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# Teaching Children With Developmental Spelling Difficulties in a One-on-One Context

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The aim of this article is to provide clinical and practical guidance for the provision of one-on-one intervention for children with spelling difficulties. We briefly discuss the requirements of theoretically guided assessment and suggest some norm-based assessment tools in this light. The main focus of this article is on teaching children with spelling difficulties in a one-on-one context. Previous research has shown that children present with spelling difficulties of different types and that intervention is most effective when targeted at the specific difficulty. Hence, we outline different interventions for different subtypes of developmental spelling difficulties.

**Keywords:** spelling difficulties, intervention, teaching methods

Children who present with reading difficulties usually also show difficulties with spelling (Berninger, 1994; Boder, 1973). Poor literacy impacts on children's academic potential in a number of ways. First, written language skills are one of the most crucial factors determining academic success (Prior, 1996). The adequacy of written work that contains poor spelling is underestimated by teachers in schools, colleges and universities (Thompson, 1995). Negative repercussions for poor spellers do not stop there. Potential employers have been shown to make judgements regarding character and reasoning abilities based on spelling mistakes (Beason, 2001). While reading difficulties can resolve, it is usually the spelling difficulties that persist — even into adulthood (Spren, 1988). Thus, it seems crucial to alleviate children's spelling difficulties as much as possible. Ideally, this extra teaching (or intervention) should begin as early as possible.

Intervention for children with spelling difficulties may occur in a group setting. For such groups, programs like Spelling Mastery (Dixon, Engelmann, & Bauer, 1990) seem well suited. Often, children who do not improve as a result of group-based intervention receive a more intensive one-on-one intervention (see Response to Intervention Model, e.g., Fuchs & Fuchs, 2006). Some clinicians only see children in a one-on-one context. What kind of intervention should be provided for children with spelling difficulties in one-on-one situations? This paper aims to guide teachers and clinicians to choose the best intervention for children with spelling difficulties.

Not all children have the same type of spelling difficulties: they vary in their relative strengths and weaknesses (e.g., Temple, 1997). This means that a one-size-fits-all

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approach to intervention is not suitable, because such an approach will contain teaching units targeting skills that may not be a problem for that particular child. To illustrate this point, let us consider two primary school children whose case descriptions have been published in the literature: KM and MC (Kohnen, Nickels, Brunsdon, & Coltheart, 2008a; Brunsdon, Coltheart, & Nickels, 2005). Both KM and MC had difficulties spelling unpredictable words, that is, words that cannot be successfully spelled using sound-letter-correspondences, but whose spellings have to be learned 'by sight' (also referred to as sight words or irregular words) such as *friend*, *asked*, *gone*. However, KM also had problems with sound-letter-correspondence-rules, for example, confusing the letters U and A (e.g., spelling *cut* as *cat*). In contrast, MC showed good knowledge of sound-letter-correspondence-rules. Therefore, a program targeting KM's spelling difficulties needed to include sound-letter-correspondences, whereas for MC, this was not necessary. For MC, a generic program, like Spelling Mastery, would spend unnecessary time focusing on skills that he already had acquired (i.e., knowledge of sound-letter-correspondences/spelling rules). In order to achieve the best possible outcome we need to target the *specific difficulties* a child presents with (rather than the ones they *could* present with). Hence, we need to have detailed knowledge of the skills that a particular child has acquired and the ones they have not acquired. It is this knowledge that guides the decision of what to teach. In other words, in order to target intervention appropriately and effectively, we must go beyond knowing that a child has poor spelling, and understand *why* they have poor spelling.

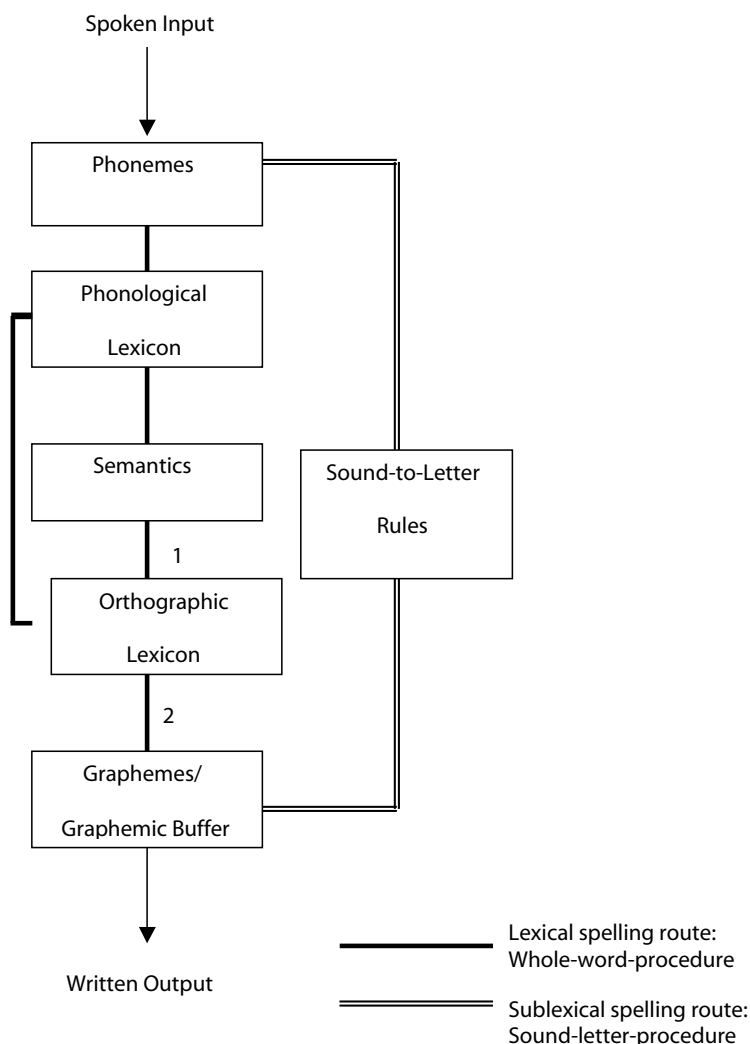
We rely on our assessment to inform us about the cause of the spelling difficulty and hence the specific skills that should be targeted in an intervention. It is therefore crucial that (all) the various skills that lead to successful spelling are assessed. This requires the use of a theoretical framework that includes all of these necessary skills. Below, we will describe such a theoretical framework.

## Theoretical Background

The dual-route model of spelling has proven a useful framework for the conceptualisation of assessment and intervention in spelling difficulties in children (e.g., Brunsdon, Coltheart, & Nickels, 2005; Temple, 1997; Westwood, 2005). Figure 1 outlines a version of such a model.

The basic premise of the dual-route theory is that there are two different cognitive pathways that allow the proficient speller to spell an item. One set of operations make use of segments of written and spoken language that are smaller than whole words. This is often referred to as the sublexical route, we will use the term sound-letter-procedure. When hearing a word like *cat*, the string of sounds can be segmented into three sound components: /k/, /a/, /t/ (letter-sounds will be presented between //). For each sound, the letter that is most frequently associated with this sound can be retrieved, that is, 'c' for /k/, 'a' for /a/, and 't' for /t/. These three letters are held active in the 'graphemic buffer', a short-term memory store, until sequences of motor (muscle) commands have been retrieved enabling them to be written. It is the knowledge of sound-letter-correspondences that help spellers to compute a reasonable written representation for unknown words (e.g., new names of people, products and places, or made-up words like *gop*). This knowledge can also be used to spell predictable (or regular) words like *cat* and *nut*. However, for words like *yacht* and *friend* a different procedure is required. It is not possible to spell such words correctly by translating each sound into a letter because the letters that make up, for example, *yacht* are not entirely predictable from their sounds. Instead, successful spelling of such unpredictable words requires knowledge about the letters that make up the word as well as their order. This knowledge has to be

memorised. The memory storage facility that holds this knowledge is often referred to as the ‘orthographic lexicon’. The spelling pathway that includes access to the orthographic lexicon is referred to as ‘lexical route’ or ‘whole-word-procedure’. When asked to spell a known word to dictation, the speller would retrieve the spoken word form, for example, *friend* in the phonological lexicon (see Figure 1). Hence, the phonological lexicon is a storage facility that holds all the spoken words a person knows. Following this, the meaning of a word may be accessed from the ‘semantics’ component before retrieving its orthography (spelling) from the orthographic lexicon. Note that we can spell words whose meanings we are not (entirely) familiar with. This fact is represented in the model by an alternative (still whole-word, or lexical) pathway that bypasses the



**FIGURE 1**  
Schematic representation of the functional architecture of spelling.

semantics component. Once a word's orthography has been retrieved from the orthographic lexicon, the graphemes of that word are activated at the grapheme level where they are held active until the motor (muscle) programs for writing the corresponding letters have been retrieved.

Children need to acquire both of these procedures (the sound-letter-procedure and the whole-word-procedure) in order to become proficient spellers. In a child with spelling difficulties, it is therefore essential to examine whether each of these procedures have been acquired. This is important in order to make decisions about the focus of the intervention as well as which teaching methods to use.

Children who have difficulties with the acquisition of sound-letter-correspondences, or acquisition of the whole-word-procedure, or both have been reported. These different types of difficulties require different forms of intervention. For example, Campbell and Butterworth (1985) reported the case of RE, who had difficulties with spelling (and reading) rules. While RE's spelling of real words was normal, she was poor at spelling nonwords. For example, she would spell *spikrolg* as *spitrola*. RE's knowledge of which letters correspond to different sounds was unreliable. RE shows quite a different spelling problem to MC (Brunsdon et al., 2005), who was almost perfect at spelling nonwords. In fact, MC had a pattern of difficulties that is exactly opposite to that of RE. MC's good nonword spelling and poor unpredictable word spelling contrasts with RE's good unpredictable word spelling and poor nonword spelling. MC tended to rely on how the unpredictable words sounded, spelling them 'phonetically', for example, *friend* as *frend*. In Figure 1, we would say that MC used the sound-letter procedure instead of the whole-word-procedure. MC was taught to remember whole words, in order to increase whole-word storage in his orthographic lexicon. In contrast, for RE, an appropriate teaching goal would have been the teaching of sound-letter-knowledge.

Most children, however, have difficulties with both sound-letter-correspondences and whole-word storage. KM (Kohnen et al., 2008a) is an example of such a child. When we first assessed KM, her spelling of unpredictable words was below age expectation. Additionally, she had difficulties with sound-letter-knowledge that had already been taught in the classroom and that her peers had no problems with. For KM, both sound-letter (spelling) relationships and unpredictable words needed to be targeted.

Below, we will set out guidelines for how these different kinds of difficulties can be assessed and then, how they can be trained.

## Assessment

Assessment aims to identify the current spelling abilities of a child, and how successfully the child has acquired the processes underlying their spelling. We have recently reviewed a number of spelling tests (Kohnen, Nickels, & Castles, 2009); here we will focus only on a selection of tests whose administration will allow to decide on a goal for an intervention.

## Diagnostic Tests

In order to pinpoint the nature of the difficulty, several tests are needed. Here, we primarily concern ourselves with spelling difficulties at the level of monosyllabic and monomorphemic<sup>1</sup> single words. While clearly, text writing and composition as well as spelling of words that have more than one morpheme (e.g., *luckily*, *unreliable*), are an issue in spelling difficulties, here, we have chosen to focus on the very basics: the acquisition of sound-letter-correspondences and whole-word storage.

Various tests are available to measure children's word spelling abilities (e.g., South Australian Spelling Test-Revised, SAST-R: Westwood, 2005, Wide Range Achievement Test, WRAT: Wilkinson, 1993). These tests allow the comparison of spelling skills to (relatively) large normative samples and thus allow the clinician to determine whether a child's spelling is adequate for his/her age (or not). However, these tests mentioned above lack in a very important feature: They do not distinguish between predictably spelled words (e.g., *rat, fan, timid*) and words that have less predictable spellings (e.g., *was, friend, nausea*). Hence, these tests do not allow a straightforward distinction between a child that has a problem with sound-letter-correspondences, and a child that has a problem with memorising unpredictable words or a child that has a problem with both.

What is needed in order to make this distinction is a test with separate norms for two types of spelling knowledge: unpredictable words and nonwords. Such a test would enable differentiation between spelling based on sound-letter-correspondences and whole-word-based spelling. While Robinson and Weekes (1995) published a list of suitable words and nonwords, only 40 normal 7- to 14-year-old children were tested. This results in small numbers of children in each age group, with the concern, therefore, that these data are not sufficient to be able to decide without any complicated statistics whether a student is performing in the normal range.

There are at least two tests that we know of that differentiate between sound-letter-knowledge-based and whole-word-based spelling. One of these, third edition of the Test of Written Spelling (TWS-3: Larsen & Hammill, 1994) has two separate word lists: predictable and unpredictable words. Administering the unpredictable words list allows the clinician to find out whether whole-word spelling is a source of difficulty for the student. However, predictable words are not the best way of assessing the knowledge of sound-letter-relationships, as they can produce misleading results. The problem is that predictable words can be spelled using both the sound-letter-procedure and the whole-word-procedure. Consider assessing a child (much like RE above) who has acquired the whole-word-procedure but has problems using the sound-letter-procedure. The poor sound-letter knowledge would not become obvious as she could compensate poor sound-letter knowledge by using her competent whole-word-procedure. However, the poor functioning of the sound-letter procedure would become obvious when using items that she has not seen before because in order to spell these nonwords, the sound-letter-procedure *has* to be used. Hence, in order to assess knowledge of sound-letter-correspondences, a nonword spelling test should be administered rather than the predictable word list

Another test that includes both nonwords and unpredictable words is the Illinois Test of Psycholinguistic Abilities (ITPA-3: Hammill, Mather, & Roberts, 2001). However, the spelling task used in this test is less than ideal as children are asked to complete incomplete spellings rather than spell the entire item.

The spelling subtest from the Wechsler Individual Achievement Test (Wechsler, 2007), which has recent Australian norms, consists mainly of words whose spellings are not entirely predictable from the sounds. Hence, for children who are in school Years 3 and above (especially in the later years of primary school and in high school), this test can be used to assess whole-word-knowledge.

The Nonword Spelling subtest of the Queensland University Inventory of Literacy (QUIL: Dodd, Holm, Oerlemans, & McCormick, 1996) is a test that can be used to assess application of sound-letter-correspondences in spelling.

Hence, we suggest the administration of the unpredictable words subtest of the TWS-3 (Larsen & Hammill, 1994) for an indication of a child's whole-word processing

skills. If the child scores one standard deviation or more below the average, the child has difficulties with whole-word spelling. Administering the nonword spelling subtest of the QUIL (Dodd et al., 1996) will allow conclusions about the child's proficiency in applying sound-letter-correspondences. Given that most children who have spelling difficulties also have reading difficulties, we suggest that reading is also assessed using the Castles and Coltheart Reading test (Castles et al., 2009).

## Further Assessments

### *Error Analysis*

While the tests above provide information regarding the functioning of the whole-word and sound-letter components of spelling, these remain relatively gross measures. For example, while the QUIL (Dodd et al., 1996) may determine that a child is able to spell nonwords less well than would be expected for his/her age, what is not clear is which specific sound-letter-correspondences a child has difficulties with. This knowledge, however, is crucial for the planning of an intervention. Clearly, we would not want to teach a child sound-letter-correspondences that he/she already knows.

Hence, having determined that a child has difficulties with nonword spelling, the next step should be to use a 'spelling sounds to dictation' task. Appendix A shows a possible format of such a task. Being able to produce a suitable letter to represent a given sound gives an indication that a child has acquired this sound-letter-knowledge. In order to be more confident that the sound-letter-correspondence has been acquired, each sound should be given several times for spelling. Does the child provide the correct letter every time?

Further information about the specific sound-letter-information a child has difficulties with can be gained by studying the errors they make. Ideally, this error analysis should be based on multiple examples of a sound-letter-correspondences in nonwords (e.g., spelling the nonwords *paim*, *trake*, *gafe*, *shail* to assess knowledge of how the 'ai' sound can be spelled — as either 'ai' like *bail* or 'a-e' like *same*). We have recently designed such a test (Kohnen, Nickels, & Castles, 2009; available from [www.motif.org.au](http://www.motif.org.au)).

Similarly, while a child's score on the unpredictable word list of the TWS-3 (Larsen & Hammill, 1994) will tell you whether or not this child has difficulties with whole-word spelling, further assessments are needed to identify the words that the intervention should focus on. We recommend that the child's spelling of a set of words is tested (using a spelling to dictation task). Intervention should focus on those words that the child misspelled prior to the intervention. Once again, it is preferable to ensure that the child can spell the words *consistently* by checking spelling on more than one occasion.

### *Letter Formation*

The correct formation of letters is a crucial part of being able to write. We do not focus on this here. However, if it is observed that a child has difficulties in handwriting, the cause of these difficulties should be assessed further.

### *Segmentation*

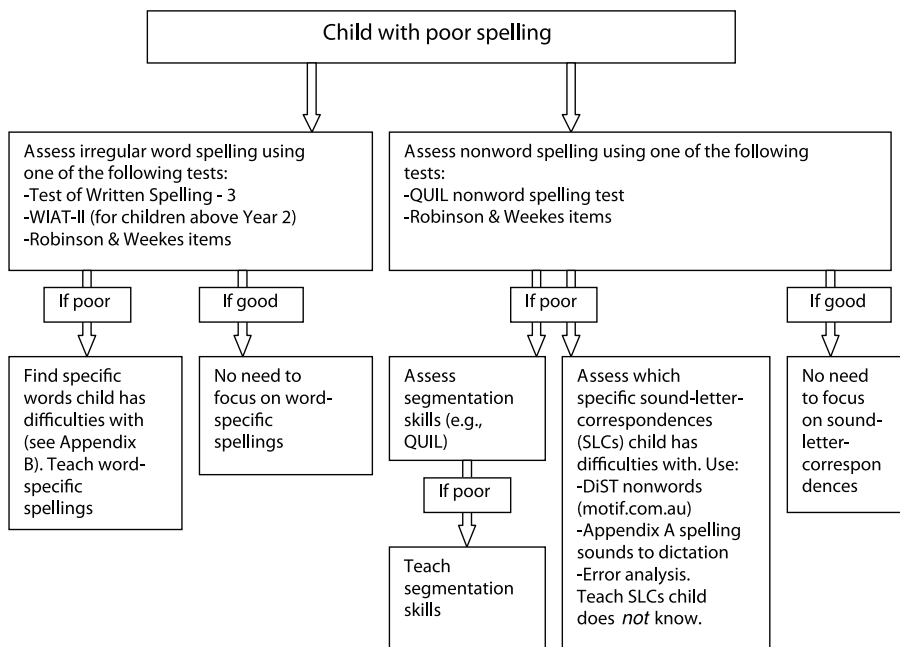
The segmentation of the incoming speech stream into smaller components, such as, for example phonemes (speech sounds), is an essential skill, especially when spelling new words, or nonwords. How well young children can segment words into component sounds tends to predict how well they spell later on (Nation & Hulme, 1997). It may be important for a child to be able to break down a word into its component sounds (e.g., c-a-t, g-r-a-m), rather than just onset and rime (e.g., c-at, gr-am). The QUIL (Dodd et al., 1996) includes tasks that assess segmentation skills (e.g., phoneme segmentation).

Figure 2 presents an overview of the different assessment tools and the resulting requirement for the focus of intervention. Intervention methods will be discussed in the next section.

## Intervention

### Deciding on a Teaching Goal (order of attack)

The administration of a test with unpredictable words and a test with nonwords can lead to three potential patterns of deficits. The first and most likely pattern is that the child has difficulties in both the whole-word-procedure and the letter-sound-procedure (also referred to as ‘mixed dysgraphia’, see the case of KM; Kohnen et al., 2008a). Such a child would have a standard score of 84 or below on the unpredictable words subtest of the TWS-3 and a standard score of 6 or below on the QUIL nonword spelling subtest. The second possibility is that the child has only difficulties with the letter-sound-procedure (also referred to as ‘phonological dysgraphia’: see the case of RE; Campbell & Butterworth, 1985). In this case, the child would score in the normal range on the TWS-3 unpredictable words subtest (i.e., a standard score of 85 or above). At the same time, performance below that of typically developing children (standard score of 6 or below) would occur on the QUIL nonword spelling test. The third pattern is the case of a child that has only difficulties in whole-word processing (also referred to as ‘surface dysgraphia’: see MC; Brunson et al., 2005). Nonword spelling in this case would be normal at a standard score of 7 or higher on the QUIL with poor results on the unpredictable word test (standard score of 84 or below).



**FIGURE 2**  
Assessment and Teaching needs

As mentioned above, most children who present with spelling difficulties, also have reading problems. Therefore, performance on the Castles/Coltheart Reading Test (Castles et al., 2009) may also be below what is normal for a child's age. Thus, it seems that the first decision to be made is whether to train reading first or spelling first or both at the same time.

### *Reading or Spelling?*

Some models predict that reading and spelling skills develop in qualitatively different ways (e.g., Frith, 1985). In particular, the more complicated sound-letter-correspondences (e.g., 'split digraphs', or 'final-e' as in mate, mope, time) are thought to develop in reading and then generalise to spelling (Davis & Bryant, 2006). There seems to be some evidence that this is true for normally developing spellers (Davis & Bryant, 2006). However, there is no systematic evaluation of this question in the remediation of spelling difficulties with children.

The evidence available leads to the conclusion that *spelling* should be taught first. Several studies found that after teaching spelling, students' reading improved too, even though reading was not targeted in the intervention. This was true both for studies focusing on teaching sound-letter-correspondences (Kohnen et al., 2008a; O'Connor & Jenkins, 1995) and those teaching unpredictable word spelling (e.g., Brunson et al., 2005; Kohnen et al., 2008b). In contrast, we are not aware of any studies that taught reading and found improvements on both reading and spelling. Wanzek et al. (2006) mention studies where reading intervention resulted in spelling improvements, however, these interventions included a spelling/writing component. Therefore, we would argue that if both reading and spelling are impaired, intervention should focus on spelling and monitor possible reading improvements.

### *Teaching Children Who Only Have Difficulties With Sound-Letter-Correspondences*

If poor knowledge of sound-letter-correspondence is diagnosed (through poor nonword spelling/spelling error analysis), intervention should focus on teaching those letter-sound-correspondences that the child has difficulties with. If segmentation is also a difficulty, improving segmentation skills can make up a part of the intervention regime. Below we will present some of the methods that have been shown to successfully teach sound-letter-correspondences. An overview is provided in Table 1.

### *Teaching Children Who Only Have Difficulties With Whole-Word Storage*

If problems with the storage of whole-word spellings are diagnosed (through poor unpredictable word spelling), intervention should focus on spelling of unpredictable words. Possible teaching methods and words to use are discussed below, and an overview can be found in Table 1.

### *Teaching Children Who Have Difficulties With Both Whole-Word Storage and Sound-Letter-Knowledge*

If two processes are affected: sound-letter-knowledge and the storage of whole words, then what should be the order of attack? While this question is of considerable interest given that most children have difficulties with both skills, there is no experimental evidence to guide us. Should both skills be trained at the same time? Or one of them first, and if so, which one? At this point in time, we can only use the underlying theory to argue in favour of one approach.



It has been estimated that about 60% of all English words are unpredictable in terms of their sound-letter-correspondence (Kreiner, 1992). However, even within unpredictable words, most letters still tend to be predictable (see Berninger et al., 1998, for a similar argument). Consider the following unpredictable words: *mountain*, *done*, *write*. In order to spell these words correctly, the speller needs to know which letters occur in this word and their order. However, if the speller was unsure, a close approximation could be created based on sound-letter-knowledge: ‘mowntin/mountin’, ‘dun’, ‘rite’. From a functional point of view, these responses are possibly recognisable as the target words. However, if sound-letter knowledge is poor, responses may be: ‘*maton*’, ‘*dan*’, and ‘*rit*’. It would be hard to recognise these responses as the target words. From a learning point of view, being able to compute some parts of a word correctly will actually help in the formation of a (correct) permanent entry in the orthographic lexicon. It also seems as if the learning task is actually somewhat easier if only (the unpredictable) parts have to be remembered rather than the entire word. Thus we argue that teaching sound-letter-knowledge should precede the teaching of unpredictable words.

## Choice of Items for Intervention

### *Number of Items Taught*

The number of items taught at any one time should be fairly small. There are two studies that directly investigated relative effects when varying the number of training words (Bryant, Drabin, & Gettinger, 1981; Gettinger, Bryant, & Fayne, 1982). Larger benefits were shown for groups that learned three new words a day (compared to four or five). However, no optimal number has been determined yet (Wanzek et al., 2006).

**TABLE 1**

Teaching Methods Overview

	Teaching whole-word knowledge	Teaching sound-letter-correspondences
Item types	Unpredictable words that child cannot spell (e.g., Appendices B and C)	Regular words and nonwords
Number of items	Up to three new words daily	Unclear how many sound-letter-correspondences should be taught per week
Feedback and praise	Feedback needs to be immediate and consistent. Praise for effort and persistence.	
Methods proven successful	Delayed copying and spelling to dictation	Keyword strategy
	Naming letters while writing the item	Writing letter sounds to dictation
	Overpronunciation (only if child is a good nonword reader and speller)	Minimal pair training
	Visual Imagery and Visual Inspection	Stating spelling rules (explicit mentioning of sound-letter-correspondences)
	Mnemonics (presenting written word accompanied by a picture)	
Other	Homophones: contrasting orthography, picture-word matching, spelling to dictation	
	Teaching words in families	

In order to be able to show statistically significant changes in clinical studies, larger numbers are needed. Thus, clinical single case intervention studies published in the literature often include fairly large numbers of training words (e.g., 74 words: Brunson et al., 2005; 42 words: Kohnen et al., 2008b), but these may be trained in small sets sequentially.

### *Types of Items Used*

There is experimental evidence to suggest that intervention techniques affect different types of items in different ways (e.g., Brown, 1988). Brown (1988) compared two teaching methods. One set of teaching techniques involved multisensory learning, practice on worksheets and phonemic analysis of words. The other type of spelling instruction was given for a relatively small number of words using immediate error imitation and computer practice. The latter technique proved to be more beneficial for unpredictable words.

These findings as well as the notion that different techniques should be paired with different kinds of words make sense when considering the model in Figure 1. Predictable words can be spelled using sound-letter-knowledge as well as using stored lexical knowledge in the orthographic lexicon. However, words that are not completely predictable can only be spelled correctly if the word is represented in the orthographic lexicon. Therefore, it seems to us that repeated practice and memorisation techniques should be used to teach unpredictable words. Techniques that focus on teaching sound-letter-knowledge, on the other hand, should include predictable words and nonwords. Unfortunately, it seems that this distinction is often disregarded in research (see review of spelling interventions by McNaughton, Hughes, Clark, 1994), clinical practice and schools. Below we will report which kinds of techniques may be used with predictable versus unpredictable words. We only report techniques where there is evidence from the literature that they have been successful. However, given that most studies do not report the kinds of items that were used when evaluating teaching techniques, there is not necessarily evidence available to say which kinds of training items these techniques are most useful for.

### *Feedback and Praise*

Teaching spelling usually includes a feedback procedure when an error has been made. It seems that the feedback procedure is a very central part of a teaching program (Fulk & Stormont-Spurgin, 1995; McNaughton et al., 1994; Wanzek et al., 2006). Useful feedback may involve pointing out the difference between the error and the correct spelling (Wanzek et al., 2006). Also, it is regarded as important that error correction occurs immediately after the error has been made (Wanzek et al., 2006).

It has been argued that items should be taught to mastery (Gettinger et al., 1982). For example, Brunson et al. (2005) discontinued training only once the child had spelled at least 90% of the training words correctly in two consecutive training sessions. Review of already learned material should be provided frequently (Gettinger et al., 1982).

Praise and a positive teaching environment contribute to increasing skill-levels (see review of the evidence by Fulk & Stormont-Spurgin, 1995).

### **Improving Whole-Word Spelling**

We will begin this section by going into more detail about which types of unpredictable words to use for training. Then we will outline some successful methods of teaching those words.

### *Which Unpredictable Words To Use?*

The same, relatively small number of words makes up the majority of words in any written text (Vousden, 2008). Many of these very frequently occurring words are also unpredictable in their spelling (e.g., was, where, who). In order to maximise the benefit of teaching, it is important that the intervention is focused on the words that a child is likely to need to write most frequently. In Appendix B, we have listed the 250 most commonly occurring unpredictable (for spelling) monosyllabic words. In Appendix C we list the 133 most frequent unpredictable (for spelling) words that have more than one syllable.

Given that there are a lot of unpredictable words and that teaching should also be limited to a reasonable number of words, which of the words that the child misspells should be taught first?

There is evidence suggesting that some unpredictable words improve without specific teaching as a result of the training of other unpredictable words (e.g., Brunson et al., 2005; Kohnen et al., 2008b). This is called generalisation across items and is more likely to affect some words than others. While more detailed studies are needed to give definite recommendations, the evidence to date allows us to make some suggestions. Words likely to generalise (show improvement without direct teaching) are of high frequency (occur frequently in written language) and tend to have more orthographic neighbours. An orthographic neighbour is a word that differs from another word by only one letter. For example, the word 'love' has 15 neighbours, including 'cove, dove, move, lobe, live, lose'; 'threat' has two neighbours: 'thread' and 'throat'. If high frequency words with many neighbours are more likely to generalise, then preference for teaching should be given to those words that are relatively less frequent and have less neighbours. However, it is important to monitor whether untaught words actually improve without teaching. This can be done by reassessing the list of unpredictable words after the teaching phase. Those words that have not improved without teaching need to be taught as well. Note that the effect of improvement without direct teaching is relatively small. For example, before teaching KM spelled about 20% of both untaught and taught words without any errors. After teaching, over 90% of the taught words were spelled correctly, compared to only about 40% for the untaught words (Kohnen et al., 2008b).

Below we describe a number of useful techniques for the teaching of unpredictable words (see Table 1 for an overview).

### *Delayed Copying/Copy-Cover-Compare*

One procedure that has been shown to be successful in the teaching of unpredictable words combines copying and correction procedures (e.g., Brunson et al., 2005; Stevens & Schuster, 1987; Frank, Wacker, Keith, & Sagen, 1987). There are various implementations of this procedure, one is as follows (Brunson et al., 2005):

- Clinician presents word on flashcard and pronounces word.
- Child copies word while flashcard is in sight. Correction if necessary.
- Written word is removed from sight and child is instructed to keep the spelling of the word in mind.
- After a delay (e.g., 10 seconds, the clinician/teacher counts to 10) the child writes down the word again. Correction if necessary.
- The child's previous spelling response is removed from sight and the clinician gives the word to spell to dictation.

Procedures like this have been successfully implemented in groups or individual settings on computers or as a paper and pencil technique (McDermott & Wattkins, 1983).

### *Letter Naming and Writing*

Bradley (1981) implemented a teaching procedure where the students were required to say the names of the letters while writing words. The steps of the intervention were as follows:

- Word is presented on a card.
- Child reads the word aloud.
- Child writes down the word with the word in sight initially, but covered up later on (i.e., when the student does not need to see the word to perform accurately), naming every letter while writing the word.
- Child reads the word aloud again and checks that it is spelled correctly.

This procedure led to spelling improvement that was maintained over time. This technique was also shown to be superior to a task where children were asked to assemble plastic letters instead of writing the word. Better retention of words trained with the naming letters and writing technique were evident when compared to two other teaching methods: assembly of letter tiles, repeating the word while writing. The letter naming and writing technique is also implemented in group-based programs such as Spelling Mastery (Dixon et al., 1990).

### *Overpronunciation*

By overpronunciation (Holmes & Malone, 2004) we mean pronouncing a word ‘the way it would sound if read aloud by letter-sound-rules’, for example, pronouncing ‘yacht’ as if it rhymed with ‘matched’. Hilde and Reitsma (2006) used this technique to train spelling of unpredictable words in Dutch. A word was presented on a computer screen along with its (normal) pronunciation. Then, a sound file with the overpronunciation was presented. The visually presented word disappeared and the child had to type the word. Feedback was given regarding the correctness of the response and the child saw the correct spelling once more. Hilde and Reitsma (2006) found that using overpronunciation helped children to learn the spelling of unpredictable words. However, this technique produced no superior effects to simply scrutinising the written word at presentation.

The overpronunciation technique is probably only suitable for children that have good knowledge of letter-sound-correspondences and sound-letter-correspondences, that is, they are good at reading and spelling nonwords. This is possibly confirmed by the finding of Holmes and Malone (2004) that poor spellers did not necessarily benefit when using this technique without guidance. However, when *provided* with the pronunciation poor spellers seem to be able to benefit (e.g., Drake & Ehri, 1984; Hilde & Reitsma, 2006).

### *Visual Imagery and Visual Inspection*

The basic idea here is that children imagine the letters of words to help them retain the spellings. Experimental designs (Darch & Simpson, 1990; Sears & Johnson, 1986) have used a four step program to test the benefits of this approach:

- A word is presented (projected onto a wall with an overhead projector, as these were group settings).
- Teacher covers the word up and asks students to imagine the word in their mind.

- Students are asked to imagine the word on a large outdoor screen.
- Students are asked to imagine themselves nailing each letter onto a screen.

Sears and Johnson (1986) implemented this technique with a group and compared it to three other methods carried out with three other groups. Two of the three other methods were copying tasks; one performed on a computer, the other as a paper-and-pencil version. The fourth technique focused on the letter sounds and pronunciation of the taught words. Sears and Johnson found that all four groups improved on the taught items. Additionally, there were no differences in long-term retention of the taught words for the copying tasks and the visual imagery task.

Hilte and Reitsma (2006) asked their students to closely attend to words that were presented on a computer screen along with a picture of the word. While this technique led to improved spelling, improvements were similar as for another group who were trained with the overpronunciation technique (see above).

Hence, visual imagery and visual inspection seem to be useful teaching techniques. However, the limited evidence available suggests that this is no more effective than other methods (e.g., copying tasks or overpronunciation).

### *Homophones*

Homophones (e.g., *write–right–rite*) are words that pose a particular problem in spelling acquisition. Even skilled spellers often make homophone confusions (e.g., using *there* for *their*). Yet, we know of only one study that specifically looked at teaching homophones (Kohnen, Nickels, & Coltheart, 2007). We used a technique with a 10-year-old child, AS, that was inspired by the literature on adults with spelling disorders (acquired following a brain injury) (Behrmann, 1987):

1. One homophone was presented on a card and the word was used in a sentence.
2. The other homophone of that pair was then introduced in the same way.
3. AS was asked to draw a picture for each homophone word on a separate card.
4. Orthography and meaning of the two words was contrasted (e.g., tail–tale: The tale that is a story has an –e at the end. The tail that is a dog’s tail has an ‘A’ and an ‘I’).
5. Cards were shuffled and the child was asked to match written words to pictures.
6. Words were removed and the child was asked to write down the words under the correct picture.
7. Pictures were removed and child asked to spell the words in a writing to dictation task. Feedback focused on orthography and semantics. For example, when tail was spelled correctly, feedback would be: ‘Yes, this is the tail that means a dog’s tail, that’s spelled with ‘A’ and ‘I’? Or, spelling tale as tail: ‘No, the tale that means a story is spelled with an –e at the end’.

We only taught homophones that AS had misspelled prior to the teaching sessions. However, even if only one word of a homophone pair was misspelled, both homophones would be taught. About five pairs were taught per session. The intervention was successful such that AS spelled significantly more of the taught homophones correctly after the intervention than before. However, the number of homophone confusions (i.e., writing one homophone instead of another, e.g., I want the chocolate over their) did not decrease over the course of the study. That is, even after the intervention, AS still made a lot of homophone confusions. It is possible that separating the teaching of the two homophone words might help in decreasing this kind of error. Therefore, we suggested that possibly teaching should only focus on one homophone member at a time. This suggestion still needs to be tested experimentally.

### *Mnemonics*

Some studies have examined the effect of providing a mnemonic picture along with an unpredictable word during teaching. These mnemonic pictures are usually related to the meaning of the word and designed to focus attention on the unpredictable portion of the word (e.g., the two 'oo' in *look* are drawn as glasses; the 'o' in *slow* drawn as a snail see Schmalzl & Nickels, 2006). Other times, the cue is simply a picture of the word (e.g., next to the written word *bath* is the drawing of a bath; the written word *month* appears with the picture of a calendar page (Brunsdon et al., 2005). This has been found to improve spelling accuracy (Brunsdon et al., 2005; Hilde & Reitsma, 2006). Hence, it is a successful technique for teaching unpredictable words. However, Brunsdon et al. (2005) compared the relative benefits of a copying/spelling-to-dictation technique with versus without mnemonic pictures. They found there was no additional benefit from adding picture mnemonics to the teaching routine. Hence, adding mnemonic pictures when teaching unpredictable words does not necessarily lead to greater improvements.

### *Word Families and Analogies*

Some groups of words share certain unpredictable parts or irregularities (e.g., 'chuh' spelled as 'ure' as in *nature*, *feature*, *picture*, *creature*, *culture*; 'or' spelled as 'ar' after 'w' as in *war*, *warm*, *ward*, *wart*, *warn*, *warp*). These word groups are also referred to as word families (Johnston, 1999). The fact that groups of words share unpredictable parts does not mean that this can be taken as a sound-letter-correspondence. However, it seems to make sense to teach word families as a group, rather than each word as a single unpredictable word. This is partly because it may be a useful way to remember the spelling of words by thinking about similar words, or other members of a word family (Templeton & Morris, 1999). In the literature, this has been referred to as spelling by analogy (e.g., Treiman, 1993). Children need to be taught this strategy, as they will not necessarily acquire it without explicit teaching (Templeton & Morris, 1999). While we are not aware of an evaluation of such a technique for students with spelling difficulties, it seems a useful teaching technique for words that share certain unpredictable features.

### *Summary*

Several different teaching techniques have proven successful to learn words with unpredictable spellings including (delayed) copying, letter naming and writing, mnemonics, 'overpronunciation', visual inspection/imagery. Current studies do not suggest that any technique is superior to another. However, care should be taken to match the teaching technique to a student's abilities (e.g., only use 'overpronunciation' for students with good nonword reading and spelling). Providing revision, teaching to mastery (e.g., achieving 90% accuracy over several consecutive sessions) and giving direct feedback regarding the spelling response are important elements of a teaching regime. Improvement for taught words can be substantial (e.g., improvements from 20% before teaching to over 90% after teaching) and long-lasting (e.g., Brunsdon et al., 2005; Kohnen et al., 2008a, b). Improvement can occur for untrained words. This generalisation effect seems to affect words with specific features (i.e., words that occur very frequently and have many orthographic neighbours). However, most improvement occurs for trained words, only few words improve without specific training.

## Improving Sound-letter Knowledge

### *Items to Use*

One way of improving spelling along the sound-letter-procedure is to teach the rules of spelling, that is, mappings from sounds to letters or sound-letter-correspondences. This can be done by using letters as the unit of teaching, but also, (regular/predictable) words or made-up words (nonwords) may be used.

Intervention should focus on sound-letter-knowledge that has not been acquired by the child, as determined from error analysis and spelling sounds to dictation task (described above). In all likelihood, the child will have difficulties with more than one sound-letter-correspondence. In this case, it has to be decided which of these to teach first. The two parameters that need to be taken into account are the number of letters that are used to represent a sound and the number of alternative letters that can be used to spell a particular sound. The sound-letter spelling test in Appendix A can be used as a rough guide. Start training sound-letter-correspondences that are unambiguous and entail writing a single letter (e.g., /b/ – Bb, /p/ – Pp). Also, vowels are usually more complicated than consonants, so begin with consonants. Long vowels (e.g. /ar, ee, oo/ as in *park, peek, loop*) are more complex than short vowels (/e, a, o/ as in *pet, cat, cot*). Berninger, Vaughan, Abbott, Brooks, Abbott, et al. (1998) suggest that instruction should include both single letter (e.g., p, e, d) and multiple letter units (e.g., oo, ee, ar) from early on in order to alert children to the fact that English sound-letter-mappings occur at several levels. That is, one sound can be represented by one letter (e.g., /p/–‘p’), but one sound can also be represented by more than one letter and have variable mappings (e.g., /ee/–‘ee,ea’). Another consideration can be how often a sound-letter-correspondence is applied. For example, say a child has problems with both the /or/ in ‘for’ and the /ar/ in ‘farm’. Given that the /ar/–‘ar’ occurs more often in written texts than /or/–‘or’ (Fry, 2004), /ar/–‘ar’ should be taught before /or/–‘or’. An excellent guide to levels of difficulty as well as lists of practice words is provided in the Single Word Spelling Test (Sacre & Masterson, 2000).

Once the target sound-letter-correspondence has been decided on, words and nonwords should be selected that include these target sound-letter-correspondences. Teach each unit for as long as it takes for the child to reach ceiling. Then move on to the next unit. You may find that teaching of one sound-letter-correspondence leads to improvement in the spelling of another untrained sound-letter-correspondence. For example, after teaching only two vowels with the final -e (*tap-tape, cap-cape; mop-mope; cop-cope*), KM improved on all five vowels that the final -e applies to (*tub-tube; dim-dime; pet-Pete*) (Kohnen et al., 2008b). If reassessment shows this to be the case, it is not necessary to go on to train the rule that improved without training.

Below, we will discuss possible items and methods to use in the intervention (see Table 1 for an overview).

### *Keyword Strategy*

Berninger, Vaughan et al. (1998) used a teaching program called ‘Talking Letters’, in which sound-letter-correspondences were taught via a keyword strategy. Letters were paired with a picture that includes the sound most frequently associated with the letter(s) (also see for a similar program: Manson & Wendon, 1997). For example, the letters ‘oo’ could be written next to a picture of the moon. First, the teacher/tutor explained to a child that the names of pictures include a clue as to the sound that is

linked to a certain letter (or letters). The teacher then named the picture, produced the key sound in the picture name, then pointed to the letter(s) again. Keyword strategies can also be combined with writing the letter-sound to dictation – either in isolation or in the context of a word or nonword.

### *Writing Letter Sounds to Dictation*

O'Connor and Jenkins (1995) taught sound-letter-knowledge by asking children to spell sounds to dictation as well as by performing phonological segmentation tasks (e.g., what is the first sound you hear in 'lad'). Similarly, in Spelling Mastery Level A (Dixon et al., 1990), letter sounds are spelled to dictation. This is repeated over several lessons so that the written form and the letter sound become firmly associated.

### *Minimal Pairs*

One further possibility of teaching sound-letter-correspondences includes using minimal pairs (e.g., Kohnen et al., 2008a; Masterson & Crede, 1999). Minimal pairs are two items that only differ in one sound/letter, for example, *mate–mat*, *bed–led*, *bin–bim*. We (Kohnen et al., 2008a) presented the case of a girl, KM, who made consistent spelling errors on certain sounds, indicating that she had difficulties with particular sound-letter-correspondences. For example, KM spelled 'kite' as 'kit', 'side' as 'sid' and 'cut' as 'cat', 'plum' as 'plam'. We used minimal pairs to contrast target sound-letter-correspondences (e.g., /uh/ to u) with incorrect correspondences (e.g., /uh/ to a). About five pairs were taught per target unit (e.g., 'cut–cat', 'hut–hat', 'mud–mad', etc.). KM was asked to spell both members of a minimal pair to dictation. Sound-letter-correspondences were also made explicit and repeated as part of the feedback on correct and incorrect responses. These techniques were very successful and KM improved from about 20% spelling accuracy before training to about 80% after training.

### *Stating Rules*

Berninger and colleagues (Berninger, Abbott, Rogan, Reed, Abbott, Brooks, et al., 1998) emphasize the importance of explicit instruction of spelling units. For example, Spelling Mastery Level B (Dixon et al., 1990) makes use of explicit sound-letter-correspondences. For example, 'The sound /v/ at the end of words is usually spelled with the letters v–e.' (Dixon et al., 1990, Level B, p. 1). In the Spelling Mastery Program, these sound-letter-correspondences are then practiced over several lessons using different words as examples. The following study may serve as another example of explicit teaching of sound-letter-correspondences. In our intervention with KM, we (Kohnen et al., 2008a) explicitly mentioned that there were sound-letter-correspondences. For example, the final -e rule (as evident in *mate*, *cute*, *time*, *Pete*, *clone*) was stated as 'The –e at the end makes the letter say its name.' Minimal pair examples were used to illustrate the rule (e.g., *mat–mate*, *cod–code*).

### *Timing of the Assessments*

The goal of the initial assessment is to identify the specific deficits that lead to the problems with spelling. In order to assess whether the intervention has induced any changes in the child's spelling performance compared to his/her peers, it is essential to carry out an assessment at the conclusion of the intervention. However, it is important to note that improvements that children make during training are not necessarily reflected in the scores of tests with norms. That is, while a child may learn to spell words that she/he could not spell prior to training, this improvement may not be reflected in a



normal score on the TWS-3 (Larsen & Hammill, 1994). There are various reasons for this. Consider the following: A child with a deficit in remembering word specific spellings receives training. Clearly, there is an improvement evident during training in that the child is much better at spelling these practiced words. However, no changes are evident when reassessed on, for example, the unpredictable words subtest of the TWS. How is this possible? It is widely assumed that teaching of unpredictable word spelling leads to an improvement in the 'mental' picture for the practiced words in the orthographic lexicon (e.g., Rapp & Kane, 2002). However, if the improvements are restricted to the practiced words only then it is only possible to pick up on these changes if the testing instrument actually contains these taught words. This is not always the case. It seems reasonable, therefore, to test the items that the child is going to practice before and after an intervention. This determines whether the child actually improved on the trained task.

A similar case can be made for the teaching of sound-letter-correspondences. Given that the taught sound-letter knowledge is not necessarily part of the nonword spelling test used in the initial assessment, an improvement might not show for this test if the improvement was restricted to the taught relationships. However, improvement should be traceable if a pre- and a posttest are administered that include nonwords and regular words including the taught sound-letter-correspondences (e.g., Kohnen et al., 2008a).

## Summary and Conclusion

This paper has discussed recommendations for 'best practice' in the one-on-one teaching of children with spelling difficulties.

One aspect that is very important in the teaching of spelling, but which we have not been able to cover, is the relationship between spelling and meaning and how this should be taught. For example, spelling a word like 'pleasant' correctly may be easier for those who are aware that it is based on the word 'please'. The interested reader is also encouraged to consult the literature on how the teaching of meaning is relevant in teaching spelling (e.g., Hurry, Nunes, Bryant, Pretzlik, Parker, et al., 2005; also see the Spelling Mastery series).

In summary, we have argued that assessment should be based on a clear theoretical framework to enable identification of the component processes of spelling. Prior to any intervention, an initial assessment of sound-letter-knowledge and knowledge of whole-word spelling is essential. In particular, we have suggested two spelling tests as part of the initial assessment: the nonword spelling subtest of the QUIL (Dodd et al., 1996) and the unpredictable words spelling subtest of the TWS-3 (Larsen & Hammill, 1994). Based on the results of these tests, it can be determined whether whole-word spelling or sound-letter-correspondences, or both are impaired.

The different subtypes of spelling difficulties require different approaches to teaching. Different items should be used to train the different types of spelling difficulties, and different methods should be applied. The success of an intervention can (and should) be monitored in at least two ways: Improvement on the trained items and improvement of tests that give reference to norms.

We hope that this summary will be useful for teachers and clinicians when deciding on the important issues of assessment and teaching goals when working with children with spelling difficulties.

## Endnotes

- 1 Words consisting of one morpheme, for example, luck (monomorphemic) vs. lucky and luckily (polymorphemic). Note though, that unpredictable polymorphemic words are often included in word-lists for the teaching of spelling (e.g., dreamt, fought).
- 2 Instructions similar to Sacre and Masterson (2001). Response sheets for DiSTs available from [www.motif.org.au](http://www.motif.org.au)

## References

- Baayen, R.H., Piepenbrock, R., & Van Rijn, H. (1993). *The CELEX Database*. Linguistic Data Consortium: University of Pennsylvania.
- Beason, L. (2001). Ethos and error: How business people react to errors. *College Composition and Communication*, 53, 33–64.
- Behrmann, R. (1987). The rites of righting writing: Homophone remediation in acquired dysgraphia. *Cognitive Neuropsychology*, 4, 365–384.
- Berninger, V. (1994). *Reading and writing acquisition: A developmental neuropsychological perspective*. Boulder: Westview Press.
- Berninger, V., Abbott, R., Rogan, L., Reed, E., Abbott, S., Brooks, A., Vaughan, K., & Graham, S. (1998). Teaching spelling to children with specific learning disabilities: The mind's ear and eye beat the computer or pencil. *Learning Disability Quarterly*, 21, 106–122.
- Berninger, V., Vaughan, K., Abbott, R., Brooks, A., Abbott, S., Reed, E. et al. (1998). Early intervention for spelling problems: Teaching spelling units of varying size within a multiple connections framework. *Journal of Educational Psychology*, 90, 587–605.
- Boder, E. (1973). Developmental dyslexia: a diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology*, 15, 663–687.
- Brunsdon, R., Coltheart, M., & Nickels, L. (2005). Treatment of irregular word spelling in developmental surface dysgraphia. *Cognitive Neuropsychology*, 22, 231–251.
- Bradley, L. (1981). The organization of motor patterns for spelling: An effective remedial strategy for backward readers. *Developmental Medicine and Child Neurology*, 23, 83–91.
- Bryant, N.D., Drabin, I.R., & Gettinger, M. (1981). Effects of varying unit sizes on spelling achievement in learning disabled children. *Journal of Learning Disabilities*, 14, 200–203.
- Brown, M. (1988). An investigation of a spelling intervention with learning disabled elementary school students. *B. C. Journal of Special Education*, 12, 1–18.
- Castles, A., Coltheart, M., Larsen, L., Jones, P., Saunders, S., & McArthur, G. (2009). Assessing the basic components of reading: A revision of the Castles and Coltheart test with new norms. *Australian Journal of Learning Difficulties*, 14, 67–88.
- Campbell, R., & Butterworth, B. (1985). Phonological dyslexia and dysgraphia in a highly literate subject: A developmental case with associated deficits of phonemic processing and awareness. *The Quarterly Journal of Experimental Psychology*, 37A, 435–475.
- Darch, C., & Simpson, R.G. (1990). Effectiveness of visual imagery versus rule-based strategies in teaching spelling to learning disabled students. *Research in Rural Education*, 7, 61–70.
- Davis, C., & Bryant, P. (2006). Causal connections in the acquisition of an orthographic rule: A test of Uta Frith's developmental hypothesis. *Journal of Child Psychology and Psychiatry*, 47, 849–856.
- Dixon, R., Engelmann, S., & Bauer, M.M. (1990). *Spelling Mastery Level B: Teacher's book*. Sydney: McGraw-Hill
- Dodd, B., Holm, A., Oerlemans, M., & McCormick, M. (1996). *Queensland University Inventory of Literacy (QUIL)*. Brisbane: The University of Queensland.
- Drake, D.A., & Ehri, L.C. (1984). Spelling acquisition: Effects of pronouncing words on memory for their spelling. *Cognition and Instruction*, 1, 297–320.
- Frank, A.R., Wacker, D.P., Keith, T.Z., & Sagen, T.K. (1987). Effectiveness of a spelling study package for learning disabled students. *Learning Disabilities Research*, 2, 110–118.
- Frith, U. (1985). Beneath the surface of developmental dyslexia. In K.E. Patterson, J.C. Marshall, & M. Coltheart (Eds.) *Surface dyslexia* (pp. 301–330). London: Erlbaum.

- Fry, E. (2004). Phonics: A large phoneme-grapheme frequency count revisited. *Journal of Literacy Research*, 36, 85–98.
- Fuchs, D., & Fuchs, L. S. (2006). Introduction to response to intervention: What, why, and how valid is it? *Reading Research Quarterly*, 41, 93–99.
- Fulk, B.M., & Stormont–Spurgin, M. (1995). Spelling interventions for students with disabilities: A review. *The Journal of Special Education*, 28, 488–513.
- Gettinger, M., Bryant, N.D., & Fayne, H.R. (1982). Designing spelling instruction for learning disabled children: An emphasis on unit size, distributed practice, and training for transfer. *The Journal of Special Education*, 16, 339–448.
- Hammill, D.D., Mather, N., & Roberts, R. (2001). *Illinois Test of Psycholinguistic Abilities (3rd edition)*. Austin: Pro-ed.
- Hilte, M., & Reitsma, P. (2006). Spelling pronunciation and visual preview both facilitate learning to spell irregular words. *Annals of Dyslexia*, 56, 301–318.
- Holmes, V.M., & Malone, N. (2004). Adult spelling strategies. *Reading and Writing*, 17, 537–566.
- Johnston, F.R. (1999). The teaching and timing of word families. *The Reading Teacher*, 53, 64–75.
- Kohnen, S., Nickels, L., Brunson, R., & Coltheart, M. (2008a). Patterns of generalisation after treating sublexical spelling deficits in a child with mixed dysgraphia. *Journal of Research in Reading*, 31, 157–177.
- Kohnen, S., Nickels, L., & Castles, A. (2009). Assessing spelling skills and strategies: A critique of available resources. *Australian Journal of Learning Difficulties*, 14, 113–150.
- Kohnen, S., Nickels, L., Coltheart, M., & Brunson, R. (2008b). Predicting generalization in the training of irregular-word spelling: Treating lexical spelling deficits in a child. *Cognitive Neuropsychology*, 25, 343–375.
- Kohnen, S., Nickels, L., & Coltheart, M. (2007). Write on: Remediation of homophone spelling in a developmental surface dysgraphic. In S. Kohnen, *Cognitive neuropsychological rehabilitation in childhood dysgraphia*. Unpublished PhD thesis, Macquarie University, Sydney, Australia.
- Kreiner, D.S. (1992). Reaction time measures of spelling: Testing a two-strategy model of skilled spelling. *Journal of Experimental Psychology: Learning, Motor and Cognition*, 18, 765–776.
- Larsen, S.C., & Hammill, D.D. (1994). *Test of Written Spelling — 3rd Edition (TWS-3)*. Austin, TX: ProEd.
- Manson, J., & Wendon, L. (1997). *Letterland early years handbook*. Cambridge, UK: Letter Land International.
- Masterson, J.J., & Crede, L.A. (1999). Learning to spell: Implications for assessment and intervention. *Language, Speech, and Hearing Services in Schools*, 30, 243–254.
- Masterson, J., Stuart, M., Dixon, M., & Lovejoy, S. (2003). The children's printed word database, <http://www.essex.ac.uk/psychology/cpwd/>.
- McDermott, P.A., & Watkins, M.W. (1983). Computerized vs. conventional remedial instruction for learning-disabled pupils. *The Journal of Special Education*, 17, 1–81.
- McNaughton, D., Hughes, C.A., & Clark, K. (1994). Spelling instruction for students with learning disabilities: Implications for research and practice. *Learning Disabilities Quarterly*, 17, 169–185.
- Nation, K., & Hulme, C. (1997). Phonemic segmentation, now onset-rime segmentation, predicts early reading and spelling skills. *Reading Research Quarterly*, 32, 154–167.
- O'Connor, R., & Jenkins, J.R. (1995). Improving the generalization of symbol knowledge: Teaching spelling to kindergarten children with disabilities. *The Journal of Special Education*, 29, 255–275.
- Perry, C., Ziegler, J.C., & Coltheart, M. (2002). How predictable is spelling? Developing and testing metrics of phoneme-grapheme contingency. *Quarterly Journal of Experimental Psychology*, 55A, 897–915.
- Prior, M.R. (1996). *Understanding specific learning difficulties*. Hove: Psychology Press.
- Rapp, B., & Kane, A. (2002). Remediation of deficits affecting different components of the spelling process. *Aphasiology*, 16, 439–454.
- Robinson, G., & Weekes, B. (1995). Subtypes of developmental dysgraphia. In J. Fourez, & N. Page (Eds.). *Treatment issues and long term outcomes* (pp. 43–51). Brisbane: Academic Press.
- Sacre, L., & Masterson, J. (2000). *Single word spelling test*. London: GL Assessment.

- Sears, N.C., & Johnson, D.M. (1986). The effects of visual imagery on spelling performance and retention among elementary students. *Journal of Educational Research*, 79, 230–233.
- Schmalz, L., & Nickels, L. (2006). Treatment of irregular word spelling in acquired dysgraphia: Selective benefit from visual mnemonics. *Neuropsychological Rehabilitation*, 16, 1–37.
- Spren, O. (1988). Prognosis of learning disability. *Journal of Consulting and Clinical Psychology*, 56, 836–842.
- Stevens, K.B., & Schuster, J.W. (1987). Effects of a constant time delay procedure on the written spelling performance of a learning disabled student. *Learning Disabilities Quarterly*, 10, 9–16.
- Temple, C. (Ed.) (1997). *Spelling disorders*. Hove: Psychology Press.
- Templeton, S., & Morris, D. (1999). Questions teachers ask about spelling. *Reading Research Quarterly*, 34, 102–112.
- Thompson, M. (1995). Evaluating teaching programs for children with specific learning difficulties. *Australian Journal of Remedial Education*, 27, 20–27.
- Treiman, R. (1993). *Beginning to spell*. New York: Oxford University Press.
- Vousden, J.I. (2008). Units of English spelling-to-sound mapping: A rational approach to reading instruction. *Applied Cognitive Psychology*, 22, 247–272.
- Wanzek, J., Vaughn, S., Wexler, J., Swanson, E.A., Edmonds, M., & Kim, A-H. (2006). A synthesis of spelling and reading interventions and their effects on the spelling outcomes of students with LD. *Journal of Learning Disabilities*, 39, 528–543.
- Wechsler, D. (2007). *Wechsler Individual Achievement Test 2nd edition – Australian Standardised version (WIAT-IIA)*. Sydney: Pearson.
- Westwood, P. (2005). *Spelling: Approaches to teaching and assessment*. Camberwell: Australian Council for Educational Research.
- Wilkinson, G. (1993). *The Wide Range Achievement Test (WRAT)*. Wilmington: Wide Range, Inc.

## Appendix A

### Diagnostic Spelling Test — Sounds (see [www.motif.org.au](http://www.motif.org.au))

Participant:

Date:

Examiner:

Comments:

**Instructions:**

1. Write down your first name and your family name on your response sheet.
2. Write down your date of birth (or age if more appropriate)
3. Write down the date. The date today is the \_\_\_\_\_ (say date)
4. Turn the sheet over.
5. I am going to give you a test and I want to see how well you can do. Please try to do your best and write as neatly as you can. If you are not sure what the correct answer is, I still want you to try your best.

Please do not talk or look at anyone else’s work or let anyone else see your work (only say when administering for a group).

Your response sheet is numbered from 1 to 32. I’m going to say 32 sounds and I want you to write down the letter or letters that make this sound. Sometimes more than one answer is correct. Only write down one answer.

I will say a sound. If you didn’t hear the sound, listen very carefully because I will say the sound one more time. Then write down your answer. If you really didn’t hear the sound, put up your hand and wait for me to ask you what the problem is<sup>2</sup>.

No.	Sound	Example word with sound	Correct letters	Response	Correctness
1	b	big	B		
2	æ	ant	A		
3	d	dog	D		
4	g	gift	G		
5	m	mit	M		
6	l	lip	L		
7	p	pot	P		
8	n	not	N		
9	f	fig	F or PH		
10	t	tip	T		
11	s	sit	S		
12	h	hip	H		
13	z	zip	Z		
14	j	yet	Y		
15	v	vet	V		
16		ill	I		
17	r	rug	R		
18		jam	J		
19	k	cat	C or K		
20	ð	then	TH		
21		ship	SH		
22	w	wet	W or WH		
23		elk	E		
24	kw	quit	QU		
25	i:	eel	EA or EE		
26		thin	TH		
27		odd	O		
28	u:	mood	OO		
29		up	U		
30		long	NG		
31	a:	arm	AR		
32	t	chair	CH		
SUM					

## Appendix B

### The 250 most common unpredictable monosyllabic words

The words were derived by considering the unpredictable monosyllabic words of the CELEX database (Baayen, Piepenbrock, & van Rijn, 1993) and then eliminating regular plurals, past tenses and homophones. We then entered these words into a database (The Children's Printed word database; Masterson, Stuart, Dixon, & Lovejoy, 2003) that gives information about the frequency of occurrence based on children's books. Frequency and neighbourhood size counts are based on the children's database.

Word	Written frequency	Orthographic neighbours	Word	Written frequency	Orthographic neighbours
said	16115	7	should	376	0
of	11891	10	warm	373	8
was	11301	6	give	368	5
they	8551	3	wall	349	10
is	6923	11	ball	346	9
his	5190	7	world	343	1
all	4938	2	hall	338	10
are	4665	10	walk	335	3
her	3981	8	show	330	6
have	3746	7	noise	322	1
were	3213	3	grass	306	5
as	3161	13	own	300	2
do	2921	15	wolf	300	2
look	2469	7	ask	300	3
come	2374	9	watch	300	6
put	1904	13	cook	300	9
could	1901	2	full	300	11
house	1880	3	earth	281	0
old	1877	1	mind	281	10
good	1493	5	front	257	1
want	1493	5	bath	257	4
took	1406	8	field	254	0
school	1393	1	call	254	8
who	1328	2	strange	252	0
has	1109	7	love	230	6
find	1036	9	slow	227	7
these	849	3	class	224	3
work	814	8	young	222	0
mouse	782	3	does	222	4
live	746	10	friend	219	0
small	717	3	gold	214	8
head	703	9	glass	211	2
fast	660	9	talk	211	4
told	646	7	path	203	2
last	617	10	built	200	2
book	541	8	glow	200	4
snow	514	4	move	200	8
gone	473	5	done	197	11
once	460	0	aunt	195	1
please	460	0	kind	192	5
most	449	8	tall	181	11
cold	446	8	wash	176	7
use	430	2	hold	176	11
grow	422	7	climb	173	0

Word	Written frequency	Orthographic neighbours
stood	173	2
laugh	170	0
shook	170	3
close	162	1
wild	160	3
ghost	157	0
learn	157	0
hood	151	11
both	149	2
fall	143	11
blow	141	9
foot	135	7
change	124	2
pull	124	7
half	114	3
swan	111	4
sign	103	1
dead	100	7
choose	95	1
cheese	89	1
post	87	7
throw	81	1
word	81	10
heart	78	2
touch	78	3
push	78	7
chief	76	1
shone	76	5
vase	76	6
blood	70	2
rose	70	10
mixed	68	2
breath	65	1
worse	65	2
taste	65	4
hose	62	8
group	59	0
stall	59	3
grown	59	7
smooth	57	0
spread	54	0
bowl	54	4
bush	54	7
soup	51	3
meant	49	1
rough	49	3
tongue	46	0
sold	46	7
hook	43	10
low	43	12
known	41	1
thief	41	1

Word	Written frequency	Orthographic neighbours
comb	41	4
wand	41	8
bull	41	10
false	38	0
whose	38	3
lose	38	7
child	35	1
blind	35	2
chose	35	5
month	32	1
search	32	1
calm	32	3
chef	30	1
health	30	1
raft	30	1
worst	27	1
wasp	27	3
tough	27	4
sword	24	1
worth	24	2
wise	24	7
wool	24	7
death	22	0
shield	22	0
crook	22	1
mask	22	4
view	19	0
prove	19	1
grind	19	2
blown	19	4
worm	19	7
fold	19	11
stroll	16	0
thread	16	0
cause	16	1
squash	16	1
swamp	16	1
calf	16	3
doubt	14	0
ski	14	1
flood	14	2
gasp	14	3
palm	14	3
crow	14	4
rise	14	5
mast	14	13
range	11	0
sponge	11	0
truth	11	0
blast	11	1
brass	11	1
flask	11	1

Word	Written frequency	Orthographic neighbours	Word	Written frequency	Orthographic neighbours
leapt	11	2	shaft	5	1
pure	11	3	staff	5	2
deaf	11	4	shove	5	4
halt	11	4	blouse	3	0
flow	11	5	brief	3	0
hind	11	6	craft	3	0
cure	11	8	scarce	3	0
swap	11	8	glove	3	1
ache	8	0	grasp	3	1
chalk	8	0	grease	3	1
geese	8	0	height	3	1
squad	8	0	shriek	3	1
weird	8	0	wealth	3	1
learnt	8	1	dreamt	3	2
cough	8	3	sweat	3	2
dread	8	3	bald	3	3
tomb	8	4	whom	3	3
bolt	8	5	womb	3	3
pass	8	10	folk	3	4
dwarf	5	0	mild	3	5
lounge	5	0	pint	3	6
priest	5	0	ease	3	7
swarm	5	0	dove	3	9
yacht	5	0	vast	3	9
broad	5	1	warp	3	9
pause	5	1	gear	3	10
pearl	5	1	war	3	10
prayer	5	1	ward	3	12

## Appendix C

### The 133 most common multisyllabic unpredictable words

Multisyllabic words were found by consulting that same child database as for monosyllabic words. We included those words that have at least one unpredictable part (e.g., an unpredictable sound-letter-correspondence or a double letter). Unpredictability was based on a set of sound-letter-correspondences by Perry, Ziegler, & Coltheart (2002).

Word	Written frequency	Orthographic neighbours	Word	Written frequency	Orthographic neighbours
little	3164	1	mother	568	1
children	2291	0	different	533	0
people	1926	0	really	468	0
Mrs	1704	0	rabbit	441	1
water	1525	2	dragon	425	0
over	1479	2	special	419	0
everyone	1133	0	adventure	408	0
other	936	1	always	406	0
narrator	719	0	paper	365	2
another	636	0	money	365	1
because	611	0	beautiful	352	0
before	598	0	behind	338	0



Word	Written frequency	Orthographic neighbours	Word	Written frequency	Orthographic neighbours
enough	325	0	naughty	127	0
village	325	0	squirrel	124	0
balloon	314	0	early	122	0
lion	314	0	hospital	122	0
machine	314	0	music	122	0
princess	308	0	able	116	1
castle	297	1	captain	116	0
elephant	287	0	listen	114	0
monster	284	0	detective	111	1
monkey	276	1	electricity	108	0
police	276	1	chocolate	105	0
picture	273	0	enormous	105	0
nothing	262	0	above	103	0
christmas	252	0	tortoise	103	0
country	249	0	anywhere	100	0
dinosaur	238	0	cupboard	100	0
towards	230	1	either	97	0
surprise	230	0	telephone	97	0
sister	227	1	brilliant	92	0
apple	219	0	mirror	92	0
bottom	195	0	autumn	87	0
honey	189	2	tomorrow	87	0
treasure	189	0	pollution	81	0
trouble	189	0	porridge	81	0
crocodile	187	0	cottage	78	0
television	187	0	desert	76	0
famous	178	0	forward	76	0
palace	176	0	message	76	0
second	176	0	mystery	76	0
mountain	173	1	café	73	8
breakfast	173	0	already	73	0
favourite	165	0	canal	70	0
pirate	165	0	colour	70	0
sergeant	165	0	whistle	68	1
camera	160	0	horrible	65	1
tiger	157	1	million	65	1
almost	157	0	interesting	65	0
basket	154	2	daughter	62	1
believe	154	0	answer	62	0
chicken	154	0	minute	62	0
bottle	151	2	cattle	59	3
brother	151	0	swallow	59	1
building	149	0	library	59	0
animal	146	0	probably	59	0
middle	143	2	biscuit	57	0
kangaroo	138	0	astronaut	54	0
dangerous	135	0	especially	54	0
jungle	133	3	vegetables	54	0
parrot	130	1	actually	51	0
angry	130	0	festival	51	0
anyone	130	0	future	51	0
instead	130	0	whisper	51	0
			zebra	51	0