowling, 2008). Contrary to the claims of stage theorists more recent research has found that 6-year-old children are able to attend to the orthographic features of words prior to fully mastering the alphabetic principle (XXXXXXX, 2006; Treiman et al., 2016). Thus, as Treiman and Bourassa (2000, p. 17) argue, it is an "oversimplification to label young children as sound-based spellers". Furthermore, Bourassa and Treiman (2014) consider orthographic rules to be a critical skill in the early stages of learning to spell.

An alternative, non-linear perspective was first proposed by Treiman (1994). Treiman argued that rather than passing through stages it is more likely that development is continuous, reflecting gradual improvements in children's phonological and orthographic knowledge. The work of XXXXX (2006) and Daffern (2017) support this non-linear view. These theorists agree that learning to spell is a non-linear process of becoming increasingly efficient in the use and coordination of phonological,

orthographic and morphological knowledge. However, whilst Daffern's research focused on children aged 7.5 years to 12 years of age XXXXXX's (2006) three year longitudinal study focused on children 5-8 years. XXXXXXXX (2004;2006) provides evidence that children as young as 5-6 years can demonstrate the ability to draw on all three sources of linguistic knowledge when spelling and that they do this via implicit learning when reading.

The role of implicit learning in the development of orthographic knowledge

In an educational environment where the primary method of teaching children to spell is an alphabetic strategy, children who are insensitive to orthographic patterns when reading are seriously disadvantaged. To come to a common understanding of what we mean by orthographic knowledge it is essential to make a clear distinction between alphabetic knowledge and orthographic knowledge. Alphabetic knowledge relates to the letters of the alphabet and the phonemes they represent. Because English has multiple mappings between graphemes and phonemes orthographic knowledge is required to know if a spelling 'looks right'. A representation of the word, or key word parts, must be in the orthographic lexicon to know if the correct letters have been chosen from the range of plausible alternatives, e.g. 'because' not 'becos'. Orthographic knowledge, therefore, is knowledge of clusters of letters that represent phonemes blended together as units; patterns in print at the intra-syllabic unit, syllable and whole word level. Orthographic knowledge is also identifiable in parts of words that cannot be identified by sound; e.g. double letters or silent letters or individual phonemes that can be represented by a number of different letters; for example the 'cuh' sound which can be represented by 'c' or 'k' at the start of a word

or ‘ck’ at the end of a word. XXXXXX (2004, 2006) contends that good readers who are good spellers can detect patterns in print and abstract rules and regularities from their reading experience, unlike good readers who are insensitive to orthographic patterns and do not benefit from frequency sensitivity when reading (the good readers poor spellers group; Lennox and Siegel, 1994; 1998). Children with dyslexia have been found to have an implicit learning deficit (Fernandez et al., 2011), meaning they will require explicit instruction in the abstraction of orthographic regularities to capitalise on their beneficial role in learning to spell (Berninger et al., 2008).

Insensitivity to orthographic patterns cannot be picked up preschool due to lack of reading experience (McMurray and McVeigh, 2014) which may be one reason why it’s role in long term difficulties has not been identified. A consequence of the predominance of an alphabetic strategy has been neglect in ensuring the development of orthographic knowledge from the beginning which is evidenced by disfluent readers and spelling errors that represent the sounds in words but the wrong letters are chosen.

XXXXX (2004, 2006) reports significant gains in learning to spell that can be achieved by all children when an integrated approach to teaching all three sources of knowledge is implemented (p=0001; Effect size 1.19). This is important because teaching methods in the UK continue to follow a phonics first staged approach which focuses on phoneme (fine grain; Ziegler and Goswami, 2005) knowledge. Treiman (2017) points to the need for research to examine different teaching methods. She acknowledges that as children learn to read spelling knowledge can develop but advises that instruction can help spelling development progress more quickly.

A significant risk factor is that in cases where the term phonology is interpreted as being synonymous with a phoneme level approach to phonics, i.e. synthetic phonics (fine grain level phonics), coarse grain levels of phonics teaching (intra syllabic unit, syllable) and their link with orthography may be neglected.

Synthetic phonics alone- a cause of long-term spelling difficulties

A synthetic phonics approach teaches children to segment spoken words into phonemes and map these onto graphemes (Steffler, 2001; Zhao *et al*., 2017). As these sound-to-letter correspondences increase in accuracy, the alphabetic principle is established and children can utilise this knowledge to support the spelling of phonologically regular words and word parts (Daffern, 2015). This alphabetic principle has been considered a driving force in the early course of learning to spell (Zhao *et al*., 2017, DfE, 2013). However, when faced with words that include phonemes that can be spelled a number of different ways, the alphabetic strategy is insufficient because it is dependent on sufficient orthographic knowledge being in place to ensure the correct choice of letters.

It is important to recognise that phonics is not a unitary phenomenon (Lennox and Siegel, 1998), and according to XXXXX (2006) can be divided into four levels of sound; phonemes (representing alphabetic knowledge), onset and rimes (c/an, m/an, r/an; b/est, w/est, t/est, r/est), syllables (in/ter/est/ing) and whole words (yacht, queue, the, are, eye). The latter three levels larger than the individual phoneme level can be described as orthographic knowledge and development of orthographic knowledge at these coarse grain levels is essential for normal spelling development. It is critical that phonics teaching therefore includes more than phoneme level

knowledge of sounds. The ability to recognise orthographic units, that is, letter patterns that represent phonemes blended together negates the necessity for decoding phoneme by phoneme for reading or encoding phoneme by phoneme for spelling and enables the development of automatic retrieval from memory. (XXXXXX, 2006; McMurray and McVeigh, 2014).

This automaticity, which can be developed through learning to spell, also enhances reading fluency. The deep nature of English orthography is characterised by a complex orthographic spelling system where one phoneme can be represented by different graphemes. Consider the vowel phoneme in t**oe**, th**ough**, gr**ow**, n**o**t**e**, fl**oa**t or the vowel phoneme as in fl**ew**, bl**ue**, sh**oe**, r**oo**m, thr**ough**. Conversely a grapheme can represent more than one phoneme. Consider different sounds made by the letter (grapheme) 'a' as in w**a**nt, c**a**n, l**a**t**e**, dr**aw**, The development of orthographic awareness is essential for the beginning speller to prevent dependence on encoding phoneme by phoneme which can lead to entrenched spelling errors that are difficult to change. In cases where this strategy is the only strategy the child can use, the phonemes in words are known and easily identified, but incorrect letters which represent the phonemes are chosen, e.g. cum for come, becos for because, sed for said, skool for school, cote for coat, cilt for killed. It is essential that the acquisition of orthographic knowledge is not left to implicit learning when reading. Just as some children can have a phonological deficit (insensitivity to sounds in words) there is a group of children who are insensitive to orthographic patterns. It has been a flaw in the synthetic phonics 'first and fast approach' to beginning reading to assume that the sources of knowledge essential for its success are in place or can develop through implicit learning.

This is a point also made by Nunes and Bryant (2009) with regard to morphology. They suggest that it is a questionable educational practice to leave the discovery of morphology to implicit learning.

Morphemic knowledge

Whilst the DfE (2013) did introduce a morphological element to their 2013 spelling guidance this advice is overshadowed by the predominance of a phoneme-based approach and the almost total absence of the underpinning role of orthographic patterns in assisting the development of a phonics strategy at all four levels of sound. There has also been neglect in understanding the role of orthographic rules in assisting the development of morphological knowledge. Orthography is the glue that holds the development of phonology and morphology together at compatible levels. Unfortunately the DFE 2013 guidance does not seek to ensure the development of all three sources of linguistic knowledge at compatible levels in an integrated way.

Morphemes are the smallest unit of meaning in spoken language. English consists of free morphemes and bound morphemes. Morphemes that can stand alone as a word are called free morphemes. Single syllable words are examples of words that have one morpheme, e.g. home / work/ cup /board are words consisting of one morpheme, however they can be combined to make new words that have two morphemes, e.g. homework and cupboard. Bound morphemes (affixes) do not stand alone as words but change the meaning of words (free morphemes) when they are bound to them, e.g. well- **un**well // event - **un**event**ful**. It is important to consider meaning (morphemic knowledge) from 5-6 years of age when learning to spell and

not just the orthographic pattern or rule. A point also made by Kemp and Bryant (2003). The spelling 'lap' represents 4 free morphemes. 'The cat sat on my **lap**'; 'The water **lapped** against the shore'; 'I ran a **lap** of the track'; 'The cat **lapped** up the milk'. Consider the spelling of the free morpheme 'read' as in 'Can you **read**?' or 'I have **read**'. Five morphemes can be spelled with the letters 'bow' as in 'a **bow** on a dress' or 'the **bow** of the ship' or 'to **bow'** (tilt your head) or 'a violin is played with a **bow'** . Consider the spelling of the bound morpheme '**ed**' frequently misspelled when it is spelled by sound, for example, 'landid (landed), helpt (helped), jumpt (jumped), dancd (danced), cald (called)'. How a morpheme or morphemes in a word are pronounced can only be determined by the meaning of the word and the context in which the spelling of the morpheme appears in a sentence. Hurry, (2006) also stresses the importance of morphemes being linked to their meaning function.

Also consider the pronunciation of the morphemes 'prove, glove and stove' and 'cough, bough, though, through and rough'. These orthographic groupings were common in spelling lists up to the 1990s. Proponents of this traditional view believed that children memorize the sequence of letters in each word with no reference to sounds in words, or patterns that apply to more than one word at a time (Treiman, 1994,1998). Indeed Peters (1970, 1985, 1992, 1993), whose influence on spelling within classrooms in the UK was considerable believed that the most important attribute in spelling was good visual perception. Learning to spell according to Peters (1993, p180):

'depends on looking carefully at words containing the same letter sequences without regard to sound'

This theoretical position neglected the important role of sounds in learning to spell and the current phoneme/grapheme approach has neglected the important role of orthography; both have led to failure for different groups of children.

The importance of ensuring the development of phonemic, orthographic and morphemic at compatible levels

All of the sources of knowledge associated with the spelling of a word should be established at point of learning and not as a later 'add on' to remediate difficulties. There is sufficient evidence of the extent of failure to suggest that the current difficulties with reading fluency and spelling that some children are experiencing have been caused by failure to ensure the development of all three sources of knowledge in tandem.

Norwich, Koutsouris & Bessudnov (2018),

'*..almost 20% of children in English Primary Schools on entering Key Stage 2 (KS2) are delayed or non-starting readers (Department for Education (DfE), 2017), and analysis of the DfE phonics test in 2016 indicates that around 10% did not reach the nationally set threshold level at the end of Year 2. Secondly, there is an ongoing debate about the primacy of certain phonics approaches over others (synthetic versus analytic) but the research evidence is inconclusive (Henbest & Apel, 2017). Since the Rose (2006) report, English policy has favoured the synthetic phonics approach. However, the fact that 10% of pupils taught using synthetic phonics still experience difficulties in reading suggests that other approaches should be tried for these children.' (Page 3)*

The assumption by teachers and policy makers that orthographic and morphemic knowledge are in place to support a synthetic phonics approach is as erroneous as the belief that the whole language approach to learning (Goodman, 1967; Smith, 1971) is sufficient for the absorption of a phonics strategy through implicit learning when reading.

A focus on one primary source of knowledge only, e.g., phoneme to grapheme correspondence, for children who do not process orthographic and morphemic knowledge implicitly from their reading experience, results in phoneme to grapheme correspondence being the only source of knowledge that a child experiencing difficulty can draw on (Devonshire and Fluck, 2010, McMurray and McVeigh 2014)). The strategy intended to be of benefit becomes a major contributor to entrenched spelling difficulties.

Working memory difficulties and the orthographic factor

Another important consideration is raised by research into working memory. According to Alloway (2011) a child of 7 years of age with average working memory capacity can only hold two items in memory. This makes blending many words in English beyond the capability of children with average working memory and those with working memory difficulties. This is because many syllables in English can be up to 6 phonemes long, e.g., strand. It is clear therefore, that encoding phoneme by phoneme (for spelling) and blending phoneme by phoneme (for reading), are developmentally inappropriate strategies for children in the 5-7 age group. To neglect to ensure that children have the opportunity to utilise a more effective orthographic strategy at 'onset and rime' level entrenches difficulties that would not arise if teaching to reduce the load on working memory is incorporated, e.g. the six phoneme word 'strand' only requires recall of two orthographic units, 'str' & 'and' if onset and rime orthographic patterns that are consistent in sound and spelling are taught. Orthographic units at the onset and rime level support 'chunking' (Kelly and Phillips, 2016); an essential and long-standing strategy for children with weak working memory (Gathercole and Alloway, 2008). Furthermore, onset and rime patterns enhance storage in long term memory, reasoning by analogy and encoding

speed and accuracy (Goswami, 1988; Squires and Wolter, 2016) and reduce the complexity of the spelling system (Kessler, 2003).

Spelling at phoneme level is a particularly arduous task, not only for children with poor working memory, but also for those with literacy difficulties and/or speech and language difficulties (McMurray, 2008; Larkin and Snowling, 2008). Despite this, spelling at phoneme level remains the most frequently used method in UK teaching practice (Devonshire, Morris and Fluck, 2013). Furthermore strict adherence to phoneme-grapheme translation can lead to phonetically plausible errors, such as 'sed' for 'said' (McMurray, 2008), and 'sgie' for 'sky' (Bourassa and Treiman, 2001). Unfortunately, as teaching moved away from rote visual memorisation the move to a phonics based approach in the 1990s encouraged 'invented spellings' (Gentry, 1982) formed purely on the basis of sound. More recent research, however, has found that exposure to phonetically plausible spellings can have an adverse effect on spelling knowledge (Bosman and Van Orden, 1997) because phonetic spellings can become embedded in memory and resistant to change (McMurray, 2008).

Furthermore, even regular words are not necessarily straightforward for children learning to spell, as the transparency of their phonemic components vary (Bourassa and Treiman, 2001). For example, young children have a tendency to omit phonemes in onset clusters as they regard these as cohesive units, e.g. 'flat' is spelled as 'fat' (Treiman, 2017). Likewise, syllable final clusters are also susceptible to omission as children can treat nasals (such as /n/ and /m/) as a property of the preceding vowel (Bourassa and Treiman, 2001). Thus, as Treiman and Bourassa (2000, p. 9) state "consistent sound-spelling correspondences would not necessarily be a cure-all during the early stages of development" hence the importance of

developing orthographic and morphemic knowledge to support the retrieval of the correct spelling.

The interrelated nature of phonology, orthography and morphology

It is important to consider the impact of insensitivity to orthographic patterns on the extent to which a child can use a morphemic strategy for selection of the correct spelling or for word building purposes. It is therefore essential that children develop sensitivity to orthographic patterns, that do not carry meaning, through the use of onset and rime patterns. This sensitivity to orthographic patterns that occur in onset and rime groupings aids the development of sensitivity to orthographic patterns (XXXXX, 2006). This in turn underpins the ability to recognise ortho-morphemic patterns across words. According to Daffren (2018) morphological knowledge, reflects the capacity to analyse and manipulate morphemes. In written language it is orthographic knowledge, orthographic rules and context that determines the spelling of morphemes. English requires sensitivity to the meaning-related structure of words (Green *et al*., 2003, cited in Daffern, 2017, p 311). Along with orthographic conventions, morphological knowledge is an important factor that drives the spelling selection process (Bourassa and Treiman, 2001) and they offer reciprocal benefits. English spelling is more regular at the level of the morpheme than the phoneme when a morpheme carries meaning across a range of words (Devonshire, Morris and Fluck, 2013). An example of this is the morpheme graph as in autograph, photograph, telegraph or as mentioned previously adding ‘ed’ to make the past tense of regular verbs.

The link between phonic, orthographic and morphemic knowledge and the importance of the integrated use of all three can be demonstrated in this nonsense word. Consider the invented spelling **'gotle'**. Consider how you would pronounce it. Did you read it by taking each phoneme in turn and then blending them together or did you read the word in syllables because you recognised combinations of letters that represent combinations of sounds removing the necessity to decode phoneme by phoneme? Either way your pronunciation of the vowel sound will have been a guess because there are two possible pronunciations and you have nothing to guide you to the correct one. I am assuming that you will have identified syllables in your attempt to read the word. Did you pronounce it got/le, with the syllable division between the t and the l? Or did you pronounce it go/tle with the syllable division between the o and the t? You will see that there are two possible words sharing the same spelling. Now if I provide you with a meaning for each of these words then it becomes clear how each word should be pronounced because the correct pronunciation is denoted by meaning (morphological knowledge). Got/le meaning 'to get something by stealing it', e.g. 'she gotled it when he wasn't looking.' OR go/tle meaning to go somewhere slowly' – 'He gotled on his way home and was late for his dinner'.

As with orthography, the role of morphology becomes increasingly significant as it overrides potential sound-based errors and supports the assembly of increasingly morphologically complex words (Bourassa and Treiman, 2001; XXXXXX, 2004).

Think 'sources of knowledge' when considering children's spelling errors.

By looking at children's spelling in their independent writing we can ascertain how their spelling knowledge is developing. All attempts at spelling are attempts to spell the sounds heard in a word. As discussed previously in this paper, if a child can only draw on knowledge of phoneme to grapheme correspondences then spelling errors will abound. Attempting to categorize spelling errors such a SEP for ship is futile. Questions such as '*are the digraph 'sh' and the short vowel 'e' for 'i' orthographic errors*? is a question which offers no insight. Instead consideration of the sources of knowledge evident in spelling errors is much more informative. The only source of knowledge evident in this misspelling is alphabetic. The child has used phoneme to grapheme correspondence to spell the word. There is no evidence of orthographic knowledge in SEP for ship. Trieman (1993, 1994, 1995) documented how young children often cannot hear the second consonant in a word. Treiman found that regular words containing both onset clusters and final consonant clusters presented difficulty for inexperienced spellers. Second consonants were found to be more susceptible to omission than the first consonants.

Failure to recognise that the spelling errors children make may be the result of neglect in explicit teaching to develop orthographic and morphemic knowledge allows the 'good readers/good spellers' group to advance well beyond their peers. Children who are 'good readers/poor spellers' and 'poor readers/ poor spellers', who cannot acquire this knowledge from implicit learning when reading, are disadvantaged from the beginning. The stages that appear apparent in children's writing and which have given rise to stage theories have been manufactured artificially because of this early neglect in spelling policy. Consequently, the resulting pedagogies which aim to follow this staged approach to spelling development

reinforce the disadvantage experienced by the 'good readers/poor spellers' group and the 'poor readers/ poor spellers' group.

Evidence from two case studies

Child A

Table 1 Baseline standardised test results (January, Year 2 NI)

Insert table here

Figure 1 Child A: June Year 2 (Year 2 children 5-6 years). Standardised spelling score 121 (above average).

Place figure 1 here

(Names blacked out to ensure anonymity)

Child A had a standardized score at the start of the research of 121 and at the end of the research her standardised score was 130 (the ceiling of the test). This sample of writing (figure 1) was written in June, Year 2 after almost 6 months on the

intervention (which commenced in January of year 2 NI, equivalent Year 1 England). The words Child A had learned to spell from participation in the intervention were; *I, my, dog, she, is, and, her, for, a, tug, me, cat, run, on, day, in, the, bat, but, did, bag*. Words that Child A had learned to spell via implicit learning when reading were; *like, new, called, every, time, take, near, away, sports, first, bean, race, little*. Spelling errors were; *rally* for really*, walke* for walk, *gos* for goes, *agian* for again, *brghte* for brought, *exitend* for excited.

It is clear that Child A is able to categorize spellings and store them in memory in an organised way. Child A is learning about the rules and regularities in print implicitly via frequency sensitivity when reading. Child A's spelling in this sample of writing demonstrates that Child A is processing three sources of linguistic knowledge; phonemic, orthographic and morphemic. Child A's orthographic lexicon is developing and organising for effective retrieval.

Let us consider the words Child A had not been taught but had spelled correctly and also Child A's spelling errors. When considering the correct spellings and spelling errors it is important to consider whether there is evidence of orthographic and/or morphemic knowledge in the word, or parts of the word, that could not be spelled by sounds alone.

In the word 'called' there is clear evidence of orthographic knowledge as the 'cuh' sound at the beginning of the word could have been spelled with a 'k' or a 'c', orthographic knowledge is also evident in the double 'll' and morphemic knowledge is evident as the bound morpheme 'ed' has been spelled correctly. There is nothing in the sound of the word that would tell child A that an 'e' is needed as only the 'd' sound can be heard. From child A's reading experience Child A knows that to make

the past tense of regular verbs you add ‘ed’ and even though Child A has added an ‘n’ into the misspelling of excited Child A is still showing awareness of the necessity to have an ‘e’ in the spelling of the bound morpheme ‘ed’’. Child A will become increasingly adept at applying this rule with further reading experience. Child A implicitly knows the rule but would not be able to verbalise it at this early stage. Child A would not know how the knowledge has been acquired and would not be able to explain the rule; *add ‘ed’ to make the past tense of regular verbs*. Steffler (2001) also makes the point that it is not until knowledge is made explicit that children are able to verbalise what they know.

Consider the spelling error in the word ‘again’ (agian). This spelling error demonstrates clearly that she has orthographic knowledge. There is no need to be concerned about the ‘i’ and the ‘a’ being in the wrong order. Further exposure to the word or direct effort to learn the spelling will be sufficient to produce the correct spelling. If ‘said’ had been spelled ‘sed’ then this spelling error would be a cause for great concern. High frequency words such as ‘said’ spelled SED are a warning signal that the child is not acquiring orthographic knowledge via implicit learning when reading. Phonemic spellings that represent the sounds in words but the wrong letters are chosen are not progress.

Let us consider the spelling error for the word brought which was spelled ‘brghte’ confirming developing orthographic awareness. Child A has recalled parts of the word correctly; ‘br’, a common blend and ‘ght’. Children with no orthographic awareness spell brought ‘brot’.

If you consider Child A’s spelling in figure 1 which provides evidence of Child A’s ability to draw on all three sources of knowledge, it is clear from the samples of

writing in Figures 2 and 3 that Child A is becoming increasingly efficient in the use and coordination of phonological, orthographic and morphological knowledge.

Over time Child A was making fewer and infrequent minor errors in spelling as can be seen in figures 2 and 3 (spelling errors highlighted).

Figure 2 January Year 3 (Year 3 children 6-7years)

Place figure 2 here

Figure 3 December Year 4 (children 7-8 years) Standardised spelling score 80 (below average).

Place figure 3 here

Now let us consider Child B's samples of writing. Child B's baseline standardised spelling score was 80 and Child B's post intervention score was 109. An increase of 29 standard points. Child B is in the same class as Child A. This sample of writing was written at the same time as Child A's Figure 1. There is no statistically significant difference in the verbal score for Child A (117) and Child B (113) as the confidence bands for Child A and Child B's BPVS scores overlap. (The BPVS is considered to correlate highly with intelligence tests.) Child B's progress learning to read was

unexpectedly poor despite very good use of language and reasoning ability at oral and practical levels.

Child B

Table 2 Baseline standardised test results (January, Year 2 NI)

Insert table here

Figure 4 Child B June Year 2 (5-6 years). Standardised spelling score 80 (below average).

Place figure 4 here

It is clear from Child B's sample of writing that Child B is spelling the words as Child B pronounces them and the spelling errors show no orthographic awareness. The only words Child B spells correctly have been taught through the spelling intervention with the exception of 'have'.

The stage 1 spelling intervention used in this research runs for twenty weeks commencing January of year 2. Spellings are not sent home to be learned. Stage 1 is designed to identify children who have orthographic processing difficulties and to

help all children establish effective learning strategies for both phonological and orthographic processing. In Stages 1-2 the rhyme patterns move very slowly to enable children with orthographic processing difficulties to develop awareness of orthographic patterns. The morphemic knowledge associated with the words in the rhyme patterns in stage 2 provides significant challenge for the majority of the class (who find rhyme patterns easy) and raise spelling performance significantly. In stage 2 high frequency words and adding curriculum words as instructed in the manual provides further extension for more able spellers and ensures that words that are taught will be required by children when writing independently. For children like Child B, who are at risk of long-term spelling difficulties, the focus is on providing frequency sensitivity to orthographic rhyme patterns to develop orthographic knowledge.

Figure 5 January Year 3 (6-7years)

Place figure 5 here

It is clear from this sample of writing that Child B is still spelling words the way Child B says them and is unable to draw on orthographic or morphemic knowledge.

Table 3: Spelling errors in Child B's second writing sample

Insert table here

Figure 6 December Year 4 (children 7-8 years)

Place figure 6 here

Child B was in the first term of Year 4 when this sample of writing was completed and there are now only eight spelling errors in a total of 99 words. Child B can spell almost any word needed. Child B's mother and teacher both identified almost to the week when 'it clicked' for Child B. Child B's brain is now making sense of patterns in written language and is retaining and retrieving correct spellings from the orthographic lexicon. It has taken Child B from January Year 2 to October year 4 to develop sufficient sensitivity to orthographic patterns to enable automatic and accurate retrieval of spellings from memory. It is contended that this progress was only possible because it was within the critical period for development of interaction between these knowledge bases.

Table 4 summarises the spelling knowledge that Child B demonstrated at the end of the first term of Year 4.

Table 4 Words spelled correctly in writing sample Figure 6
Insert table here

Child B showed greater mastery of vowel sounds in words and the orthographic rule for adding the morpheme for the past tense of regular verbs 'ed'. Although these errors still appear in Child B's writing, they are much less frequent. See table 5.

Table 5 Spelling errors in writing sample
Insert table here

XXXXXX (2004) proposes that it is not until the brain has experience of a significant number of visual patterns and sequences consistent in sound and spelling that it can begin to make sense of the common elements in the specific formula (pattern) that make up, for example, rhyme patterns and sequences in general. Each rhyme pattern is different; for example, man, can, ran, van / got, lot, hot, pot, but rhyme patterns, consistent in sound and spelling, have common elements –that is, same end pattern with changes only in the initial sound. What may be sufficient experience for one child, to abstract these statistical relationships between phonology and

orthography, may be insufficient experience for another. Repeated attempts to spell the same rhyme pattern for weeks on end can be unproductive for some children. This may be because repeating the same rhyme pattern over and over again does not supply the brain with sufficient information regarding common elements relating to rhyme patterns in general. Similarly reliance on phoneme to grapheme correspondence without regard to orthographic patterns also prevents the brain from abstracting the statistical relationships between phonology and orthography. The 'formula' remains undiscovered and without the formula the appropriate calculations, at a subconscious level, cannot be made to generate the correct spelling (xxxxx, 2004).

XXXXXXX, (2004, 2006) claims that there is a critical period for establishing effective interactions between all three sources of linguistic knowledge. She draws on evidence from a 3 year quasi-experimental research design.

Figure 7

Place figure 7 here

The graph illustrates that the Experimental schools performed significantly better than the Control schools. It can also be seen that the Control schools were unable to make up this significant gap even in the final year when both the Experimental and the Control schools experienced a ceiling effect. The experimental schools average

post intervention spelling score was 113 standard points (p=0001; Effect size 1.19). Almost one standard deviation above the mean. Were it the case that the experimental schools progress was accelerated in years 2 and 3 and the ceiling reached it would be reasonable to expect that the controls schools would catch up by the end of year four. It would just take longer. The fact that the pattern of progress was the same for both the experimental and control groups may be an indicator that the critical time for connections to be established is reached by the age of 7 and thereafter the potential for establishing connections between the three sources of linguistic knowledge necessary to ensure interactive processing is lost. All of the children in the experimental schools increased their standardised scores over the period of the research. For children in the control schools the standardised scores for 25% of the children decreased over the period of the research. These are the children who could not learn about morphology and orthography implicitly from there reading experience and for whom spelling may now be a long term or lifelong difficulty. The critical period to establish connections has passed.

Critical periods for the development of language to complex sentence stage and for the development of vision have been established by medical evidence.

Critical Periods for the Development Language and Vision

Neurological Development

The human brain consists of approximately 100 billion nerve cells, or neurons. Each is capable of making connections with any of the others although not all possible connections are appropriate for normal development. Repeated stimulation causes neurons to route closer and closer together until they connect in an electrical jump or synapse. The more frequent the stimulation the more permanent the connection becomes as Ratey (2002, p26) explains:

'The exact web of connections among neurons at a particular moment is determined by a combination of genetic makeup, environment, the sum of experiences we've imposed on our brains, and the activity we are bombarding it with now and each second into the future. What we do moment to moment greatly influences how the web continually reweaves itself.'

This interconnected 'web' of nerve cells is constantly changing, with connections that receive a lot of sensory input becoming stronger, while those that do not, die off in a process resembling Darwin's natural selection. 'Neural Darwinism' (Ratey 2002, p31) is the theory that explains why the brain needs to be plastic. It explains how we can learn in the first instance, and also why people with brain injuries can recover lost functions. Understanding how neurons acquire a particular role or function in the early stages of brain development is important in helping us understand the advantages and disadvantages of later rerouting due to lost neural function either as a result of brain damage or lack of stimulation.

Age makes it harder to reroute and establish new connections. Furthermore, there are critical periods for brain development when connections for a function are extremely receptive to input. Critical periods for development beyond which new connections cannot be made have been identified. The neurons allocated to these particular functions die and cannot be revived if they do not receive sufficient stimulation within the allotted timescale for development.

One example of this comes from well established medical evidence about the development of vision. Information about the presence of complex light patterns falling on the retina is passed on to the cortex of the brain in the form of electrical activity (electrical synapses connecting a chain of neurons). If there is poor vision in a left or right eye, the stronger eye does all the transmitting of information from the sensory receptors. The dominant eye does all the "seeing"; the eye with the poorer vision does not learn to process visual information- it has no need to. If the weak eye is not exercised the dominant eye will continue to do all the work and although the weaker eye is capable of seeing it can lose the ability to do so and by the age of 7 or the child can become blind in that eye. This condition is known as amblyopia. In these cases the lost sight cannot be retrieved.

Children, as young as two, who have a dominant and weak eye are encouraged to wear a patch on the dominant eye to ensure that the weaker eye is stimulated and exercised. The dominant eye must be prevented from seeing for this period of stimulation so that the neurons responsible for the development of the weaker eye are forced to activate and branch out to make the necessary connections. For connections to become permanent there must be repeated stimulation over

sustained periods of time and therefore some children are required to patch the dominant eye for at least one hour each day, for as little as 3 months or as much as 5 years. Patching is traditionally discontinued when the child reaches 7-8 years of age because beyond this age it is more difficult to establish connections in that area of the brain and in many cases limited progress can be made. Whatever level of vision is achieved by 7 years of age is likely to be the optimum level of vision that the eye will have for life. (Repka, Beck, Kraker, Cole, Holmes, Birch, Cotter, 2002; Holmes, Kraker, Beck, Birch, Cotter, Everett, Hertle, Quinn, Repka, Scheiman, Wallace, 2003) . However, in a more recent study into critical periods, Holmes et al (2011: 1456) did find that,

'there is improvement in visual acuity across all age ranges (from 3 to 13 years of age), children 7 to less than 13 years of age are least responsive to amblyopia treatment.

They also found a steeper decline in response with age among children with severe amblyopia.

A second example can be found by looking at studies of language development in cases of extreme deprivation (Curtiss, 1977). These studies indicate that children's language will develop normally if the deprived child is exposed to normal stimulation by the ages of 7 or 8 but where the deprivation continues until later, normal language fails to develop.

Koluchova's (1972) case study of twins born in Czechoslovakia in 1960 indicates how removal from an environment of extreme deprivation can reverse the effects of the deprivation. The twins' mother died when they were born. Their father remarried

and from the age of 18 months until 7 years, the twins spent their time in an unheated room away from the rest of the family. Their stepmother would not let her own children talk to them and she punished the twins by locking them in the cellar. No one outside the family knew of their existence and the neighbours sometimes heard strange animal like sounds coming from the cellar.

When the authorities found the twins at the age of 7 they had the appearance of 3 year olds. They could hardly walk because of rickets. They could not play and they relied mainly on gestures to communicate. They were removed from the family and placed in a home for pre-school children. The prognosis was poor. Kolochova estimated their intelligence to be around an IQ of 40. Once placed in a supportive environment their progress was remarkable. After a year they were placed in a school for children with severe learning difficulties. The next year they progressed to the second class of a normal infant school and were placed in the care of two sisters. A review at the age of 14 found the twins completely normal in their language development and functioning at an average academic level in a class of children only 18 months younger than them. Children who have been rescued beyond the age of 7 or 8 years never develop language to complex sentence stage.

Educational programmes that focus heavily on one processing route to the exclusion of others, may be detrimental for children who need to learn in balance to ensure activation of all processes. Learning is considered to be a lifelong process, which of course it is. However, if the cells that are essential for the development of the visual system are culled due to deprivation of necessary stimulation (and in the extreme

cases vision is lost entirely) and language development can functionally atrophy due to lack of stimulation because of extreme deprivation it seems reasonable to suggest that we may be able to draw similar conclusions in relation to the development of and interaction between phonological and orthographic processing. Potential for optimum development and interaction between these processes may be permanently restricted because there has been insufficient stimulation within the critical period for development.

It is essential that we help children to develop phonological and orthographic processing in parallel so that children can make the connections linking phonological and orthographic knowledge. For many children this does not happen without sufficient linguistic experience at both an implicit level through frequency sensitivity and at an explicit level through intentional teaching and reinforcement. This needs to take place within an integrated approach which allows the brain to make connections which integrate all the processes within the entire neurological system at an implicit and explicit level.

In summary

Spelling development for children with no difficulty processing orthographic and morphemic knowledge is underpinned and supported by implicit learning when learning to read. As a result of frequency sensitivity to words in print, orthographic and morphemic knowledge are learned implicitly supporting the organisation, storage and retrieval of words from memory.

Orthographic processing difficulties cannot be determined pre-school because children have limited experience of print. It is not until the end of year 3 NI (6-7

years of age) that children with orthographic difficulties are clearly identifiable but it may be too late at this point to provide the necessary experience to ensure the development of orthographic knowledge at compatible levels with phonology.

Children who have difficulty processing orthographic knowledge show no benefit of frequency sensitivity when reading (good readers-poor spellers) and together with the group of poor readers-poor spellers the 20%+ of children with potentially entrenched difficulties can be identified.

Orthographic processing difficulties are independent of IQ.

Whilst phonics is a critical source of knowledge in spelling and reading development its overemphasis, as seen in the UK adoption of synthetic phonics, prohibits normal literacy development because it prevents the brain from integrating the three main sources of linguistic knowledge at compatible levels within the critical period for development. This is because children have been trained to focus on phoneme grapheme correspondences taking each sound in turn '*all through the word*'. DFE (2010: 2). Further problematic recommendations in this core criteria document are:

'*that children apply phonic knowledge and skills as their first approach to reading and spelling even if a word is not completely phonically regular (page 2),*

'that, as pupils move through the early stages of acquiring phonics, they are invited to practise by reading texts which are entirely decodable for them, so that they experience success and learn to rely on phonemic strategies' (page 2), and

'It is important that texts are of the appropriate level for children to apply and practise the phonic knowledge and skills that they have learnt. Children should not be expected to use strategies such as whole-word recognition and/or cues from context, grammar, or pictures'.(page 3)

The promotion of blending at phoneme level is developmentally inappropriate for 5 to 8 year old children. Neglect in teaching orthographic patterns at the intra-syllabic unit level means that children with working memory difficulties and insensitivity to

orthographic patterns fail to develop automatic recall of spellings and automatic sight word recognition for reading.

In schools where there has been a focus on synthetic phonics as described in the DFE (2010) document, without ensuring that the other sources of linguistic knowledge develop at compatible levels, the group of children with orthographic processing and working memory difficulties have been seriously and unnecessarily disadvantaged.

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Table 1 Baseline standardised test results (January, Year 2 NI)

Standardised Test: Average score for each test =100	Standardised Score: January Year 2	Standardised score: May Year 4
British Picture Vocabulary Scales	117	
British Spelling Test Series	121	130
Primary Reading Test	98	110

Table 2 Baseline standardised test results (January, Year 2 NI)

Standardised Test Average score for each test =100	Standardised Score January Year 2	Standardised score May Year 4
British Picture Vocabulary Scales	113	
British Spelling Test Series	80	109
Primary Reading Test	78	93

Table 3: Spelling errors in Child B's second writing sample

Correct spelling	Child B's attempt	Error
still shot	sil sot	Second initial consonant sound has been omitted and also double 'l' at end of still. This is consistent with Treiman's research.
just lazer was meteor	jesd liesr weos, wes meter	Spelling errors indicate attempts to spell the sounds in the words as Child B pronounced them.
called destroyed killed	callod desrod cilt	Verb inflection 'ed' spelled by sound rather than the orthographic rule for the morpheme 'ed'.
earth aliens	erath aleins	Incorrect sequencing of letters. Child B spelled both words as they are pronounced by Child B.
spaceship strip	sepiship setrib	Addition of vowel sound in consonant blend in both words; also incorrect final consonant in strip
but Mars	be mros	Incorrect vowel and omission of final consonant because Child B may omit the sound in speech. Spelling by sound for the word Mars.

Table 4 summarises the spelling knowledge that Child B demonstrated at the end of the first term of Year 4.

Table 4 Words spelled correctly in writing sample Figure 6

Phonemic knowledge only required to spell these words	then, to, and, day, he, a, up, boy, his, it, with, gum, got, in, of, went, by, big, but, me, that, did,
Orthographic knowledge required (more than one way to spell some of the sounds in these words)	**one**, came, th**e**, w**as**, b**y**, c**oul**d, ag**ai**n, gra**ss,** bu**tt**on, advent**ure**, b**oo**t, ma**ch**ine, fa**th**er, shrunk
Verb inflections added correctly (orthographic rule for the spelling of the morpheme 'ed') Orthographic knowledge also required for letters underlined and in bold	w**a**nted, pre**ss**ed, ca**ll**ed, landed, a**tt**a**ck**ed, tri**ck**ed, reali**s**ed

Table 5 Spelling errors in writing sample

Correct spelling	Child B's attempt
stuck	stock
shoe	shuy
shovel	shevel
lifted	levtd
press	prese

Correct spelling	Child B's attempt
chewing	chuthing
thrown	thorn
sting	stingk

FIGURE 1

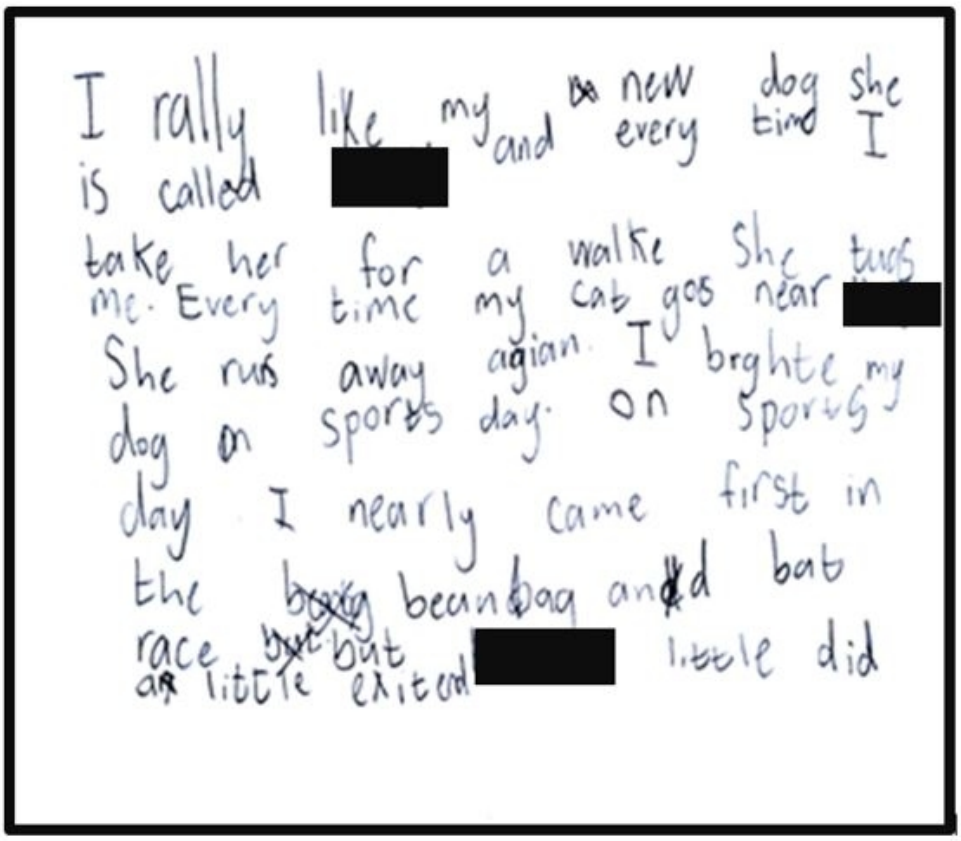

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FIGURE 2

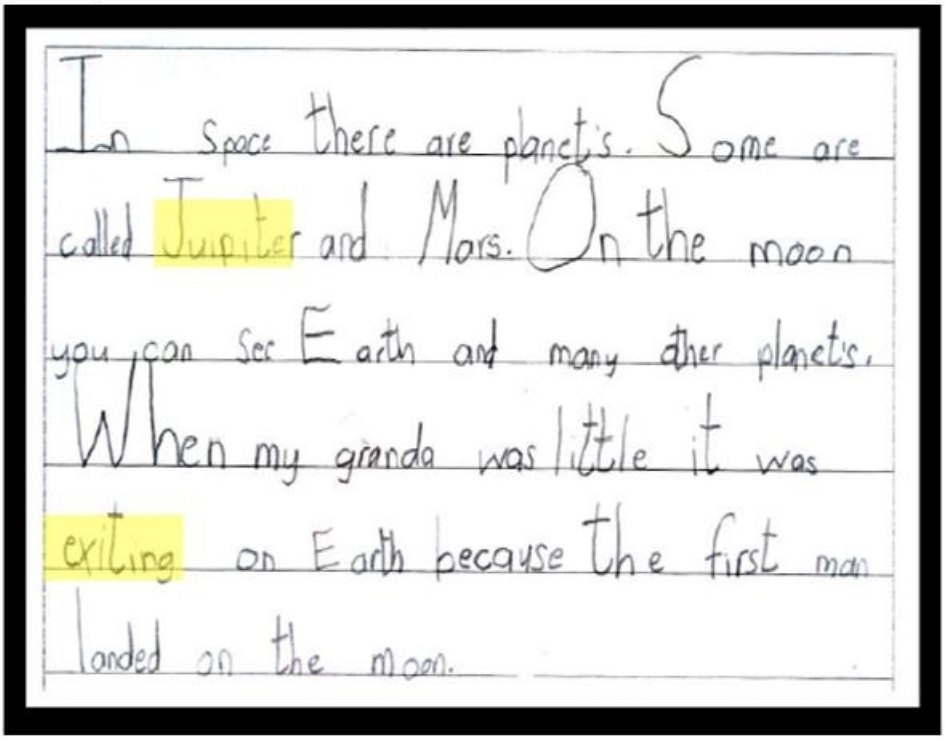

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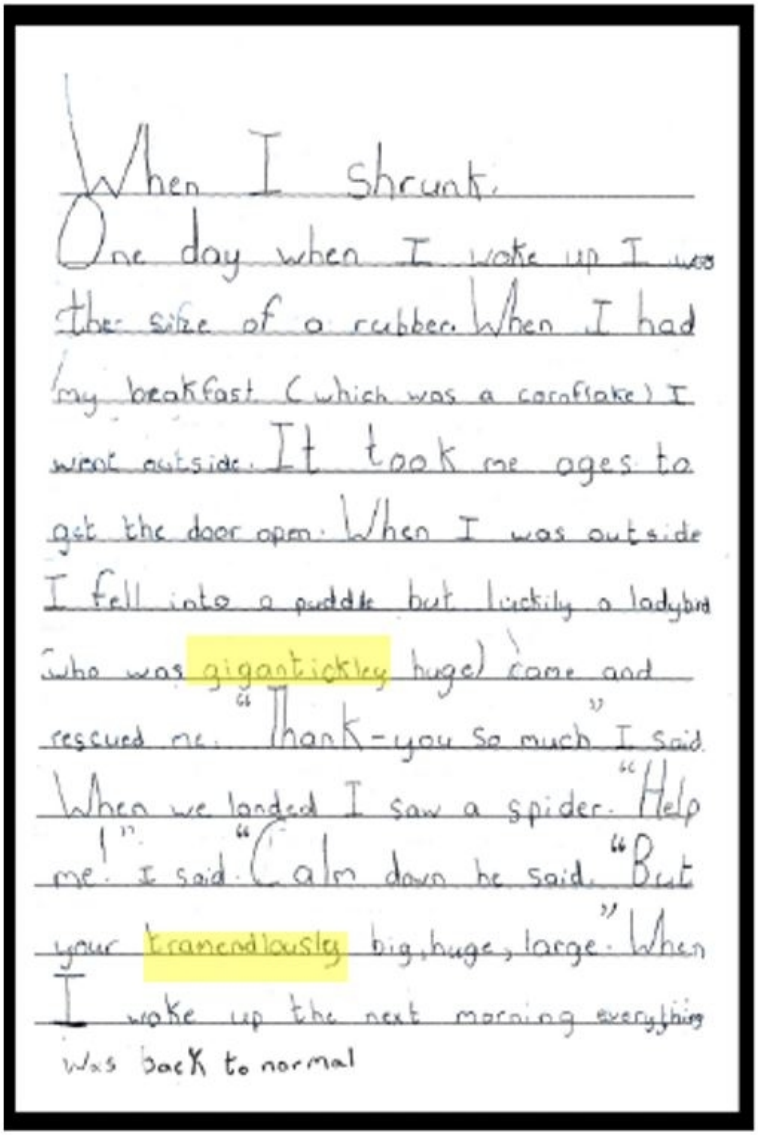
FIGURE 3



When I Shrunk.

One day when I woke up I was the size of a rubber. When I had my breakfast (which was a cornflake) I went outside. It took me ages to get the door open. When I was outside I fell into a puddle but luckily a ladybird (who was gigantickley huge) came and rescued me. "Thank-you so much" I said. When we landed I saw a spider. "Help me!" I said. "Calm down" he said. "But your tranendiously big, huge, large." When I woke up the next morning everything was back to normal

141x212mm (96 x 96 DPI)

FIGURE 4

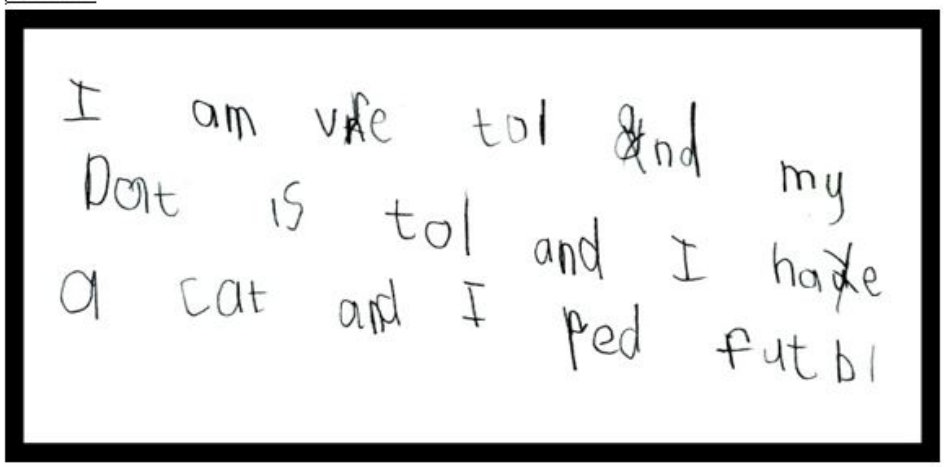


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FIGURE 5

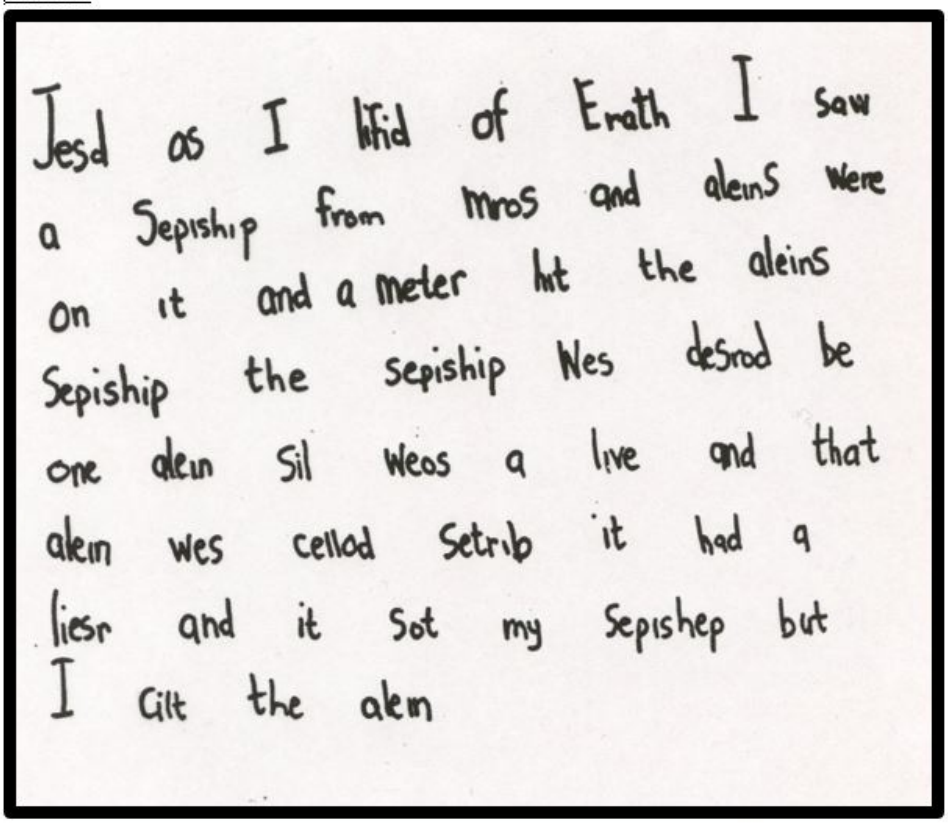

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FIGURE 6

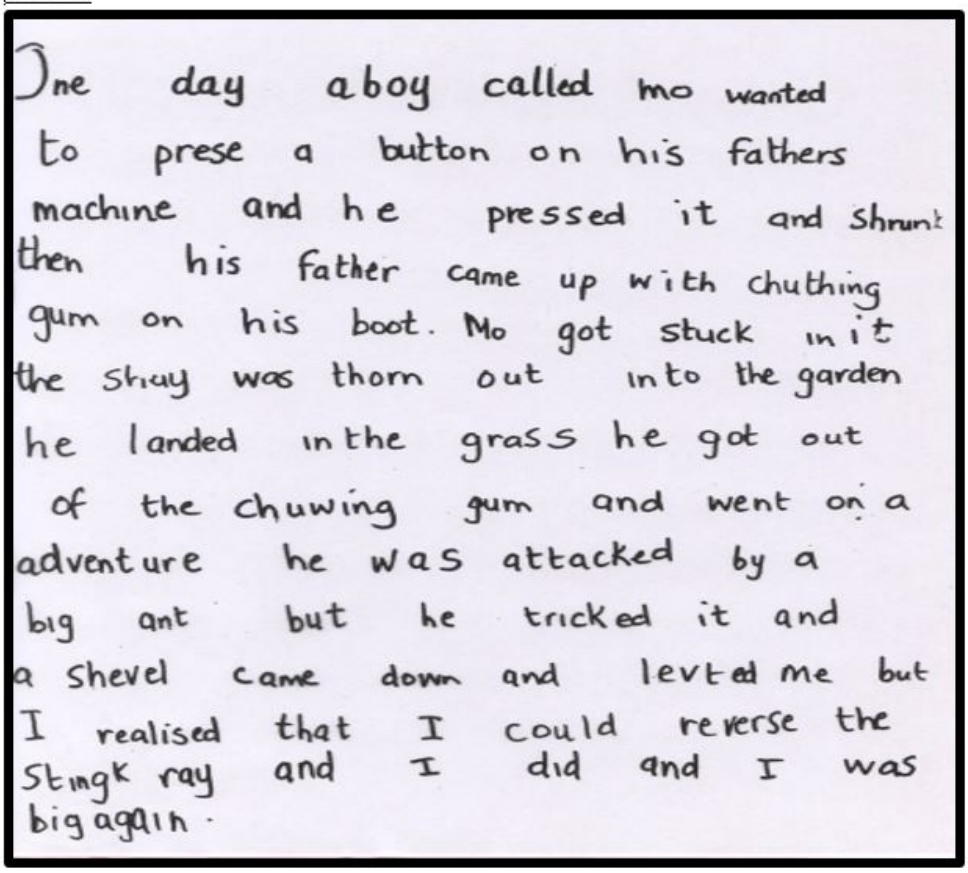

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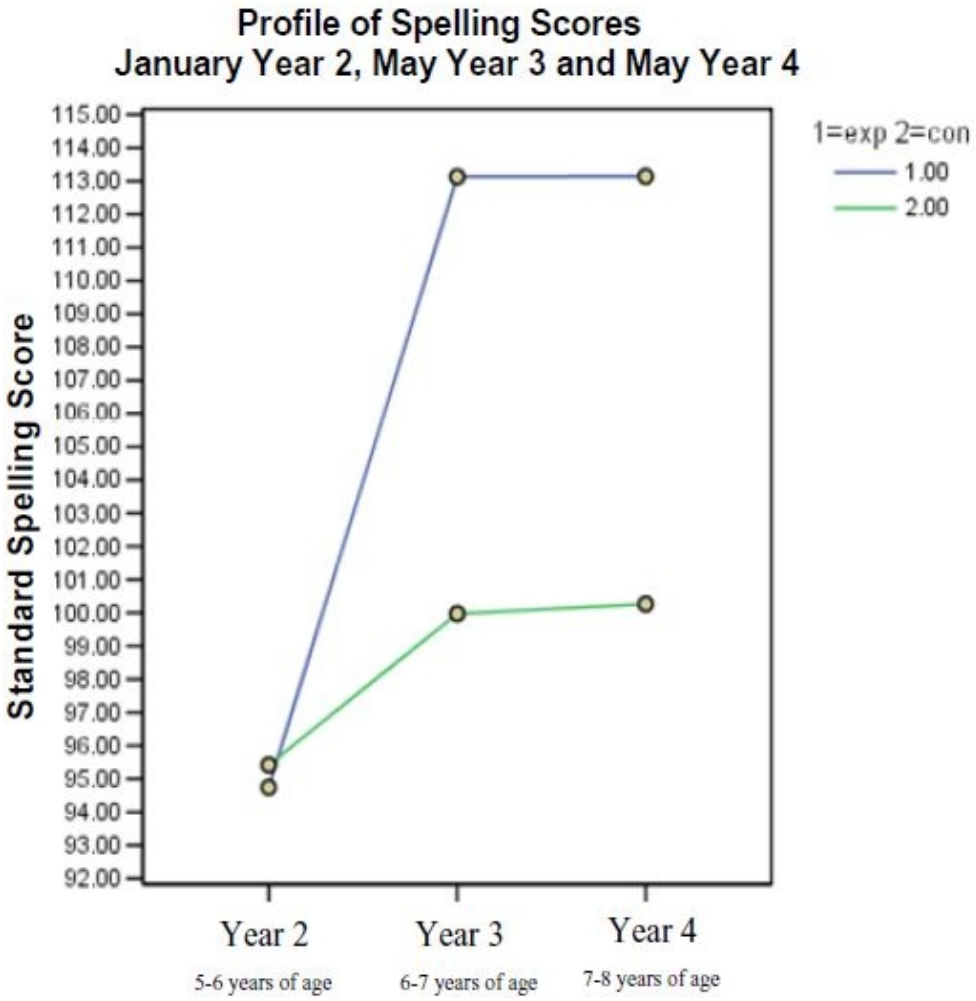
FIGURE 7



138x159mm (96 x 96 DPI)